PHILIPPINE
AGRICULTURAL
REVIEW

12-13
1919-20

The Philippine Agricultural Review

VOL. XII FIRST QUARTER, 1919 No. 1

SPECIAL ARTICLES

A QUARTERLY PUBLICATION

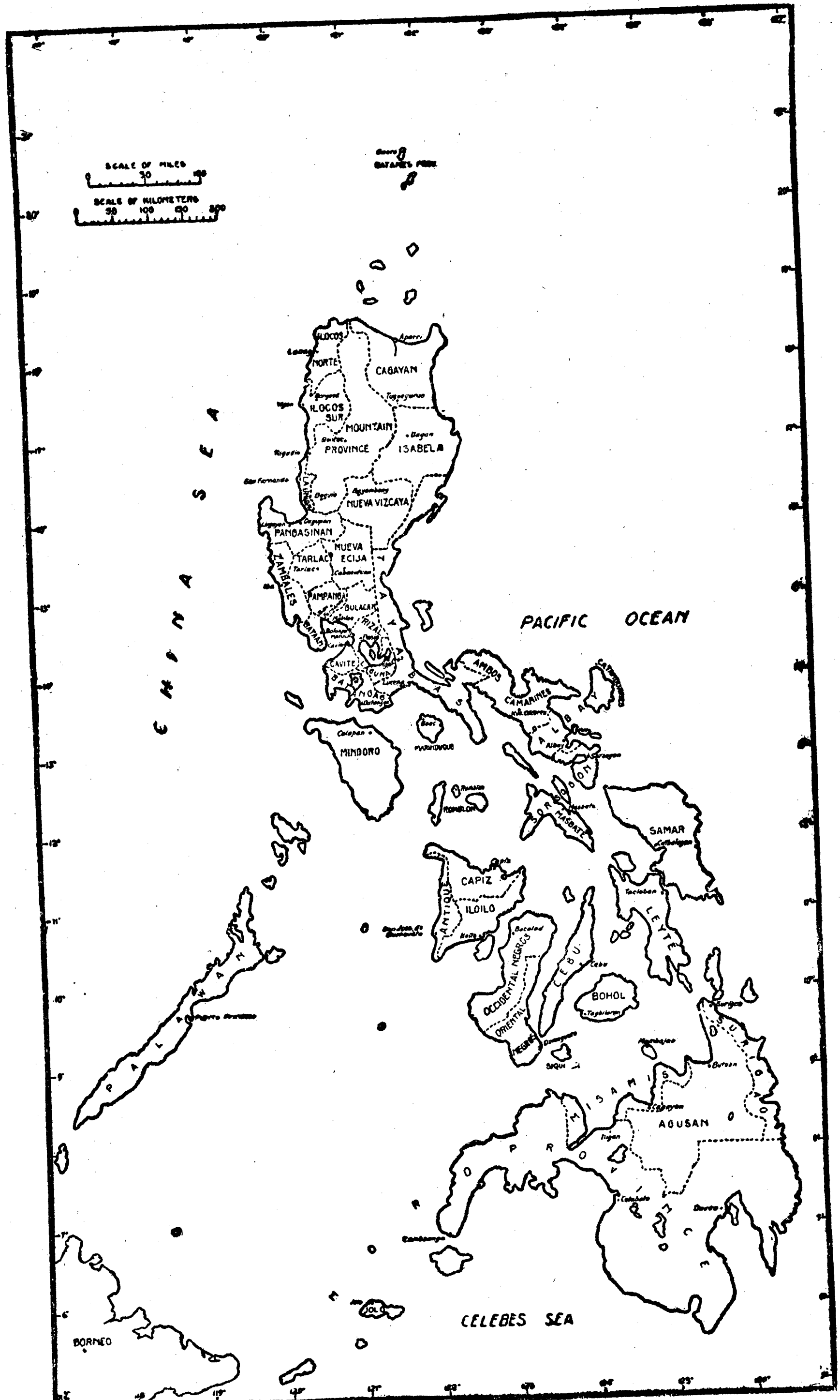
ISSUED IN ENGLISH BY THE
BUREAU OF AGRICULTURE

The Government of the Philippine Islands
Department of Agriculture and Natural Resources

Terms of subscription: ₱2 (Philippine currency) or $1 (U. S. currency) per annum in the Philippine Islands and the United States and territories.
$2 (U. S. currency) per annum in foreign countries.
Subscribers receive free copies of the Philippine Farmer, a monthly farm paper, or its Spanish edition, *El Agricultor Filipino.*

MANILA
BUREAU OF PRINTING
1919

(Entered at the post office at Manila as second-class matter.)



SCALE OF MILES
SCALE OF KILOMETERS
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CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
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PANGASINAN
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[Courtesy of the Department of Agriculture, Java.]

PICKING TEA IN JAVA.

THE PHILIPPINE

Agricultural Review

VOL. XII FIRST QUARTER, 1919 No. 1

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CAN TEA BE PROFITABLY GROWN IN THE PHILIPPINES?[1]

By P. J. WESTER, *Agricultural Advisor, Department of Mindanao and Sulú.*

During my visit to Java in 1914, owing to the limited time at my disposal which was crowded with other, at the time more pressing investigations but little opportunity offered itself to study the tea industry in that country. However, so far as observations were made in general, soil and climatic conditions in several large regions in the Philippines appear so closely approximate those under which tea is grown in Java that in this respect these conditions would appear distinctly favorable for the encouragement of a tea industry in the Philippines. In this connection it is well to remember that long experience has convinced the Dutch administrators in Java that a good quality tea is best produced on large estates, where plucking and drying of the leaves is under close supervision by competent, experienced managers, rather than by many small growers—unless these can be educated to intelligently handle the harvesting and preparation of the tea for the market. However, if the sugar, copra and coffee central proves to be a practicable institution in the Philippines why may not the tea central do so? In this connection the following information gleaned from various publications may be of interest.

While the annual tea imports of the Philippines are only approximately one-fourth of those of coffee, or roughly ₱200,000, yet this amount is sufficiently large to be worth considering means of its retention in this country. And, let us not forget that the annual tea importations of the United States total over 41 million pesos, of which even a part would not come amiss were it to find its way to the Philippines.

Here, it may not be inopportune to call attention to the fact that the British Government, notwithstanding the commanding

[1] Modified extracts from a report made in June, 1918, to the Hon. F. W. Carpenter, Governor, Department of Mindanao and Sulú, Philippines.

position of British India and Ceylon in tea production considering further expansion of the tea industry, for some time has been investigating the possibilities of New Guinea for tea with a view of the opening up tea estates in that country.

Mitchell, in Bulletin No. 234, Bureau of Plant Industry, U. S. Department of Agriculture, referring to the tea growing in Pinehurst, South Carolina, United States, says:

> With a yield of 280 kilos per hectare, the cultivation of tea at Pinehurst becomes remunerative although burdened in some instances by an expenditure of ₱29.64 per hectare for commercial fertilizer; at 500 kilos to the hectare it cannot fail to be quite profitable.

No tea gardens in Pinehurst exceed an area of 3.5 hectares. The picking, which begins in May and is concluded in October, is attended every 7 to 15 days, the work being done by colored children, who average 18 kilos of green tea per day, some picking 35 kilos per day. A production of 1,000 kilos of tea per hectare has been attained in Pinehurst during exceptional years.

Tea was first introduced from China into Java in 1826, but this variety was not adapted to the country and an inferior product was obtained. The present tea industry dates back to the introduction, in 1878, of tea from Assam, which has proven an unqualified success from the start. At first a tea of rather indifferent quality, as the culture and manufacture became better understood the quality also improved until now Javanese tea is nearly equal to the best Ceylon tea.

In the meantime the Javanese tea export has grown during the 10 year period ending in 1914, from 11,592,000 kilos in 1905 to 32,420,000 kilos in 1914.

Mr. G. D. Hope, Scientific Officer of the Indian Tea Association, Indian Museum, Calcutta, India, who a few years ago visited Java to study tea growing there for the benefit of the tea growers in India, stated in his report after his return from Java, relative to the tea estates in that country:

> To the foresight of the Dutch planters in Java in terracing and protecting their ground from wash, and not to any lack of appreciation of the value of manures, is due the fact that at the present time comparatively little manuring is being done in Java. Not only are the tea soils of Java as a rule magnificent, but in Java planters take the greatest pains to prevent loss of surface soil by wash, and terrace all steeply sloping land after cleaning it and before or very shortly after planting out seedlings or stumps. The soil of the edges and banks of the terraces are kept up and bound by leguminous or other plants suited to the purpose

by the nature of their root formation and general habit of growth. Less steep slopes are dealt with by the means of contour ridges and catch trenches in combination with a system of hedges of suitable plants grown along the contours.

The following table, showing the elevation, number of rainy days, and the monthly and annual average precipitation at some of the tea districts in Java, is necessarily of great interest.

TABLE I.—*Rainfall in tea districts in Java.*

Months.	Localities.			
	Djasinga.	Tjisampara.	Soekaboemi.	Perbawati.
	Rainfall.	Rainfall.	Rainfall.	Rainfall.
	mm.	*mm.*	*mm.*	*mm.*
January	312.5	302.5	617.5	445.0
February	298.5	245.0	290.0	332.5
March	292.5	387.5	377.5	520.0
April	365.0	322.5	402.5	535.0
May	250.0	167.5	260.0	352.5
June	185.0	140.0	162.5	247.5
July	182.5	100.0	97.5	152.5
August	187.5	52.5	98.0	135.0
September	195.0	70.0	100.0	200.0
October	257.5	257.5	227.5	325.0
November	307.5	305.0	345.0	525.0
December	295.0	309.0	410.0	550.0
Total	3,127.5	2,640.0	3,375.0	4,290.0
Elevation, meters	525	515	590	1,150
Rainy days, number	177	171	191	239

The following table shows the mean monthly and annual rainfall in some of the famous tea districts in India and Assam:

TABLE II.—*Precipitation in the Indian and Assamese tea districts.*

Month.	Localities.						
	Chittagong.	Silchar.	Sibsagar.	Tezpur.	Darjeeling.	Jalpaiguri.	Dehra Dun.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	10.0	15.0	27.5	15.0	17.5	22.5	55.0
February	42.5	57.5	52.5	22.5	27.5	10.0	50.0
March	52.5	197.5	117.5	60.0	50.0	37.5	27.5
April	110.0	337.5	245.0	150.0	100.0	90.0	15.0
May	252.5	392.5	292.5	240.0	195.0	295.0	35.0
June	570.0	510.0	352.5	317.5	605.5	647.5	227.5
July	571.0	500.0	397.5	357.5	892.5	737.5	650.0
August	500.0	467.5	407.5	320.0	650.0	620.0	657.5
September	345.0	347.5	292.5	222.5	457.5	565.0	222.5
October	160.0	160.0	130.0	82.5	132.5	120.0	20.0
November	35.0	32.5	27.5	17.5	5.0	2.5	5.0
December	12.5	12.5	15.0	12.5	5.0	17.5	17.5
Total	2,625.0	3,035.0	2,357.5	1,825.0	3,045.0	3,142.5	1,992.0

The following table, adapted from "Ceylon Tea Soils," by M. K. Bamber, indicates the elevation, rainfall and yield of dried tea per hectare on several of the prominent tea estates in Ceylon.

TABLE III.—*Statistics relative to tea estates in Ceylon.*

Estates.	Elevation.	Annual rainfall.	Annual yield per hectare.
	Meters.	*mm.*	*Kios.*
Springwood	750	3,250	510
St. Leonards	90	2,500	450
Doonvale	120	2,500	400
Bandarapola	480	2,250	680
Attabagie	900	3,125	360
Pantiva	120	3,500	570
N. Pundaloa	1,200	3,500	400
Galaha	900	3,125	800
Weova	300	3,750	680
Kandapolla	1,920	4,850	625
Carolina	1,050	4,500	680
Glen Alpin	1,200	1,875	625
St. Leonards	1,350	2,500	680
Darrawella	1,200	3,000	400

In Assam, Dooars and Darjeeling the yield per hectare is 500, 545 and 275 kilos respectively. According to Hope, in Java the yield varies from 450 to 1,620 kilos per hectare according to the soil and climate, and who states that there can be no doubt as to the superiority of the tea soils of Java as compared with those of North East India.

Speaking of tea growing in Sumatra Hope says: "Assuming that in the first three years Fl. 720 per acre were spent, including everything, in the fourth year, 1,200 pounds of dry tea may be expected; the cost per pound would be:

Upkeep after the 3rd year, costs of manufacture and transport to Belawan	cents	20
Depreciation of buildings	do	4
Freight, Belawan-London	do	6
Total	do	30

This tea should sell for at least 40 cents per pound, giving a net profit of 10 cents per pound, say Fl. 120 per acre, or 15 per cent on the capital of Fl. 720. A 2,000 acre estate would therefore require a capital of Fl. 1,500,000, and should make a profit of Fl. 240,000 in the fourth year." (1 acre is 0.4 hectare, Fl. 1 is equivalent to ₱0.80, 1 pound is 0.45 kilo.)

To sum up, while a careful study of the literature relative to soil and climate has served to confirm my previous opinion that tea will flourish in the Philippines, it would appear that Japanese and Chinese varieties are unlikely to be of much value. On the other hand the Assam tea, grown in British India, Ceylon and Java, will probably succeed well.

Owing to a more equal distribution of the rainfall in the Dutch East Indies as compared with India and Ceylon the growth of the tea continues without interruption, resulting in larger crops than in those countries. This observation relative to the climate of the Dutch East Indies is equally true of a large area of Mindanao where elevation and soil are adapted to tea.

Granted, then, that the Islands are adapted to the tea plant it would appear that when the probable yield, and the cost of labor in the Philippines and other tea producing countries are considered, after the customary mistakes incident to the establishment of a new industry have been corrected tea could be produced at a profit in the Philippine Archipelago.

OBSERVATIONS ON AGRICULTURE IN HAWAII.[1]

By P. J. WESTER, *Agricultural Advisor, Department of Mindanao and Sulu.*

GENERAL STATEMENT.

The Hawaiian Islands, including Hawaii, Oahu, Maui, Kauai, Molokai, and a number of small islands of minor importance, contain an area of 6,406 square miles, in other words, Hawaii equals Negros and Cebu in area. The Archipelago has a population of 250,000 inhabitants of which 57,000 are Caucasians, 102,000 Japanese, 22,000 Chinese and 19,000 Filipinos. There are also 23,000 Hawaiians which are annually decreasing in number.

The imports for the fiscal year ending 1917 amounted to ₱92,761,000, and the exports totaled a trifle more than ₱150,000,000, with the exception of somewhat less than ₱1,400,000, all to the United States.

These exports included:

Sugar and molasses	[2] $63,133,274
Fruits and nuts (mostly pineapples)	8,355,395
Coffee	391,568
Hides	295,965
Rice	165,779
Honey	62,462
Miscellaneous	2,978,364

Owing to the latitude the average temperature is considerably lower in Hawaii than in the Philippines, and the highest mountains are covered with snow during a part of the year. The

[1] Extracts from a Report made June, 1918, to the Hon. F. W. Carpenter, Governor of the Department of Mindanao and Sulu, Philippines, after a visit to Hawaii.

I wish to express my appreciation for the many courtesies and assistance extended and information furnished to me by planters and others during my stay in Hawaii, especially to Mr. E. J. Higgins, horticulturist of the Hawaii Agricultural Experiment Station, Honolulu; Mr. L. McFarlane, manager of the Captain Cook Coffee Company, Kealakekua, Hawaii; and to Messrs. A. L. and H. Louisson, owners of the Louisson Brothers Coffee Plantation, Paauilo, Hawaii, whose hospitality I enjoyed during my stay in Paauilo.

[2] $1 U. S. currency is equal to ₱2 Philippine currency.

rainfall varies greatly in different localities, from being extremely limited in some districts to very abundant in others. Tables showing the rainfall in the coffee, pineapple, and the wet sugar districts will be found throughout the report. Honolulu has an annual rainfall of 755 millimeters, in the Philippines nearest comparable to Zamboanga with a precipitation of 926 millimeters.

Sugar is by far the predominant industry of the Hawaiian Islands, though cattle and pineapples are also of considerable importance. Fresh milk and cream of good quality are obtainable at all times. The large exports of more than ₱150,000,000 from these small islands are well worthy of notice to the student of Philippine economic development. Those of coffee, rice, and honey no less than the major items of sugar and fruits, since those products might well be produced in the Philippines for export, and on a greatly increased scale as compared with Hawaii.

Spread out from sea level at the port and rising on the slope of Mount Tantalus Honolulu is exceedingly attractively located. No seaport of importance in the Philippines has equal advantages in this respect. Then, the natural beauty of the site of Honolulu has been greatly enhanced by the judicious planning of the residential sections, in the creation of numerous parks and squares planted with a wealth of ornamental shrubs, trees, and palms. The residential section of the city gives the impression of airy, cool spaciousness that is quite absent from the large cities in the Philippines, where the ambition frequently would seem to have been to crowd as many houses as possible within a given area. Crowded quarters in a tropical climate are conducive neither to health nor comfort and it would appear that in the further extension of the cities and towns in the Philippines we might very profitably emulate other cities in the tropics such as Honolulu. Again, the apparently in an irresponsible fashion whimsically winding roads and avenues at first somewhat confusing to the strange visitor, open ever varying vistas at every turn which add greatly to the charm of Honolulu. (Plates I and II*a*.)

The Hibiscus is one of the features of Honolulu, no other ornamental being so universally planted. Most Hibiscus varieties found in other countries have been introduced into Hawaii and hybridized with the native species until there are said to be 2,000 varieties cultivated in Honolulu, many of which are exceedingly attractive.

Much has been said about the *Lantana* as a troublesome weed in Hawaii and so doubtless it has been in the cattle regions, but to me the guava appeared to be the more serious pest of the two.

Hawaii has four well manned and well equipped institutions devoted to agricultural educational, research and demonstration work. The College of Hawaii, which is chiefly an educational institution. The Board of Agriculture and Forestry, which handles the forestry problem, including reforestation and the annual propagation of large numbers of forest trees for sale to planters at a nomial figure, and maintains the veterinary and entomological service including plant inspection at the port of Honolulu. The Hawaii Agricultural Experiment Station, the activities of which are devoted chiefly to horticulture and the minor agricultural industries. The Sugar Planters Experiment Station, which is engaged in work relative to sugar cane. These institutions are working in close coöperation in order to avoid duplication of work, and are rendering effective service.

SUGAR CANE.

Sugar cane being one of the major crops of the Philippines the following data from Hawaii may be of interest, especially as it is generally conceded that the sugar industry of Hawaii has attained a higher degree of perfection in its development than that of any other country, and notwithstanding, or perhaps therefore, that the conditions for cane growing in at least many parts of the Islands are by no means ideal. Certain coffee growers in Hawaii in arguing for a protective tariff on coffee, point out what the protective duty on sugar has accomplished for the sugar industry in Hawaii, and state that the removal of the tariff would spell ruination to the sugar planters. Be that as it may, with successive ups and downs the export of sugar has risen from a value of 27 million dollars in 1901 to exceeding 63 million dollars in 1917.

The value of the sugar exports from Hawaii for the last 10 years are as follows:

TABLE I.—*Hawaiian sugar exports.*

1908	₱39,816,082
1909	37,632,821
1910	42,625,069
1911	36,794,364
1912	50,038,750
1913	36,748,430
1914	33,337,517
1915	53,148,594
1916	54,745,584
1917	63,133,274

PLATE I.

(*a*) Royal Palms in Honolulu, Hawaii.

(*b*) Corner in a Public Park, Honolulu, Hawaii.

As is well-known irrigation of sugar cane is extensively practiced in Hawaii but cane is also grown where the rainfall is very heavy, for instance, in Hilo and adjacent districts. The rainfall tables below taken at various point in the wet cane growing localities will therefore be of interest for comparison with the rainfall tables for the humid regions in Mindanao where the culture of sugar cane might be considered. The rainfall at Olaa is of especial interest as having a bearing on the success that has attended the experiments made with paper mulch.

TABLE II.—*Mean monthly and annual rainfall in the wet sugar districts, Hawaii.*

Months.	Localities.		
	Olaa.	Papaikou.	Hilo.
	mm.	*mm.*	*mm.*
January	261.7	318.2	245.0
February	229.5	262.5	291.7
March	364.3	462.1	373.3
April	361.7	427.4	333.2
May	253.3	362.2	248.5
June	229.5	276.3	200.0
July	281.2	379.0	263.5
August	331.5	435.5	306.5
September	299.5	370.7	274.0
October	275.3	344.0	279.3
November	302.0	568.5	362.7
December	403.5	410.5	385.0
Total	3,592.0	4,556.2	3,562.8

According to the statement of Dr. C. F. Eckhart, manager of the Olaa Sugar Company, and formerly Director of the Hawaiian Sugar Planters Experiment Station, Honolulu, in the course of the experiments with paper mulch which was started three years ago by the Olaa Sugar Company, Olaa, it has been demonstrated that a saving of 50 per cent of the labor required in the cultivation of the cane as grown under conditions at Olaa has been effected by the use of a suitable paper mulch, and that incidentally it increases the production of cane with 25 tons per hectare.

This new method of sugar cane "culture" has been looked upon with more or less skepticism in some quarters, but the results at Olaa seems to have been so conclusive to the satisfaction of the directors that the sugar company in question last year appropriated ₱370,000 for the construction of a paper mill at Olaa, which is expected to be in operation next year. Bagasse will be used for the manufacture of the paper which is a thin felt saturated in asphalt. The projected paper mill will have a capacity of approximately 16 tons of paper per day.

In the experiments various widths of paper have been used, from 40 to 80 centimeters, but where cane is planted 1.5 meters apart a paper 60 centimeters broad seems to be the most desirable width.

The procedure in applying and using the paper mulch is as follows: After the cutting of the cane, before the sprouting of the ratoons or, in the case of a new field, after the planting of the cane points, the trash and weeds are hoed and raked into the middles. The fertilizer is then applied and the roll of paper unrolled and laid so that the cane row is in the center, and entirely covered by the paper. Then, the rubbish, and if necessary soil, is raked back over the edges of the paper so as to weight it down and prevent its blowing about by the wind. As the cane starts growing the spears penetrate the paper, while the weeds are unable to do so and eventually are choked to death.

The greater luxuriance of the cane in plots mulched with paper as compared with check rows of cane under ordinary culture was very marked in the cane fields examined.

One of the striking features of the landscape in the wet sugar cane districts in Hawaii are the wooden flumes, in which the harvested cane is floated to the sugar mills instead of being transported by ordinary means. For the successful operation of this method of transporting sugar cane the mill should, of course, be located at the lowest point of the plantation, there should be more or less slope to the land and water should be abundant.

PINEAPPLES.

Next to sugar, canned pineapples is the most important export product of Hawaii. A few pineapples had been canned previous to that time, but the present development of the industry dates back to 1901, when the season's pack was 1,893 cases. Since then the growth of the industry has been both rapid and sure, but now appears to have come to a standstill. The expansion of the pineapple industry is best illustrated in the following figures of the pack for the past fifteen years:

TABLE III.—*Exports of canned pineapples from Hawaii.*

Year.	Cases.	Year.	Cases.
1903	6,000	1911	726,000
1904	20,000	1912	1,313,000
1905	45,000	1913	1,667,000
1906	74,000	1914	2,269,000
1907	178,000	1915	2,670,000
1908	391,000	1916	2,609,000
1909	462,000	1917	[a]2,600,000
1910	545,000		

[a] Estimated.

A few years ago the production of pineapples was divided among many small growers, but few of these weathered the disastrous prices received for the fruit in 1915, and the reorganization of the industry saw practically all fields pass into the hands of a few large corporations.

The cost of production of pineapples is said to be ₱20 to ₱22 per ton, the present price paid by the canneries being ₱46 per ton.

More than 80 per cent of the pineapples are grown on the Island of Uahu, smaller areas being planted on Maui and Kauai. The largest pineapple district is located at Wahiawa, a short distance from the Schoofield Barracks, at an elevation ranging between 250 to 325 meters. (Plate II–*b*.)

The rainfall in various pineapple districts is given in the following table:

TABLE IV.—*Rainfall in prominent pineapple regions in Hawaii.*

Month.	Haiku.	Schoofield barracks.	Wahiawa.	
	Average rainfall.	Average rainfall.	Rainfall 1916.	Rainfall 1916.
	mm.	*mm.*	*mm.*	*mm.*
January	158.7	138.7	519.0	298.0
February	139.3	92.0	115.2	72.0
March	210.7	110.2	137.9	314.5
April	179.0	61.0	100.8	42.0
May	131.0	76.2	109.7	136.3
June	107.0	55.0	136.0	37.0
July	125.2	31.5	68.5	58.7
August	140.0	40.3	71.0	29.2
September	114.8	89.1	40.8	138.7
October	132.7	57.0	116.5	70.8
November	184.5	61.7	132.3	95.0
December	191.5	172.0	310.5	212.0
Total	1,814.5	987.7	1,858.2	1,504.2

The features of the general landscape in Wahiawa, the native vegetation and the soil itself, all remind one strongly of the grassy plains of Bukidnon, Mindanao, especially the country beyond Maluko on the road to Malaybalay. A more or less undulating country, here and there deep gulches and ravines providing perfect drainage, the land covered with native grasses interspersed with guava shrubs. The soil is a reddish, grayish or black, friable, light volcanic ash with a fair humus content.

The land is leased by the growers at the rate of ₱39 per hectare. The labor employed is mostly Japanese though Filipinos and Chinese are also employed. The current wages range from ₱2.40 to ₱5 per day.

While to some extent drainage has been provided to carry off the surface water during heavy rains, but little thought appears to have been paid to the need of soil conservation and the prevention of loss of soil from erosion. No terracing is practiced, and the pineapple rows frequently run up and down even quite steep hill slopes. Also it is said that greater or lesser areas of pineapples are washed out now and then during heavy rains. It would appear that if the fields are to retain their fertility for any considerable number of years, more attention to the conservation of the soil by a carefully arranged system of terracing would be necessary.

The breaking of the land and its preparation is done by steam plows and tractors, by the use of which the cost of production has been brought to a minimum.

On virgin land, where this is of the best quality no fertilizer is applied at the time of the first planting. Usually three, rarely five crops are harvested from one planting after which the old plants are uprooted. Then, the land is again plowed and prepared for another planting. By then the soil has become so exhausted that fertilizer is generally applied at the time of setting out the plants. In Wahiawa as much as 22.25 tons of stable manure is applied to the hectare. Deep furrows are plowed up along where the rows of plants are to be set, the manure is scattered in the furrows, after which the soil is thrown back so that a slight ridge is formed upon which the plants are set out. Between 12 to 13,000 plants are set out to the hectare the plants being set out one or two rows on each ridge with middles about 1.25 meters wide which are kept under clean culture. Large gangs of men with hand-hoes are constantly and systematically going through the fields removing weeds between the plants that cannot be reached by the cultivator.

After the crop has been harvested and the slips and suckers that are required for the planting of new fields are removed, soil is drawn up between the plants from the middles to assist in the rooting of the new tops forming from the suckers.

Remembering the calamities that have overtaken other great plant industries by the appearance of destructive pests, of which the coffee blight is such a pertinent example, the Hawaiian Pineapple Packers Association have started the rearing of a large number of pineapple hybrids and seedlings. This work is under the general supervision of Mr. H. L. Lyon, pathologist of the Hawaiian Sugar Planters Experiment Station in Honolulu. Between 2 to 3,000 of these seedlings in all stages of development, and of remarkable variability, were seen on the plantation of the Hawaii Preserving Company in Wahiawa.

(*a*) Avenue of Date Palms, Honolulu, Hawaii.

(*b*) A field of Cayenne Pineapple, Hawaii.

This apparently very well managed plantation includes 2,830 hectares of which about 2,000 hectares are in cultivation. The company operates two canneries, one at the plantation in Wahiawa and one in Honolulu, of which the latter turned out 200,000 cases of canned pineapples during the past season.

The injurious effects of manganese to pineapples on certain lands in Hawaii threatened to become a very serious problem to the growers in some districts, but this difficulty has been solved by Mr. M. O. Johnson, chemist of the Agricultural Experiment Station, who found that the effect of the manganese could be neutralized by the spraying of an iron sulphate solution on the plants.

As it happened, a large area of the plantation of the Hawaii Preserving Company which I visited had been affected by the presence of manganese and, as I had the opportunity to note, the recovery of the plants after spraying is remarkable. A sprayer in operation at the time of the visit was examined. It is simple in construction, home made, and performs the work cheaply and economically.

It would appear that a similar somewhat modified machine, could be employed to great advantage in spraying the weeds and encroaching vegetation with weed killers along the roads and trails in many parts of the Philippines, by which it is believed that the cost of maintenance of the roads could be greatly reduced.

Formerly there was much waste of fruit in the canning of the pineapples, the market being unable to absorb more than a limited quantity of crushed pineapple and juice, but processes have recently been developed by the means of which both sugar and citrate is recovered from the waste, the sugar being employed to supplement cane sugar in the canning process. Altogether, the phenomenally rapid rise of the pineapple industry of Hawaii and its present organization is a notable achievement, and it is a prophesy of what with the proper organization and financial backing might be accomplished in the Philippines in this and other tropical plant industries, where, it appears to me, the natural resources and opportunity for development are infinitely greater than those of Hawaii.

COFFEE.

The status of coffee growing and manufacture in Hawaii was of unusual interest from the Philippine point of view, because the coffee is produced on small areas by the individual growers and the coffee brought in the berry or in the parchment to a few large mills, where it is bought and prepared for the market. A situation that is likely to obtain in many parts in the Philippines.

After supplying the internal demand (practically no roasted coffee is imported into Hawaii) the Hawaiian Archipelago exported in 1917 1,165 metric tons of raw coffee valued at ₱783,136, or about ₱66.50 per 100 kilos. According to Mr. A. L. Louisson of the Louisson Brothers Coffee Plantation, Paauilo, the total production in 1914 was approximately 2,718,000 kilos, valued at ₱1,600,000; it was stated that in 1912 and 1913 the production was even greater than in 1914.

Coffee, *Coffea arabica,* was introduced into Hawaii long ago. In Hilo, on Hawaii, the only island in the Archipelago where coffee is grown on a commercial scale, trees still in good condition, were indicated to me as being eighty years old. Apparently before the climatic requirements of coffee were well understood, considerable areas were said to have been planted south of Hilo in a district where excessive rains during the flowering period of the coffee caused the bloom to drop without setting fruit, with the consequence that the coffee culture there was abandoned for other districts more favorable to this crop, though in Olaa coffee is also said to have been uprooted in favor of sugar cane. At present the commercial culture of coffee is confined to the so-called Kona coffee district on the west coast, and in the Hamakua district on the northeast coast, both on the Island of Hawaii.

Most of the coffee in Kona was originally planted by white residents, but the handling of the coffee in the field has gradually drifted into the hands of the Japanese, usually as renters. Owing partly to the scarcity of labor and the rise in wages on the sugar plantations, partly to the drop in the price of coffee in the market, the production has declined within the last few years, one coffee garden after another being abandoned as the renters are able to earn more as laborers in the cane fields than as coffee growers.

Most of the coffee is produced in Kona, where about 2,200 hectares are planted to coffee at an elevation said to range between 300 to 800 meters on a mountain side of rather steep slope facing the west. The mean monthly and annual rainfall is given in the following table. The precipitation is quite evenly distributed, the driest period occurring from November to April. The rainy days number 192.

[Courtesy of Louisson Bros.]

Arabian Coffee in Louisson Bros. Coffee Plantation, Paauilo, Hawaii.
The coffee is topped about 2.25 meters from the ground, and is interplanted with Silk Oak, *Grevillea robusta* for shade.

TABLE V.—*Rainfall in Kealakekua, the Kona coffee district.*

Months.	Rainfall.
	mm.
January	84.0
February	87.2
March	94.5
April	112.0
May	161.0
June	161.7
July	156.5
August	174.0
September	188.5
October	147.7
November	86.0
December	100.5
Total	1,373.7

The soil is of volcanic origin, black, grayish to brownish, fertile and friable but scant; loose stones and frequently bed rock cropping out on the surface everywhere. Terracing is never practised, though here and there the loose stones are piled up to prevent erosion. No shade trees are planted, notwithstanding which the coffee was in remarkably good condition. On inquiry it was stated that the sky was commonly overcast which probably explains the success of the unshaded coffee. While topping is practiced most coffee in this district is untopped, Mr. McFarlane stating that topping had in many instances resulted in the dying back of the trees which had prevented the general adoption of this practice.

What is generally known as "Hawaiian coffee," the original importation of coffee into the Archipelago, is the variety most commonly grown in Kona, some coffee gardens forty years old still being in good condition. A smaller area is planted to "Guatemala," a variety of more recent introduction, and of very distinct, sturdy habit, distinguished by its shorter bean. The Guatemala is said to be more productive than the Hawaiian, both varieties being equal in quality.

Sometimes it is applied even earlier, but as a general rule coffee is planted and grown for three to four years without fertilizer. After that period artificial fertilizer is applied at the rate of about 280 kilos per hectare twice annually, (560 kilos per year) at a total cost of ₱120.

The average yield of clean coffee is claimed to be the surprisingly high yield of 1,220 kilos per hectare not infrequently rising to 2,250 kilos. Five kilos of coffee cherries are required to make 1 kilo of clean, marketable coffee. If pickers are hired the cost of picking the coffee is about ₱3.75 per 100 kilos of cherries, sometimes rising to ₱4.40. If, then, the gross yield was 6,100 kilos cherries and pickers were hired, the average net return to the grower would be a trifle more than ₱100 per hectare. The annual balance sheet of the grower for a hectare of coffee would then appear as follows:

Six thousand one hundred kilos of cherries		₱483.12
Rent	₱25.00	
Fertilizer	120.00	
Harvesting	228.75	373.75
Net return, total		109.37

The rent might be twice the amount quoted in this account, then again, the harvesting is usually done by the wife and children of the tenant, which in this instance would treble the net income per hectare. Some of the more well-to-do Japanese pulp, ferment, wash and dry their crop and deliver the product in parchment to the mill and thus add still more to the net return for their labor. However, this procedure is by the mill owners and whole sale dealers considered less desirable than the delivery of the coffee in the cherry to the mill for the reason that the processing of small lots of coffee by the individual owners does not produce the uniform grade of coffee that is obtained when the coffee is delivered in the cherry to the mill where it can be treated in large lots, and where better supervision is exercised in its manufacture than when the coffee is handled by the growers. Consequently such coffee is at a disadvantage in competition with the best grades of coffee in the market.

For comparison with the figures noted from Hawaii the following data relative to coffee growing in Porto Rico may be of interest.

According to Van Leenhoff, formerly coffee expert of the Porto Rico Agricultural Experiment Station, Mayaguez, Porto Rico, the expenses of bringing one hectare of Arabian coffee into bearing in Porto Rico are as follows:

First year.

Clearing	₱54.34
Staking	10.88
Holing	87.73
Propagation in nursery	24.70
Planting	43.86
Shade trees	7.41
2 hoeings	43.86
4 weedings	26.28
Total	299.06

[Courtesy of Louisson Bros.]

View in Louisson Bros. coffee plantation, Paauilo, Hawaii.

Second year.

Total expenses		₱76.77

Third year.

Total expenses		69.70
Yield third year	coffee, kilos	90

The cost of picking, preparation and transportation to port is about ₱11 per 100 kilos of clean coffee, or approximately the same as in Java.

The average yield of coffee in Porto Rico is 355 kilos per hectare per annum.

In this connection it is interesting to recall that on a coffee estate in Java with wages 16 to 24 centavos per day, the cost of harvesting the berries, preparation of coffee and transportation to nearest port was ₱10.14 per 100 kilos; on another estate, where wages were 24 to 28 centavos per day the expenditure for these items was ₱11.34.[1]

To return to Hawaii. Of the 2,200 hectares planted to coffee in Kona about 800 hectares are controlled by the Captain Cook Coffee Company, with mill and warehouse in Napoopoo, and office in Kealakekua. In 1912 the output of this company was 1,035 metric tons of marketable coffee, somewhat less than one-half of the total production of the Kona coffee district. Since that year, 1912, with gradually declining coffee production, last year the mill handled only 540 tons of berries and about 225 tons of parchment coffee.

The mill of this company processes coffee from the berry as well as in parchment, receiving coffee from within a radius of about 8 kilometers.

The Captain Cook Company has leased the coffee plantations of the original planters and is sub-leasing them to Japanese in small lots, from 2 to 4 hectares to each renter at an annual rental of ₱25 to ₱50 per hectare. In individual instances, though not to this company, an annual rent of ₱150 has been paid per hectare. The company aforesaid advances fertilizers and money on the prospective crop, the lessee obligating himself to deliver his entire crop of coffee to the mill at a stipulated price, varying with the market price of coffee. This price has fluctuated between ₱6.38 to ₱9.45 per 100 kilos of berries, the present contract price being ₱7.92, in addition to which the purchaser pays an average of 35 centavos per 100 kilos of berries for delivery from the field to the mill. The current price of parchment coffee, dried, ready for hulling, is now ₱35.20 per 100 kilos.

[1] See this Review, Vol. IX, pp. 129–130, 1916.

At present the total cost of manufacture of coffee from the berry including bags and transportation of the finished product to the wharf at Napoopoo, amounts to ₱5.95 per 100 kilos. In other words, together with the purchase price of the cherry coffee, ₱39.60, and the transportation to the mill, ₱1.75, the prepared coffee of all grades is laid down at the port ready for shipment to the market at a cost of ₱47.30 per 100 kilos with current wages ranging from ₱1.50 to ₱3.50 per day.

The coffee mill of the Captain Cook Coffee Company, is more compact than similar establishments that came under my observation in Java and is employing more labor saving devices. Here, as in all the Hawaiian coffee mills, the chief difficulty appeared to be scarcity of water, and the money expended in providing for a sufficient water supply forms a very considerable item of the total investment, including a three-mile pipeline from a watershed on the mountain side to the mill and a great number of large water tanks. Even so the water must be carefully husbanded in the manufacture of coffee; so much so that the same water is used twice in the washing process. While in Java water is used to carry away the pulped coffee and the refuse, here traveling chain conveyors are so employed, and also to convey the berries to the pulpers and the fermented and washed coffee from the washer to the drying floors.

Owing to carelessness by the renters in picking immature fruit together with the ripe berries and getting stones and pebbles in the product delivered to the mill, it has been found necessary to use one crusher and two pulpers in succession through which each lot of coffee has to pass. Nevertheless, the pulping was so incomplete that it became necessary to install an additional small pulper to which is carried the berries that pass whole through the other pulpers. For the same reason cylindrical pulpers have been found more desirable than the "Gordon" disk pulper so popular in the Dutch East Indies. In order to remove twigs, leaves and large stones, at the Louisson Brothers coffee mill in Paauilo, before entering the pulper, the coffee from the field first passes through a revolving drum about 1.5 meter long and 1.2 meter in diameter, made of large-meshed screen with a worm of galvanized iron, the flange being 25 cm. wide and fitted to the mesh on the inside to carry out the leaves and trash, the mesh being just large enough to allow the berries to fall through as the drum revolves.

The pulping is done in the afternoon, and the pulped coffee falls into wooden vats directly below the pulpers where it remains over night to ferment and is washed the next afternoon. The time allowed for fermentation is here consequently much shorter than is customary in Java, and naturally results in greater economy of equipment since a smaller number of fermentation vats are necessary.

The fermentation vats are provided with a vent in the bottom through which the coffee is flushed to a revolving washer. On the exit from the washer the mass falls on a perforated shaker through which is carried away most of the slime and refuse with the water, the coffee dropping into the lower end of a trough about 3.5 meters long, tilted upward at an angle of about 30 degrees, containing a worm carrier about 30 centimeters in diameter. As the coffee is being carried upwards in the trough by the screw it is met by a stream of clean water which rinses the coffee and overflows at the top of the lower end of the trough carrying with it all "floaters," or light, imperfect beans, which are thus separated and later made into a cheap grade of coffee. After passing through the rinsing trough the coffee falls on another shaker for the removal of the few remaining impurities and water, and from where it goes to a chain conveyer which carries the coffee to the drying floor.

This is made of cement, the newest section being provided with movable flat covers of corrugated iron in sections about 8 by 25 meters square which, when rain threatens, are pulled over the drying floor on rails overhead by the means of cables wound on a drum. Both rails and the drying floor are constructed slightly inclined to one side, so that when it is desired to again uncover the coffee the cover rolls away by gravity merely by releasing a catch attached to the drum on which the cable is wound. Part of the drying floor is covered by canvas thrown over a ridgepole during rainy weather. After a preliminary drying for three or four days on the floor, the drying of the coffee is completed in a "Guardiola" hot air drier, or in a drier similar in construction to the grain driers used in United States, after which the coffee is hulled, graded and sacked ready for shipment.

In the Hamakua district on the northeast coast of Hawaii at an elevation said to range from about 475 to 700 meters, about

250 hectares are devoted to coffee, of which 160 are operated by the Louisson Brothers in Paauilo, who have a plant for the preparation of parchment coffee. (Pl. III, IV, V, and VI.)

The land in the Hamakua district is rolling and the soil deep, fertile and friable, apparently a fine, volcanic ash quite similar in texture to some of the soils in the Lake Lanao region, Mindanao. The coffee trees in the oldest fields are now 21 years of age and still in good condition and yielding well. All the coffee is topped. No fertilizer is applied. The entire plantation of the Louisson Brothers is interplanted with *Grevillea robusta* for shade. The shade trees are here planted somewhat closer, but an ultimate distance of 9 to 15 meters is believed to be more satisfactory for this species. The leaf-fall of the Grevillea is very remarkable and would appear to be rather greater than that of either the *Leucaena glauca* or Dadap, though the compensating value of the nitrogen gathering bacteria in these two species is doubtless sufficiently great to more than off-set the value derived from the more abundant leaf-fall of the Grevillea. The rather large and finely divided leaves of the Grevillea seem to have an excessive tendency to lodge on the coffee bushes though possibly this is not of importance. At any rate, the coffee, which is almost exclusively Guatemala, presented a splendid appearance at the time of my visit. According to Mr. A. L. Louisson, the yield ranges from 550 to 675 kilos of coffee per hectare. As those in Kona, this plantation is divided into parcels or so called "coffee gardens" that are cared for by Japanese, who in Paauilo pay no rent, but have contracted to deliver the cherry coffee to the mill of the plantation owners.

According to Mr. McFarlance, in Mexico it is the rule that coffee is shaded most heavily at the lowest elevation where it is grown, the need for shade decreasing with the rise in altitude, the reverse of the procedure in Java. These apparently contradictory statements are undoubtedly due to the difference in the cloudiness of the atmosphere at the high and low level in the respective countries.

The experience in Kona and Paauilo respectively tends to show that a minimum of shade consistent with the maintenance of the trees in the best condition tends to produce maximum crops, which, indeed, is the experience with other plants requiring protection from the sunlight.

According to Mr. Louisson, whose observations extend over several years, the avocado, *Persea americana*, makes a very satisfactory shade tree for coffee because of its abundant leaf fall.

[Courtesy of Louisson Bros.]

Arabian Coffee in bloom. The plants are topped at a height of about 2.25 meters, Paauilo, Hawaii.

[Courtesy of Louisson Bros.]

Arabian Coffee in bloom, Paauilo, Hawaii.

The handling of the coffee in Hamakua is similar to that already described fro Kona except that as stated, the leaves and trash are separated from the berries before they are pulped and that no crushers are used. After a preliminary drying this is here finished in drying houses not unlike those employed in Java except that a coarse screen instead of perforated iron plates is used as a floor upon which to spread the coffee, an obvious economy.

Instead of hot air, in one house the heat was generated from a system of steam pipes running below the drying floor. In this establishment it was also planned to utilize the space above some of the machinery and workshop as a drying floor in the future.

The dried parchment coffee is shipped to the Hilo Coffee Mill, Hilo, where it is hulled and graded for shipment to the market. In this establishment the coffee, as it is being handpicked, is slowly carried forward towards the sorters on traveling canvas belts from which all defective beans are removed. Altogether, the mill has eleven machines for the sorting of coffee. The work is done by women, who are paid 70 to 80 centavos per day for beginners, and gradually advanced to ₱1.50 to ₱2 per day as they become more proficient in their work. According to the quality of the coffee, with the aid of these machines a woman can handpick from 50 to 225 kilos of coffee per day.

In Hawaii both the Marcus Mason, New York, and the Gordon, London, cylindrical pulpers are used with satisfactory results. The Engelberg, Syracuse, N. Y., and M. S. Smout, England, hullers, have likewise proved satisfactory. A Marcus Mason polisher is used by H. Hackfeld & Co. The Captain Cook Coffee Company has installed a huller made locally that has proven so satisfactory that the polisher has been discarded. In fact Mr. McFarlane expressed as his opinion the obvious fact that the polishing of coffee involves an extra expense in the preparation of coffee that looses its value at least in those cases where the raw coffee is purchased in bulk by the large coffee roasting plants, and where the appearance should count for little, if anything at all, considering that the coffee is retailed roasted and even ground.

A home made pulper with a cylinder 38 centimeters long, was examined at the home of the owner, a Japanese, who stated that its cost was ₱54, that it was driven by a gasoline motor of 2½ horse power and capable of pulping a trifle more than 800 kilos of berries per hour. The perforated cylinder cover was nailed on a wooden cylinder, which was said to be unsatisfactory however, since the wood swells as water is absorbed during the pulping process.

Mr. Louisson who appeared to have made a thorough study of this question argued very strongly for an import duty on all foreign coffee imported into the United States as a means of the upbuilding of a coffee industry, in the tropical possessions of that country, including Hawaii, Porto Rico and the Philippines.

Most certainly this would appear to be a subject worthy of thorough consideration by those interested in the development of a coffee industry in the Philippines, as a preferential coffee tariff in the United States could not help but benefit the planter in this Archipelago. In this connection it may be well to remember that in 1916, the United States imported 1,118,690,524 pounds of coffee valued at $115,485,970.

As having a bearing upon this subject I quote from the Annual Report of the Governor of Porto Rico for 1917, the following table of the coffee exports of Porto Rico for the last 10 years, given in round figures:

TABLE VI.—*Coffee exports of Porto Rico.*

Year.	Pounds.[1]	U. S. currency.	Average price.
		Value.	*Per lb.*
1908	35,256,000	4,304,000	0.122
1909	28,489,000	3,716,000	.130
1910	45,210,000	5,670,000	.125
1911	33,937,000	4,993,000	.147
1912	40,146,000	6,755,000	.168
1913	49,774,000	8,511,000	.171
1914	50,212,000	8,194,000	.163
1915	51,126,000	7,083,000	.138
1916	32,144,000	5,049,000	.157
1917	39,615,000	5,892,000	[1].149

It has frequently been argued that it would be unprofitable to establish a coffee industry in the Philippine in face of the much lower scale of wages in Java. Yet, it is a remarkable fact that the coffee industry has managed to maintain itself in Hawaii notwithstanding a wage scale far higher than that in any other coffee producing country, and greatly in advance of the prevailing wages in the Philippines. In fact, much of the coffee consumed in these Islands is imported from Hawaii. In addition to the disadvantages pertaining to labor, the cost of manufacture in Hawaii is increased owing to an insufficient water supply.

These disadvantages appear to have been overcome by the construction of more compact and less expensive mills and the

[1] 1 pound=0.45 kilogram.

installation of more modern and automatic machinery than has been done in Java, with a consequent reduction of the labor force. In the Kona district the application of artificial fertilizer has resulted in a greatly increased yield of coffee per hectare, a very distinct advantage where labor is expensive.

With the natural advantage of an abundant water supply and the combination of certain features of the different methods of the preparation of coffee in both Java and Hawaii to suit local conditions it would seem that the Philippines ought to produce coffee profitably for export, at a cost but very slightly if at all in excess of the cost of production in Java, and considerable below that in Hawaii.

For the production of a uniform, high grade of Philippine coffee it would appear desirable that all phases of the milling be done in large lots at large, centrally located plants where the work could be done more economically than it could be accomplished by the individual producer on a small scale. This in turn would enable to grower to tend a larger area of coffee.

There are many remote districts where coffee might be grown but where the area is not large enough to warrant the erection of large mills, and where the transportation of heavy machinery would be expensive and difficult. This difficulty could be solved by the manufacture of small pulpers in Manila, modeled after imported machines. Hullers might be made locally also for a similar purpose, though imported small models possibly may be found more desirable.

Considering the already large home demand for coffee in the Philippines that is now supplied from abroad, it would appear that for the present we may dismiss the fear of being unable to dispose of the coffee produced even if it is not so attractive in appearance as some of the imported coffee. Then, when coffee is produced in sufficient quantities for export, by disposing of the coffee to large roasting establishments, the appearance should be of little consequence provided the quality is satisfactory.

The success of the tenant system in Hawaii as previously related, with central mills to prepare the coffee, appear to show that the plan for the establishment of "coffee centrals" in the Philippines is sound and feasible. Also, where the surrounding country is of a nature that makes this practicable, the cost of manufacture might be considerably lowered by the construction of manufacturing plants capable of handling coffee from within a far greater radius than is customary in Java. One plant might conceivably handle the produce from 1,000 to 2,000 or even more hectares. With the ample water supply available nearly everywhere in the prospective coffee regions of the Philippines, in many instances the coffee berries might be flumed from the fields to the mills at a reduced cost of transportation, as is now done with sugar cane in Hawaii. It is well to remember that on a plantation once in full bearing transportation will be required from field to factory for 4,000 to 9,000 kilos, 80 to 180 bags of cherry per hectare annually; on 1,000 hectares 4,000 to 9,000 metric tons, 80,000 to 180,000 bags, 50 kilos each.

RUBBER.

A number of corporations were formed some years ago to engage in the culture of Ceara rubber in Hawaii and a considerable area was planted to this tree, but nearly all the trees have now been abandoned or torn up to be replanted with sugar cane or other crops. This failure has been largely attributed to the high cost of labor. Since it involved but a trifling expense and but little loss of time I visited one of these plantations south of Hilo.

It would appear that the failure of rubber in this locality was due to uncongenial soil conditions rather than the labor situation; or more precisely expressed—lack of soil. At the plantation visited, except in small areas here and there, the soil did not average a depth of 10 centimeters and was underlaid with hard, undecomposed lava with a surface of extremely broken configuration, making all machine cultivation impossible. Also, the trees were extremely stunted and of poor growth. I was informed that the other rubber plantations were planted on similar land, some of possibly better quality.

The failure of the rubber in Hawaii is a pertinent illustration of the need of a thorough investigation of competent men familiar with their subjects before engaging extensively in an agricultural enterprise in a new country or locality.

So far as I have been able to ascertain Ceara rubber has been most extensively planted in German East Africa, where the area in cultivation in 1914 was somewhat less than 25,000 hectares. The trees are there planted at the rate of 800 to the hectare. The yield is said to be as follows per hectare:

Age, years.	Kilos.
4	50
5	100
6	150
7	200
8	200

It will thus be noted that Ceara is greatly inferior to the Para in the yield of rubber and it is not recommended where Para will grow. Like Para and Castilloa, the Ceara, owing to the brittleness of the growth, requires a still atmosphere to succeed. On the other hand it is more tolerant relative to soil, succeeding even where this is less fertile, and growing well up to an elevation of 900 meters, and with an annual rainfall of only 800 millimeters. *Manihot heptaphylla, M. piauhyensis* and *M. dichotoma,* are regarded as more productive than their relative, the Ceara rubber, *Manihot glaziovii.*

From the information at hand it is apparent that Ceara will never seriously compete with Para where this can be cultivated. On the other hand the growth of Ceara in Bukidnon, Mindanao, has been so good that the experimental planting of Ceara is well justified. Again it would be advisable to import seed of the other Manihots mentioned.

Castilloa does not succeed well above an elevation of 600 meters, and is not adapted to heavy, clayey, or swampy soils. The following species of Castilloa, yielding rubber, might be worth introducing in Davao where Castilloa has proven so remarkably successful:

Castilloa costaricana Liebm.
Castilloa fallax Cook.
Castilloa lactiflua Cook.
Castilloa nicoyensis Cook.
Castilloa panamensis Cook.
Castilloa guatemalensis Pit.
Castilloa deguensis Pit.
Castilloa australis Hemsl.
Castilloa ulei Warb.

The following quotations from recent books by acknowledged rubber authorities are not without interest:

The growth (of *Hevea*) in the Amazon valley is distinctly less rapid then in Malaysia, or even Ceylon where the development is much slower than in the Federal Malay States, Java or Sumatra. Rubber trees in the gardens of the Museo Goeldi at Para carefully cared for during the last fifteen years, are no greater in height or girth than those seven years old in many of the Malay plantations. * * * In clearings, where plants have been set out they are in even a more backward condition, and after 20 years growth are frequently under seventy-five centimeters in girth ninety centimeters from the ground. (Akers, C. E., The Rubber Industry in Brazil and the Orient, 1914.)

All the evidence obtainable, including much that has been written upon the sources of rubber by scientific writers, distinct from those who have been influenced by commercial and other reasons, goes to prove that there can be no doubt that *Hevea brasiliensis*, especially the so-called black variety, will be the future source of the world's supply of rubber, and all others must tend to disappear from the markets unless it pay to cultivate the Manihots in drier soils where Para will not grow or at least will not yield. As one authority put it, *Hevea* will be planted where the yield repays the cost, and the *Manihot* in those districts which are too dry for the *Hevea*. (Woodroffe, J. F. & Smith, H. H. The Rubber Industry of the Amazon, 1915.)

These writers estimate that there are 300 million mature *Hevea* trees in Brazil.

THE MEDITERRANEAN FRUIT FLY.

During my stay in Hawaii my attention was repeatedly called to this, perhaps the most destructive fruit pest in the world, which notwithstanding our constant communication with Australia, so far fortunately has not been introduced into the Philippines. The information contained hereinafter relative to this insect has been obtained in part from Mr. C. E. Pemberton, entomologist of the Bureau of Entomology, U. S. Department of Agriculture, who has been engaged in a study of the insect for a period of more than 3 years in Hawaii. In part it has been gleaned from a bulletin on the subject recently published by Mr. Pemberton in coöperation with Mr. E. A. Back, of the same institution.

The Mediterranean Fruit Fly, (*Ceratitis capitata* Wied.) is a native of tropical Africa, from where it has spread since 1840 to all the countries bordering on the Mediterranean, practically the whole of Africa, including Madagascar, and the Islands to the West of that continent; to Australia, Brazil, Argentina and the Bermuda Islands. It was introduced from Australia to Hawaii about 1907–1908, where it has now become the most serious fruit pest, infesting 72 distinct species of fruits. Among these the following species are especially subject to attack, all of which are also very common in the Philippines; Mandarin, lime, lemon, pomelo, orange, coffee, mango, guava, papaya, palo maria, kabiki, mangosteen, tomato, and talisay. Many other species of Philippine fruits are also attacked though somewhat less susceptible than those enumerated.

So dangerous is this pest considered by the American authorities that all imports of fruit except pineapples and bananas from Hawaii to United States and Canada have been prohibited for fear of its introduction into these countries.

Because of the climatic checks the Mediterranean Fruit Fly is of less importance in the Temperate Zone, but in tropical countries where the climate and the successive ripening of the various fruits throughout all months of the year affords the insect an opportunity to multiply without interruption, this insect is apt to become one of the most serious of all plant pests. In the Philippines it would affect all the more important fruits except the banana, pineapple, chico and possibly the lanzon.

I quote the following from the bulletin previously referred to:

In the Bermuda Islands the peach industry has been ruined for many years * * * Lounsbury and Mally of South Africa, considered *C. capitata* one of the greatest drawbacks to the development of the fruit industry in Cape Colony, and have stated that during certain favorable seasons large areas of apricots, figs, pears, apples, plums and quinces were almost all affected. Hooper, writing from southern France, states in 1904, that, as the result of fruit fly attack, what was once a lucrative and important industry was at that time little more than a haphazard traffic in fruit casually produced. In 1903 Compere found that peach growing about Barcelona, Spain, had been so demoralized by fruit-fly attack that few trees were being grown, and that the market was supplied by fruit from the Balearic Islands, while at Cadiz the fruit merchants no longer cared to handle peaches owing to the fact that they were badly infested. At Malaga * * * the bitter Seville oranges are seriously affected. * * * Other instances of damage caused to citrus crops in southern Europe, South America, Africa and Australia might be added which would impress one, unfamiliar with the ravages of *C. capitata* that it is a very serious pest. * * * *Its economic importance is so great that every effort should be taken to prevent its establishment in new territory.* * * * A study of the fruits infested by this world wide pest shows that practically every fruit crop of value to man is subject to attack. The unrestricted consignments of fruit and ships stores have been responsible for much of the spread of *C. capitata* between countries. * * * The establishment of *C. capitata* in both the eastern and western parts of the Australian continent is traceable to the development of cold storage and rapid ocean transportation which made possible the large exports of citrus fruit from the Mediterranean region to Australia. Kirk records the receipt at Auckland, New Zealand, of a case of peaches from Cape Colony which contained living larvae, although they had been enroute in cool storage for four weeks. The same writer intercepted 47 cases of infected apples at Wellington, New Zealand, imported from New South Wales. Lea in 1908, states that larvae of *C. capitata* were seen in numbers every year in fruit imported into Tasmania from Sydney.

The only method employed at the present time in Hawaii satisfactorily to protect fruits from attack of the Mediterranean fruit fly is the covering of the fruits while they are still too green to be affected. (Mosquito netting or paper bags) So far as the writers know, there is no way in which clean culture can be made effective in Hawaii under present conditions.

The ideal climate and host conditions of Hawaii have rendered less effective and impracticable the usual artificial methods of control, the value of which has been demonstrated in other countries possessing natural features less favorable to fruit-fly increase. At the present time the only hope of relief lies in the establishment of parasites. Six parasites have been introduced during the past 3 years and are now well-established. While they have more than repaid the Territory of Hawaii for the cost of their introduction by bringing about an improved condition in the coffee growing industry, it is doubtful whether they will effect a sufficient decrease in the proportion of infested host fruits to be considered efficient factors in control. This conclusion appears inevitable in spite of the remarkable success attendant on their introduction.

The above quotations from the two foremost American authorities on the Mediterranean fruit fly require no comment, except to state that the conditions so favorable for the multiplication of the pest in Hawaii are present to an equal or even greater degree in the Philippines. Both the actual and relative value of the fruit that would suffer destruction following the invasion of the fruit fly in the Philippines would be vastly greater in this country than it has been in Hawaii, owing to the greater importance of fruit production in the Philippines.

It would appear that in order to prevent the entry of the Mediterranean fruit fly into the Philippines the logical course to pursue would be to prohibit the importation of all fruits except bananas and lemons into the Philippines from countries infested with this pest, including Hawaii, Australia, and the Mediterranean countries.

THE TOBACCO SEEDBED.*

By PEDRO A. DAVID.

INTRODUCTION.

The preparation of a seed bed for tobacco is of the greatest importance in tobacco growing as the health and vigor of the tobacco plants depend to a great extent upon the method followed in producing the seedlings. Hence this part of tobacco culture should receive the most careful attention. Probably in no tobacco growing country does this matter receive so little attention as in the Philippines. The seed beds receive little preparation and are located usually in bare and unprotected places along the banks of rivers. When the rivers overflow, as is often the case in the Islands, the seed beds are frequently washed away. It is not an uncommon occurrence for almost all of the seed beds in a community to be entirely destroyed by a severe storm. In the year 1915, a very serious loss in the tobacco crop occurred in Cagayan Valley, caused by a hard storm which followed the planting of the seeds. In this particular year the farmers planted all their seeds in the first planting and they had a hard time to obtain a fresh supply for replanting. It is usually the case that the farmer reserves no seed for replanting and consequently his loss is very great for he loses not only directly but also through delay in planting. This loss through delay in planting is enormous for the reason that the growing period of the second planting oftentimes extends into the dry season when irrigation is absolutely essential for the proper development of the plants. Whereas, when tobacco is planted in the right season in this country irrigation is unnecessary.

These losses through severe storm and flood could be avoided by constructing seed beds which offer protection to young plants. This is not difficult for seed beds which will withstand storm are comparatively easy to make.

In other tobacco growing countries, this part of the tobacco

* Contribution No. 1 from the Experiment Station of the College of Agriculture, University of the Philippines.

culture is given careful attention and the best judgement possible exercised.

In the Philippines, little or no attention has been paid to the construction of tobacco seed beds; to the effect of different kinds of shadings and fertilizers; and to the proper method of soil sterilization. The present status of tobacco culture makes it imperative that improved seed bed operations be introduced if healthy and vigorous tobacco seedlings are to be produced and if tobacco production in the Philippines is to prosper.

PREPARATION OF SEED BEDS.

The selection of a suitable location and the preparation of the seed bed is the first step that a tobacco farmer should consider, as the failure to have an abundant supply of good strong plants may cause a partial or total failure of the crop. Along the banks of the rivers where there is danger of the beds being washed away by floods or heavy rains is a most undesirable location. As the cost of transportation of plants is very small, it would be better to construct the seed beds a considerable distance from the field intended for tobacco. A location having a suitable soil, sufficiently elevated, and yet near a supply of water is very desirable.

The field in which the experiment discussed in this paper was conducted is situated on newly opened land which once had been a corral for goats and cattle. The nature of the soil, in general, is clay loam. The land is sufficiently high to furnish a good drainage.

The preparation of the seed beds was begun on April 15, 1918, by clearing the land and then plowing it, but on account of unfavorable weather conditions the actual work of the seed beds was not commenced until June 16, 1918. The land was first plowed. Forty-two seed beds were made, each by six meters. The earth was raised about one foot above the general level in bed form and the sides of the beds supported by bamboo. The passageways between them were one-half meter in width.

The necessary operations of tilling and stirring the soil proceded the sowing of the seed by several weeks. Each bed was thoroughly spaded several times to a depth of more than one foot. All roots, sticks, and other waste material were removed both by rake and by hand, and the soil was thoroughly pulverized.

A suitable shelter made of cloth, nipa, cogon or banana leaves was constructed for each bed with the exception of the controls. The shelter was raised above the ground to about two feet in front and one foot at the back.

STERILIZATION.

Practically all the troubles which the tobacco grower has to contend with in seed bed management can be cured by different methods of sterilization of the soil. For damping-off disease there were several methods undertaken. The damping off of seedlings is caused by various fungi which attack the young plants just at or below the surface of the ground. Under favorable conditions such as excess of moisture, high temperature, thick sowing and poor ventilation, this disease will spread rapidly up to the stem and may cause great damage. The characteristic appearance of a seed bed attacked by this trouble is a bending over or wilting of the diseased plants. The fungi which cause the trouble have been identified by Professor Reinking of the College of Agriculture.

The principal results to be accomplished by sterilization are the destruction of all weed seeds and the fungi causing diseases. With this end in view, the following methods were tried during the progress of the experiment.

1. *Roasting, or pan frying.*—This required the removal of part of the soil from the seed bed into a pan and returning it, after it was sterilized for two hours. The pan under which the fire was maintained was made of two pieces of galvanized iron roofing, resting upon supports. Plate XV–*b*.

In heating the soil care was taken not to let it become so dry that the vegetable matter was burned out. It took two heatings for each bed. Beds, 10, 11, 12, 14, 16, 17, 20, 23, 25, and 29 were sterilized by this method. It cost forty centavos to sterilize one bed, two men being employed at ten centavos an hour.

2. *Hot water method.*—This required boiling water. It was heated in petroleum cans resting upon supports in such a way that fire could be maintained under them. Plate XV–*b*. It took about an hour to heat the water to boiling. While the water was boiling hot, it was poured, can by can, onto the beds to be treated. Eight petroleum cans of hot water were used for each bed. Beds, 1, 2, 3, 4, 5, 6, 7, 9, 13, 22 were treated by this method. It cost twenty centavos to sterilize one bed, two men being employed at ten centavos an hour. It must be understood, however, that in this case the supply of water is very near the field used for seeed bed, otherwise the cost would be more.

3. *Firing, or burning the bed.*—The actual burning of the beds was done after the above two operations were finished. This was accomplished by placing dried cogon, grasses, and rubbish on the beds and on top of this dry wood was piled. Plate XVI

The layer of the materials that was placed on the beds was about two feet high, and the fire started on the leeward side in order that it might burn slower and the heat have a chance to penetrate the soil. A slow, steady fire will heat the ground better than a quick one. After setting fire to the brush, the pile was pushed on skids by means of long poles until the whole seed bed was thoroughly and uniformly burned. After burning the beds in this way, they were fenced and then all partly burnt sticks roots and other trash were raked off allowing only the ash to remain. The beds were again spaded up not deeper than four inches. Beds, 19, 26, 27, 31–34, 36–37 and 39 were treated by this method. It took from twenty to thirty minutes to burn each bed. It cost about ten centavos to burn one bed, two men being employed to do the work.

Table I shows the number of beds treated, number of separate tests, treatments, amount of material or time used per six square meters of bed and the cost of each treatment:

TABLE I.

No. of Bed.	Number of separate tests.	Treatment.	Amount of material or time used per six square meters of bed.	Cost of operation.
1	10	Hot water	8 petroleum cans	₱0.20
2		do	do	0.20
3		do	do	0.20
4		do	do	0.20
5		do	do	0.20
6		do	do	0.20
7		do	do	0.20
9		do	do	0.20
13		do	do	0.20
22		do	do	0.20
10	10	Roasting or pan frying	2 hours	0.40
11		do	do	0.40
12		do	do	0.40
14		do	do	0.40
16		do	do	0.40
17		do	do	0.40
20		do	do	0.40
23		do	do	0.40
25		do	do	0.40
29		do	do	0.40
19	10	Firing or Burning	20-30 minutes	0.10
26		do	do	0.10
27		do	do	0.10
31		do	do	0.10
32		do	do	0.10
33		do	do	0.10
34		do	do	0.10
36		do	do	0.10
37		do	do	0.10
39		do	do	0.10
8	9	Control	None	None.
15		do	do	Do.
18		do	do	Do.
21		do	do	Do.
24		do	do	Do.
28		do	do	Do.
33		do	do	Do.
35		do	do	Do.
38		do	do	Do.

4. *Formaldehyde.*—This was applied ten days before the seeds were sown. As shown in Table II, different strengths were tried. The strength of the stock formaldehyde solution used was 40 per cent. After mixing the solution of formaldehyde with the water necessary to obtain the required strength, the mixture was immediately applied to the beds, at the rate of ten liters to one square meter. The beds treated were kept covered for ten days with banana leaves on top of which some pieces of boards and bamboo were placed to keep it tight. No spading was done after the treatment. After a period of ten days the cover was taken off and the seeds were sown. The amount of seeds sown was one teaspoonful (heaping). The variety used was Broadleaf No. 9975. The seeds were covered with sterilized soil from outside of the bed and pressed a litttle so as to be well in contact with the soil, and then were watered slightly.

5. *Copper sulphate.*—As shown in Table II, one per cent and two per cent were tried. To every one square meter of bed, three and one half liters solution was used. This was applied immediately after sowing the seeds which were pressed a little so as to be well in contact with the soil. The amount of seeds sown was one teaspoonful (heaping) of Broadleaf No. 9975. The beds were sheltered.

6. *Lime.*—One hundred twenty-six grams of stone lime was pulverized and immediately applied dry to one square meter of bed. One hundred twenty-six grams of the same stone lime was dissolved in water. The water was added little by little so as to make good lime water. This was applied to another bed of one square meter. After it was carefully pulverized two hundred fifty-two grams of stone lime was applied dry to a bed of one square meter. To another bed of one square meter, two hundred fifty-two grams dissolved in water applied. Air-slaked lime at the rate of ninety-five grams to one square meter of bed was also tried. The lime was raked into the upper three inches of soil just before sowing the seeds. The seeds were pressed a little so as to come well in contact with the soil. The amount of seed sown to each bed was one teaspoonful (heaping). The variety used was Broadleaf No. 9975.

Each of the beds was watered daily with ordinary tap water and each watering was at the rate of approximately six liters per square meter of bed. All beds were treated in exactly the same way.

Table II shows the kind and the amount of substance added, the strength, number of tests, amount of solution used per square meter of bed and the cost.

TABLE II.

Substance added.	Strength.	Number of tests.	Amount of solution used.	Cost of substance added.
			Per 1 sq. m.	
Formaldehyde	1-50	1	10 liters	₱0.28
Do	1-75	1	10 liters	0.18
Do	1-100	1	10 liters	0.14
Do	1-150	1	10 liters	0.09
Do	1-200	1	10 liters	0.07
Control	Control	1	Control	0.00
Copper sulphate	1 per cent	2	3.5	0.03
Do	2 per cent	3	3.5	0.05
Control	Control	1	Control	0.00
Stone lime (dry)	126 grams	1	126 grams	0.01
Stone lime (dissolved)	126 grams	1	126 grams	0.01
Stone lime (dry)	252 grams	1	252 grams	0.02
Stone lime (dissolved)	252 grams	1	252 grams	0.02
Air-slaked lime	95 grams	1	95 grams	0.008
Control	Control	1	Control	0.00

PLAN OF THE WORK.

Plan of the soil sterilization and disinfection experiments.

Firing	Firing	Heating	Liming	CuSO4	Formalin
39	32	25	40	41	42
Control	Firing	Control	Control	Heating	Hot water
38	31	24	18	12	6
Firing	Control	Heating	Heating	Heating	Hot water
37	30	23	17	11	5
Firing	Heating	Hot water	Heating	Heating	Hot water
36	29	22	16	10	4
Control	Control	Control	Control	Hot water	Hot water
35	28	21	15	9	3
Firing	Firing	Heating	Heating	Control	Hot water
34	27	20	14	8	2
Firing	Firing	Firing	Hot water	Hot water	Hot water
33	26	19	13	7	1

Plots 40, 41, 42 were divided as shown in the following diagrams.

40	41	42
Check	Check	Check
95 grams hydrated	2 per cent CuSO4	Formalin 1-50
252 grams dissolved	2 per cent CuSO4	Formalin 1-75
252 grams dry	2 per cent CuSO4	Formalin 1-100
126 grams dissolved	1 per cent CuSO4	Formalin 1-150
126 grams dry	1 per cent CuSO4	Formalin 1-200

APPLICATION OF FERTILIZERS.

On July 27, 1918, the compost and the horse and chicken manures were applied. The horse manure was procured from Camp Eldridge at Los Baños and the chicken manure from the Animal Husbandry Department of the College of Agriculture. The compost was gathered from the College grounds.

The compost and horse manure were forked in and the land allowed to lie in this condition until September 1, 1918. Then the soil was reforked and sterilized from September 2 to 7. The chicken manure was applied broadcast on the beds.

All the commercial fertilizers used in this experiment were applied broadcast in September 5–6, 1918. After this surface application, the fertilizers were worked into the top surface of the soil and the beds raked and leveled again, putting them in the best possible condition for receiving the seeds.

Table III shows the kind of fertilizers used and the amount per six square meters of bed and the cost of the fertilizers.

TABLE III.

Bed No.	Kind of fertilizer used.	Amount of fertilizer per 6 square meter in kilos.	Cost of fertilizer.
1	NaNO3 *	½	₱0.10
2	Dried blood	1	0.10
3	K2SO4 * *	½	0.125
4	(NH4) 2SO4 * * *	½	0.125
5	Chicken manure	1	0.02
6	NaNO3, Ca(H4PO4)2, † K2SO4	½	0.11
7	Horse manure	30	0.15
8	NaNO3, Ca(H4PO4)2, K2SO4	½	0.11
9	Compost	30	0.09
10	NaNO3	½	0.10
11	Control	None	0.00
12	K2SO4	½	0.125
13	Control	None	0.00
14	(NH4)2SO4	½	0.125
15	Dried blood	1	0.10
16	Chicken manure	1	0.02
17	(NH4)2SO4, Ca(H4PO4)2, K2SO4	½	0.11
18	Compost	30	0.09
19	(NH4)2SO4, Ca(H4PO4)2, K2SO4	½	0.11
20	Compost	30	0.09
21	NaNO3	½	0.10
22	NaNO3, Ca(H4PO4)2, K2SO4	½	0.11
23	Horse manure	30	0.15
24	K2SO4	½	0.125
25	Dried blood	1	0.10
26	Chicken manure	1	0.02
27	Dried blood	1	0.10
28	Horse manure	30	0.15
29	NaNO3, Ca(H4PO4)2, K2SO4	½	0.11
30	(NH4)2SO4, Ca(H4PO4)2, K2SO4	½	0.11
31	Control	None	0.00
32	(NH4)2SO4	½	0.125
33	Horse manure	30	0.15
34	K2SO4	½	0.125
35	(NH4)2SO4	½	0.125
86	NaNO3	½	0.10
37	Compost	30	0.09
38	Chicken manure	1	0.02
39	(NH4)2SO4, Ca(H4PO4)2, K2SO4	½	0.11
40	None	None	0.00
41	None	None	0.00
42	None	None	0.00

In the combination of double superphosphate and sulphate of potash with sodium nitrate, the following amounts were used:

NaNO3	grams....	185
Ca (H4PO4) 2	grams....	150
K2SO4	grams....	165

Ammonium sulphate was mixed with double superphosphate and sulphate of potash using the following amounts of each:

(NH4) 2SO4	grams....	156
Ca (H4PO4) 2	grams....	159
K2SO4	grams....	185

All of the commercial fertilizers used in this experiment were bought during 1916. The only expense connected with the natural fertilizers was labor. The cost was estimated on 90

* NaNO3 = Sodium nitrate.

* * K2SO4 = Sulphate of potash.

* * * (NH4) 2SO4 = Ammonium Sulphate.

† Ca (H4PO4) 2 = Double Superphosphate.

centavos a day, the prevailing wage. The cost of the different commercial fertilizers as given in the last column of Table III were computed on the Manila prices for 1916.*

Plan of the Work.

Plan of the fertilizer experiments.

$(NH_4)_2SO_4$ $Ca(H_4PO_4)_2$ K_2SO_4	$(NH_4)_2SO_4$	Dried blood			
39	32	25	40	41	42
Chicken manure	Control	K_2SO_4	Compost	K_2SO_4	$NaNO_3$ $Ca(H_4PO_4)_2$ K_2SO_4
38	31	24	18	12	6
Compost	$(NH_4)_2SO_4$ $Ca(H_4PO_4)_2$ K_2SO_4	Horse manure	$(NH_4)_2SO_4$ $Ca(H_4PO_4)_2$ K_2SO_4	Control	Chicken manure
37	30	23	17	11	5
$NaNO_3$	$NaNO_3$ $Ca(H_4PO_4)_2$ K_2SO_4	$NaNO_3$ $Ca(H_4PO_4)_2$ K_2SO_4	Chicken manure	$NaNO_3$	$(NH_4)_2SO_4$
36	29	22	16	10	4
$(NH_4)_2SO_4$	Horse manure	$NaNO_3$	Dried blood	Compost	K_2SO_4
35	28	21	15	9	3
K_2SO_4	Dried blood	Compost	$(NH_4)_2SO_4$	$NaNO_3$ $Ca(H_4PO_4)_2$ K_2SO_4	Dried blood
34	27	20	14	8	2
Horse manure	Chicken manure	$(NH_4)_2SO_4$ $Ca(H_4PO_4)_2$ K_2SO_4	Control	Horse manure	$NaNO_3$
33	26	19	13	7	1

* It costs ₱2 to haul one cubic meter of horse manure from Los Baños to the College grounds. It took 3.7 hours at ten centavos an hour for one laborer to haul 120 kilos of compost. It took one-fourth hour at ten centavos an hour for one laborer to haul four kilos of chicken manure.

One cubic meter of horse manure=55 petroleum cans. (Average)

One petroleum can of horse manure=7.5 kilos.

SOWING THE SEED.

On September 8, 1918, the seeds were sown in thirty-nine beds. The amount of seeds sown to each bed (1 by 6 meters) was one teaspoonful (heaping), weighing about 3.6 grams. The average weight of 100 good seeds was 0.0072 grams. From these data we find that 50,000 seeds were sown to each bed of one by six meters.

The seeds were mixed with corn meal, naphthalien, dry ash, or sand. This was done because tobacco seeds are so small that it is a difficult matter to scatter them evenly over the bed so as to get a uniform stand of plants. The combinations used are given in Table IV. They were mixed in the proportion of one teaspoonful (heaping) of seeds to two handfuls of meal, naphthalien, dry ash or sand. The seeds were sown broad-cast. Care was taken to distribute them evenly. It requires careful handling to do this work.

Corn meal did not only serve to enable the planter to sow his seed more evenly but was used as a partial protection against ants. The ants would be occupied in carrying away the meal while the tobacco seeds were sprouting. Naphthalien served to drive the ants away so they would not eat the seeds. No ants were found on the beds where naphthalien was used in combination with the seeds. The sand and dry ash when mixed with the seeds before they are sown, enables one to see where the seed has fallen.

The beds were watered to make them moist before the seeds were sown. After sowing the seeds, the seed beds were rolled with a roller weighing about 4.2 kilograms Plate XV–*b*. This was done so that the seeds would be buried and come in close contact with the soil. After the seeds were rolled they were thoroughly sprinkled with tap water to firm the earth.

Many planters make the great mistake of using too large a quantity of seed, and as a result the plants are so crowded in the bed that they produce long spindling stalks and have low vitality so that many of them die on being transplanted to the field. And those which do survive require several weeks to get a firm hold in the soil and start growing. Also when plants are crowded there is more chance for the damping off disease to do damage. It is far better to make the mistake of using too small a quantity of seed, for then the plants will be large, healthy and stocky, and may be transplanted to the field when there is but little moisture in the soil, without danger of their drying.

The seeds used in this experiment were obtained from the Bureau of Agriculture, Manila. There were four varieties, namely, Broadleaf No. 9975, Romero No. 9977, Echague mixed No. 9978, and Repollo No. 9976.

SHADING THE SEED BEDS.

The principal objects in shading the seeed bed are, to protect the young plants from the strong rays of the sun, and to conserve the moisture on the surface of the bed.

Four different kinds of shading materials were used in this experiment; cloth, nipa, cogon and banana leaves. Plates XIII–*b*, XIV–*a*, XIV–*b*, XV–*a*. Four small posts were driven in the ground on each side of the bed, at intervals of 1.5 meters. On one side of the bed the posts were left projecting about two feet above the surface of the ground, and on the other side about one foot. Then strong poles were placed across the bed with the ends resting on the posts; the shading materials were placed on these poles. Plates X–*b*, XIII–*b*. The beds shaded with cogon, banana leaves or nipa required three long posts which served as braces when the cover was to be opened. Plates XIV–*a*, XIV–*b*. In the case of the cloth cover, these braces were not necessary. One side of the cloth which was cut as long as the bed, was nailed to a long straight pole so that it could be rolled up when opened, while the other side of the cloth was nailed to the pole which rested on the high posts. Plates X–*a*, X–*b*.

PLAN OF THE WORK.

Plan of the shade experiments.

Banana leaves 39	Cogon 32	Control 25	Cloth 40	Cogon 41	Nipa 42
Banana leaves 38	Cogon 31	Cloth 24	Cloth 18	Nipa 12	Nipa 6
Banana leaves 37	Cogon 30	Cloth 23	Cloth 17	Nipa 11	Nipa 5
Control 36	Control 29	Cloth 22	Control 16	Nipa 10	Nipa 4
Banana leaves 35	Cogon 28	Cloth 21	Cloth 15	Control 9	Control 3
Banana leaves 34	Cogon 27	Cloth 20	Control 14	Nipa 8	Nipa 2
Banana leaves 33	Cogon 26	Control 19	Cloth 13	Control 7	Nipa 1

MANAGEMENT OF THE BEDS.

While the plants are small, it is essential that the beds receive frequent and careful attention. During the progress of this experiment, the soil was not allowed to dry out to any depth as this would materially check the growth or even kill some plants. The water was put on so as to allow it to soak into the soil gradually but not so as to flood the plants. The beds were watered thoroughly using one sprinkling can of tap water to each bed. This was done every afternoon instead of watering with small quantities at frequent intervals. The amount of water applied every afternoon was enough to make the soil in the bed wet to a depth of three or four inches. This application was made while the plants were small. The amount of water put on each bed was increased as the plants grew larger. The surface soil was allowed to dry off occasionally so that the feeding roots would go down instead of remaining at the surface. The amount of water added to every bed was measured by means of the sprinkling can so that all the beds would receive the same amount of water. No interval between watering the beds was allowed, so that the water was received by the plants practically at the same time.

Hand weeding was practised as soon as the weeds were of sufficient size to be readily pulled up. The weeding was done soon after the bed had been watered so that the weeds might be pulled up more readily.

After the plants were all well up, the covers were opened for a short time each day from 6 to 7.30 a. m. and from 4 to 5 p. m. The time of exposure was gradually increased, and eventually the plants were shaded only from 11 a. m. to 2.30 p. m. A few days before transplanting to the field, the shade was removed and the plants exposed throughout the day in order to accustom them to the strong rays of the sun.

The beds 1 to 39 inclusive were given exactly the same treatments from the time the seeds were sown, as regards watering, exposure to the sun and weeding.

METHOD OF TRANSPLANTING.

Before the seedlings were transplanted to the field the seed beds were thoroughly moistened in order that the seedlings could be removed with ease with the least possible injury to the roots. The roots should be exposed to the sun as little as possible because a few minutes' exposure of the roots to a bright sun is often sufficient to kill the plant. Hence, transplanting may well be done on cloudy days or in mornings and evenings. Ordinary garden trowels were used in removing the young plants from the beds. The plants were drawn one at a time, leaving the smaller ones uninjured in the beds for future planting. In drawing the plants, care was taken so as not to injure them. They were taken hold of by the leaves above the bud as the leaves can withstand a slight bruise without hurting the plants. The young plants were set out in the fields immediately after being pulled up from the seed beds. Enough soil was dug up with the roots of the plants so as to have a good ball of earth around them. The plants were taken out to the field in boxes.

The seedlings that were produced in this experiment were planted beginning October 23, 1918 by the Agronomy III class and a thesis student.

COST OF SEED BED CONSTRUCTION.

Type I, Plate XII.

6½ pieces of bamboo at ₱0.375	₱2.44
200 nipa at ₱9.50 per thousand	1.90
Nails	0.14
Wire	0.10
Labor, 30 hours at ₱0.10	3.00
Total	7.58

Type II, Plate XIII.

5½ pieces of bamboo at ₱0.375	2.06
Cloth (12 meters at ₱0.65)	7.80
Wire	0.16
Nails	0.05
Labor, 22.5 hours at ₱0.10	2.25
Total	12.32

Type III, Plate XIV.

8 pieces of bamboo at ₱0.375	3.00
Wire	0.34
Gathering cogon	0.90
Labor, 23 hours at ₱0.10	2.30
Total	6.54

Type III, Plate XV.

8 pieces of bamboo at ₱0.375	3.00
Wire	0.34
Gathering banana leaves	0.30
Labor, 22 hours at ₱0.10	2.20
Total	5.84

Tye IV, Plate XV.

93 board feet of lawan lumber at ₱0.08	7.44
Nails	0.55
Labor, 10 hours at ₱0.10	1.00
Gathering banana leaves	0.30
Total	9.29

The above prices are very much higher than those prevailing prior to the outbreak of the European War. It is believed that the present high prices are only temporary.

If careful calculation of cost in seedbed construction in the Philippines has ever been made, the prices given would be undoubtedly very much lower than the ones quoted above. This high cost is due in part to the fact that great care was taken in the preparation of the materials. As the skill with which laborers handle any kind of work differs a great deal, the cost of labor is a variable factor even in the same locality. The cost of materials varies also, so it follows that the cost of constructing any type of seed bed will not always be the same even in the same community in the same year.

Actual data showing the maximum period of service of the different types of seed beds would aid in making a selection of the type to be constructed. For this purpose, careful observations as to the attack of white ants were made during the progress of the experiment. White ants were found very frequently on the walls of Type II. This was probably due to the fact that they could easily build their nests on this more closely woven type of wall. No such trouble was observed on the other types. No sign of attack of any kind was observed on Type IV. It is believed that this was due to the fact that the boards used in constructing type IV were coated with cement as they had been used in mixing cement by the Engineering Department before being utilized for this experiment.

If a farmer desires to construct any one of the types described in this paper, he should consider several points. He should select the type that would best suit his conditions and give the most service for the labor and money invested. In considering the two types, one of which is built up with boards and the other with bamboo, the initial cost in constructing the first is much higher than the second. But the seed bed constructed with bamboo will last only about three of four years or even less, while the one made with boards will last very much longer. Also the farmer can store the boards when not in use, while this can not be done with bamboo.

TABLE IV.

The following table shows the different treatments in each bed:

Type.	Bed No.	Shading.	Fertilizer used.	Method of sterilization.	Materials mixed with seeds.	Variety.
1	1	Nipa	NaNO3	Hot water	Corn meal	Romero.
	2	do	Dried blood	do	Naphthalein	Broadleaf.
	3	Control	K2SO4	do	Sand	Do.
	4	Nipa	(NH4)2SO4	do	Naphthalein	Romero.
	5	do	Chicken manure	do	do	Broadleaf.
	6	do	NaNO3, Ca(H4PO4)2 K2SO4.	do	do	Do.
	7	Control	Horse manure	do	Corn meal	Do.
	8	Nipa	NaNO3, Ca(H4PO4)2 K2SO4.	Control	do	Echague.
	9	Control	Compost	Hot water	Sand	Do.
	10	Nipa	NaNO3	Pan frying	Naphthalein	Broadleaf.
	11	do	Control	do	Control	Do.
	12	do	K2SO4	do	Naphthalein	Repollo.
11	13	Cloth	Control	Hot water	Dry ash	Broadleaf.
	14	Control	(NH4)2SO4	Pan frying	Corn meal	Do.
	15	Cloth	Dried blood	Control	do	Do.
	16	Control	Chicken manure	Pan frying	Sand	Romero.
	17	Cloth	(NH4)2SO4, K2SO4, Ca(H4PO4)2.	Pan frying	Corn meal	Broadleaf.
	18	do	Compost	Control	Naphthalein	Romero.
	19	Control	(NH)2SO4 K2SO4, Ca(H4PO4)2.	Firing	Sand	Broadleaf.
	20	Cloth	Compost	Pan frying	Corn meal	Do.
	21	do	NaNO3	Control	Control	Do.
	22	Cloth	NaNO3, Ca(H4PO4)2 K2SO4.	Hot water	Corn meal	Do.
	23	do	Horse manure	Pan frying	Sand	Romero.
	24	do	K2SO4	Control	Corn meal	Broadleaf.
	25	Control	Dried blood	Pan frying	Sand	Echague.
111	26	Cogon	Chicken manure	Firing	Naphthalein	Repollo.
	27	do	Dried blood	do	Corn meal	Broadleaf.
	28	do	Horse manure	Control	Naphthalein	Repollo.
	29	Control	NaNO3, Ca(H4PO4)2 K2SO4	Pan frying	Sand	Broadleaf.
	30	Cogon	(NH4)2SO4 K2SO4, Ca(H4PO4)2.	Control	Naphthalein	Do.
	31	do	Control	Firing	Dry ash	Do.
	32	do	(NH4)2SO4	do	Sand	Do.
	33	Banana leaves	Horse manure	do	Naphthalein	Echague.
	34	Banana leaf	K2SO4	do	Corn meal	Broadleaf.
	35	do	(NH4)2SO4	Control	Naphthalein	Do.
	36	Control	NaNO3	Firing	Sand	Do.
	37	Banana leaf	Compost	do	Naphthalein	Romero.
	38	do	Chicken manure	Control	Corn meal	Echague.
	39	do	(NH4)2SO4 K2SO4, Ca(H4PO4)2.	Firing	Corn meal	Repollo.
	40	Cloth	None	Lime	None	Broadleaf.
	41	Cogon	do	CuSO4	do	Do.
	42	Nipa	do	Formalin	do	Do.

NaNO3 = Sodium nitrate.
K2SO4 = Sulphate of potash.
(NH4)2SO4 = Ammonium Sulphate.
Ca(H4PO4)2 = Double Superphosphate.

TABLE V.—*Effect of fertilizers and shade upon germination.*

Bed No.	Shade.	Fertilizer.	Dates.		Time required from sowing to germination.
			Planted.	Germinated.	
1	Nipa	$NaNO_3$	Sept. 8	Sept. 14	6 days.
2	do	Dried blood		13	5
3	None	K_2SO_4		14	6
4	Nipa	$(NH_4)_2SO_4$		15	7
5	do	Chicken manure		14	6
6	do	NaNO34, Composite fertilizer		14	6
7	None	Horse manure		15	7
8	Nipa	$NaNO_3$, Composite fertilizer		13	5
9	None	Compost		15	7
10	Nipa	$NaNO_3$		14	6
11	None	Control		19	11
12	Nipa	K_2SO_4		15	7
13	Cloth	Control		17	9
14	None	$(NH_4)_2SO_4$		15	7
15	Cloth	Dried blood		13	5
16	None	Chicken manure		14	6
17	Cloth	$(NH_4)_2SO_4$, Composite fertilizer		13	5
18	do	Compost		13	5
19	None	$(NH_4)_2SO_4$, Composite fertilizer		15	7
20	Cloth	Compost		13	5
21	do	$NaNO_3$		13	5
22	do	$NaNO_3$, Composite fertilizer		13	5
23	do	Horse manure		13	5
24	do	K_2SO_4		13	5
25	None	Dried blood		15	7
26	Cogon	Chicken manure		15	7
27	do	Dried blood		15	7
28	do	Horse manure		14	6
29	None	$NaNO_3$, Composite fertilizer		20	12
30	Cogon	$(NH_4)_2SO_4$, Composite fertilizer		16	8
31	do	Control		19	11
32	do	$(NH_4)_2SO_4$		16	8
33	Banana leaf	Horse manure		14	6
34	do	K_2SO_4		14	6
35	do	$(NH_4)_2SO_4$		16	8
36	None	$NaNO_3$		19	11
37	Banana leaf	Compost		13	5
38	do	Chicken manure		14	6
39	do	$(NH_4)_2SO_4$, Composite fertilizer		14	6

TABLE VI.—*Soil disinfection for the control of damping-off tobacco.*

Substance added.	Strength.	Amount used.	Number of independent test.	Number of seedlings.		Per cent disease above surface.	No seedlings to square feet.	No seedlings to square feet reached transplanting.	Remarks.
				Germinated.	Reached transplanting.				
		Per sq. m.							
Formalin	1-50	10 L	1	4,985	3,827	None	565	423	Stimulated.
Do	1-75	10 L	1	4,458	3,609	None	492	401	Do.
Do	1-100	10 L	1	2,835	2,628	10	315	292	No effect.
Do	1-150	10 L	1	1,215	927	80	135	103	Do.
Do	1-200	10 L	1	765	450	90	85	50	Do.
Check			1	837	306	95	93	34	
Cu. SO4	1 per cent	3.5 L	2	315	189		35	21	*Few weeds appeared before transplanting.*
Do	1 per cent	3.5 L		198	135		22	15	Do.
Do	2 per cent	3.5 L	3						Inhibited No weed.
Do	2 per cent	3.5 L							Do.
Do	2 per cent	3.5 L							Do.
Check			1	1,125	252	90	125	28	
Air slaked lime		95 grams	1	2,097	801	50	233	89	No effect.
H2O Stone lime		252 grams	1	999	675	75	111	75	Slight inhibition.
Dry Stone lime		252 grams	1	638	567	90	72	63	Do.
H2O Stone lime		126 grams	1	90		100	10		No effect.
Dry Stone lime		126 grams	1	261	135	95	29	15	Do.
Check			1	153	45	100	17	5	No effect.
Hot water	Boiling	8 P. C.	10	17,100			285	Average to square meter	Stimulated.
Heating	80-90°	2 hours	10	13,800			230		Do.
Firing	20-30	Minute	10	12,780			213		
Contol			9	7,992		25	148		

NOTE.—The tests included in the above table were conducted on a considerable scale, the total area involved for Formalin, CuSO4 and Lime being 15 square meters in the treated plots and 3 square meters in the untreated plots. In all cases actual counts of seedlings were made only on one-fourth of each plot. The test for hot water, heating or pan frying, and firing were conducted in 30 beds of 6 square meters each. The total area involved for each test is 60 square meters.

Table VII.

The following table shows the total height and size of leaf of the seedlings just before they were transplanted to the field.

Bed No.	Kinds of fertilizer.	Number of plant.	Broadleaf No. 9975.		
			Total height.	Leaf.	
				Length.	Width.
			cm.	*cm.*	*cm.*
2	Dried blood	1	24.3	14.1	7.2
		2	19.8	13.2	6.3
		3	22.1	15.5	6.5
		4	18.6	12.1	6.6
		5	18.5	12.4	6.6
		6	29.0	18.4	8.1
		7	19.1	13.4	7.4
		8	19.2	13.6	7.0
		9	19.7	15.1	6.9
		10	30.4	21.6	11.5
3	K_2SO_4	1	5.5	4.2	2.9
		2	4.6	4.0	2.7
		3	5.5	5.0	3.2
		4	5.5	4.2	2.6
		5	4.4	4.2	3.0
		6	9.2	8.6	5.0
		7	10.5	8.8	5.7
		8	11.8	9.8	6.2
		9	15.2	12.9	7.4
		10	14.9	11.4	7.3
5	Chicken manure	1	13.7	10.6	6.0
		2	18.8	10.6	6.3
		3	14.5	11.9	6.0
		4	14.6	11.6	6.5
		5	14.3	11.3	6.3
		6	11.8	9.1	5.1
		7	13.5	12.4	6.1
		8	16.1	12.9	6.7
		9	19.7	14.4	7.2
		10	17.4	13.0	7.0
6	$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4	1	16.6	13.5	7.7
		2	18.7	13.3	6.7
		3	18.9	14.4	8.3
		4	16.0	12.7	7.0
		5	15.4	11.9	6.3
		6	12.5	10.3	5.3
		7	18.0	13.8	7.3
		8	21.1	15.4	8.0
		9	15.2	11.7	5.5
		10	15.9	12.6	6.5
7	Horse manure	1	7.2	5.6	3.0
		2	5.4	4.8	3.1
		3	7.3	5.8	3.3
		4	9.4	7.1	3.7
		5	8.5	6.8	4.6
		6	17.6	13.8	7.1
		7	13.6	9.9	6.3
		8	17.5	12.5	7.0
		9	21.1	15.3	7.5
		10	23.6	17.4	9.4
10	$NaNO_3$	1	10.9	9.0	5.9
		2	12.0	9.7	5.1
		3	13.3	11.3	6.6
		4	16.4	12.9	6.5
		5	16.0	12.3	7.0
		6	14.2	11.1	6.0
		7	13.1	10.0	5.1
		8	10.9	9.0	4.7
		9	11.0	8.5	5.3
		10	19.2	15.2	8.5

TABLE VII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Broadleaf No. 9975. Total height.	Leaf. Length.	Leaf. Width.
			cm.	*cm.*	*cm.*
11	Control	1	10.6	8.5	4.5
		2	8.4	7.0	4.1
		3	11.6	9.5	4.9
		4	12.0	11.4	5.1
		5	11.1	9.0	4.6
		6	12.0	9.9	4.5
		7	10.6	8.3	5.9
		8	10.6	8.3	3.2
		9	10.1	8.6	3.4
		10	11.5	9.7	4.4
13	Control	1	7.4	5.9	3.8
		2	10.0	7.4	4.5
		3	7.1	5.1	4.0
		4	10.4	9.2	5.0
		5	7.0	5.2	4.1
		6	10.7	8.9	5.0
		7	11.9	10.2	4.7
		8	13.0	10.1	6.0
		9	13.5	10.6	5.4
		10	14.3	11.2	6.1
14	$(NH_4)_2SO_4$	1	9.5	7.9	5.3
		2	7.5	6.2	4.2
		3	8.1	7.0	4.7
		4	7.2	6.2	4.3
		5	8.3	7.8	5.2
		6	16.8	14.1	5.9
		7	8.7	6.6	3.2
		8	7.2	6.1	3.8
		9	10.3	9.0	4.9
		10	12.1	9.5	6.7
15	Dried blood	1	25.2	13.5	6.2
		2	26.5	16.3	7.3
		3	22.5	15.1	7.2
		4	29.5	16.7	6.7
		5	25.5	15.8	7.2
		6	19.7	14.0	8.3
		7	18.4	14.1	8.7
		8	19.2	13.9	7.6
		9	16.1	10.8	5.6
		10	21.6	13.4	6.7
17	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	1	21.6	14.3	7.5
		2	22.4	14.9	6.8
		3	21.3	14.3	6.7
		4	16.6	13.3	6.4
		5	22.8	15.6	7.4
		6	29.9	17.3	8.1
		7	20.5	15.1	8.9
		8	20.1	15.0	7.9
		9	16.9	12.4	5.9
		10	21.3	14.6	7.8
19	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	1	6.9	6.1	4.0
		2	10.1	8.3	4.6
		3	8.9	7.0	3.8
		4	5.2	5.0	3.3
		5	7.4	6.6	3.9
		6	14.6	11.1	4.5
		7	12.0	9.7	4.6
		8	7.6	6.8	3.1
		9	7.1	6.1	2.9
		10	8.1	7.6	4.0

TABLE VII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Broadleaf No. 9975. Total height.	Leaf. Length.	Leaf. Width.
			cm.	*cm.*	*cm.*
20	Compost	1	18.6	12.0	6.0
		2	20.0	13.8	7.0
		3	18.5	11.9	4.9
		4	18.0	11.9	5.1
		5	19.7	13.5	6.1
		6	22.4	15.4	8.4
		7	22.3	14.3	8.1
		8	19.1	10.8	5.1
		9	20.2	12.5	7.3
		10	24.3	18.0	9.4
21	$NaNO_3$	1	10.0	8.1	4.4
		2	10.3	9.7	4.6
		3	9.9	7.9	4.7
		4	11.7	9.0	4.8
		5	11.1	9.6	5.0
		6	15.0	10.7	6.0
		7	12.9	10.8	5.2
		8	11.5	9.4	5.5
		9	14.5	9.8	5.1
		10	13.5	10.8	6.1
22	$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4	1	19.2	16.2	8.9
		2	18.0	13.8	7.6
		3	23.6	16.7	9.8
		4	24.1	17.9	10.8
		5	19.3	12.9	8.4
		6	17.9	12.8	6.7
		7	22.4	16.2	9.8
		8	20.9	16.2	9.7
		9	18.1	12.9	7.9
		10	19.4	13.1	6.9
24	K_2SO_4	1	14.1	10.9	5.3
		2	10.6	8.7	4.9
		3	11.1	9.0	4.8
		4	10.8	8.9	4.9
		5	19.3	9.6	6.1
		6	15.6	11.6	5.7
		7	12.1	9.1	4.9
		8	13.4	10.4	5.2
		9	8.4	7.0	3.9
		10	9.2	7.0	4.2
27	Dried blood	1	19.1	15.5	8.1
		2	21.7	15.3	7.2
		3	19.4	13.7	6.3
		4	18.4	10.5	5.9
		5	12.8	9.0	4.8
		6	16.5	13.5	7.6
		7	14.0	11.1	6.1
		8	13.3	10.7	6.1
		9	11.9	9.9	5.5
		10	12.6	10.5	5.4
29	$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4	1	5.6	4.5	2.3
		2	6.3	5.7	3.6
		3	4.9	4.0	2.3
		4	6.0	4.9	3.0
		5	6.5	4.9	3.1
		6	12.8	8.8	4.7
		7	17.1	12.0	5.3
		8	16.8	11.3	5.1
		9	14.2	11.0	6.1
		10	13.2	10.6	5.7

TABLE VII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Broadleaf No. 9975. Total height.	Leaf. Length.	Leaf. Width.
			cm.	*cm.*	*cm.*
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	1	12.0	9.3	5.2
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	2	10.4	9.3	4.6
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	3	11.2	8.3	4.7
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	4	15.1	11.0	6.0
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	5	13.2	10.4	5.6
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	6	9.9	8.5	4.6
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	7	11.6	9.1	4.8
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	8	14.4	11.2	6.0
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	9	15.0	11.7	7.3
30	$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	10	16.3	12.2	6.1
31	Control	1	7.7	6.1	3.3
31	Control	2	8.7	6.4	3.4
31	Control	3	9.2	7.3	3.9
31	Control	4	9.6	7.6	4.3
31	Control	5	11.1	9.3	5.0
31	Control	6	11.4	9.1	4.9
31	Control	7	13.6	10.5	4.8
31	Control	8	13.5	10.9	6.3
31	Control	9	10.5	8.1	4.0
31	Control	10	10.4	8.1	4.4
32	$(NH_4)_2SO_4$	1	10.7	8.6	4.9
32	$(NH_4)_2SO_4$	2	11.3	8.9	4.4
32	$(NH_4)_2SO_4$	3	10.3	8.5	4.3
32	$(NH_4)_2SO_4$	4	12.5	9.4	5.3
32	$(NH_4)_2SO_4$	5	11.5	9.8	5.7
32	$(NH_4)_2SO_4$	6	15.1	12.0	8.2
32	$(NH_4)_2SO_4$	7	10.1	8.8	5.5
32	$(NH_4)_2SO_4$	8	10.3	8.3	4.5
32	$(NH_4)_2SO_4$	9	11.1	8.7	4.3
32	$(NH_4)_2SO_4$	10	12.0	9.2	4.6
34	K_2SO_4	1	14.6	11.7	6.0
34	K_2SO_4	2	15.0	11.9	6.3
34	K_2SO_4	3	18.3	12.5	6.5
34	K_2SO_4	4	19.3	13.2	6.5
34	K_2SO_4	5	13.3	9.9	5.1
34	K_2SO_4	6	16.5	13.6	6.9
34	K_2SO_4	7	15.1	12.1	6.4
34	K_2SO_4	8	14.5	9.6	5.0
34	K_2SO_4	9	13.5	10.3	5.9
34	K_2SO_4	10	13.2	10.2	5.5
35	$(NH_4)_2SO_4$	1	16.1	13.0	7.0
35	$(NH_4)_2SO_4$	2	10.6	9.1	4.3
35	$(NH_4)_2SO_4$	3	10.4	8.3	4.9
35	$(NH_4)_2SO_4$	4	12.1	9.7	4.6
35	$(NH_4)_2SO_4$	5	12.0	9.7	4.6
35	$(NH_4)_2SO_4$	6	18.0	13.0	6.3
35	$(NH_4)_2SO_4$	7	15.9	11.9	5.7
35	$(NH_4)_2SO_4$	8	11.4	8.4	4.7
35	$(NH_4)_2SO_4$	9	10.4	7.9	4.4
35	$(NH_4)_2SO_4$	10	20.1	15.1	8.0
36	$NaNO_3$	1	5.6	4.7	2.8
36	$NaNO_3$	2	6.0	5.1	3.1
36	$NaNO_3$	3	7.3	4.7	3.0
36	$NaNO_3$	4	5.2	4.4	2.7
36	$NaNO_3$	5	4.9	4.0	2.3
36	$NaNO_3$	6	10.5	8.6	4.5
36	$NaNO_3$	7	9.6	6.1	3.3
36	$NaNO_3$	8	10.8	7.2	4.5
36	$NaNO_3$	9	10.9	9.1	5.8
36	$NaNO_3$	10	9.4	5.2	3.1

TABLE VII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Repollo No. 9976. Total height.	Leaf. Lenght.	Width.
			cm.	cm.	cm.
12	K2SO4	1	19.1	15.2	7.0
		2	13.7	11.5	6.9
		3	10.2	8.9	4.7
		4	18.0	15.1	6.8
		5	16.3	12.1	6.5
		6	21.4	13.1	6.1
		7	17.6	13.9	7.3
		8	19.6	13.3	6.3
		9	19.6	14.1	7.7
		10	18.5	13.2	6.3
18	Compost	1	13.2	8.8	4.9
		2	13.9	10.6	5.4
		3	14.5	11.3	5.0
		4	15.5	11.9	5.7
		5	17.1	11.6	5.6
		6	18.6	13.0	6.7
		7	15.9	9.8	5.2
		8	19.6	13.3	6.3
		9	19.6	14.1	7.7
		10	15.6	11.5	6.0
26	Chicken manure	1	14.9	12.3	6.5
		2	13.0	10.7	5.8
		3	13.5	11.0	5.7
		4	14.9	12.3	6.7
		5	11.9	9.7	5.4
		6	12.8	10.7	6.1
		7	12.0	9.5	4.8
		8	13.4	11.0	6.5
		9	13.6	10.9	5.2
		10	12.6	9.8	5.1
28	Horse manure	1	12.3	10.7	5.3
		2	11.0	9.3	4.5
		3	14.5	10.9	5.0
		4	13.0	9.7	5.2
		5	13.2	11.1	5.6
		6	13.3	11.0	5.4
		7	10.4	8.3	4.1
		8	10.0	8.1	4.4
		9	13.1	11.1	5.5
		10	12.1	9.6	4.8
39	(NH4) 2SO4, Ca(H4PO4)2, K2SO4	1	13.7	8.6	4.7
		2	12.0	8.7	4.6
		3	13.2	9.9	5.5
		4	15.5	11.2	5.2
		5	14.4	10.3	4.7
		6	15.4	11.6	6.4
		7	14.1	10.3	5.3
		8	16.1	10.2	8.5
		9	18.1	12.1	9.4
		10	17.2	11.9	6.6

TABLE VIII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Romero No. 9977. Total height.	Leaf. Length.	Leaf. Width.
			cm.	*cm.*	*cm.*
1	$NaNO_3$	1	10.5	8.5	4.9
		2	18.4	9.4	6.9
		3	17.6	8.9	4.5
		4	10.3	8.3	5.7
		5	15.5	10.1	5.4
		6	11.5	9.4	6.7
		7	12.7	11.1	7.0
		8	13.5	12.1	7.2
		9	19.1	18.6	9.1
		10	11.1	9.5	6.0
4	$(NH_4)_2SO_4$	1	12.7	10.3	6.0
		2	12.1	10.0	5.6
		3	11.9	9.9	5.0
		4	11.4	9.1	5.6
		5	19.5	18.3	9.3
		6	13.0	10.4	5.7
		7	11.2	8.5	4.7
		8	13.1	10.3	5.5
		9	11.5	8.7	5.0
		10	13.2	10.5	6.0
16	Chicken manure	1	6.5	5.8	4.2
		2	8.2	7.1	4.5
		3	9.1	7.8	5.0
		4	8.2	7.7	5.3
		5	10.2	8.8	5.5
		6	10.0	8.0	5.3
		7	11.7	9.7	5.7
		8	10.5	8.6	6.1
		9	11.5	8.6	5.1
		10	9.4	5.4	3.5
23	Horse manure	1	14.7	11.6	7.0
		2	11.5	9.7	6.0
		3	14.0	11.6	7.1
		4	15.5	12.4	7.9
		5	13.3	11.1	6.8
		6	17.2	13.6	8.2
		7	10.3	8.7	5.3
		8	14.8	12.2	8.5
		9	14.3	10.9	6.9
		10	17.1	12.7	7.1
37	Compost	1	18.3	12.1	6.9
		2	19.2	13.4	6.5
		3	19.3	11.9	6.3
		4	18.4	12.1	5.9
		5	18.9	12.3	6.6
		6	13.4	10.0	6.0
		7	11.8	8.9	5.0
		8	10.4	8.9	5.3
		9	19.9	15.5	7.8
		10	11.9	10.2	6.0

TABLE VIII—Continued.

Bed No.	Kinds of fertilizer.	Number of plant.	Echague mixed No. 9978. Total height.	Leaf. Length.	Leaf. Width.
			cm.	*cm.*	*cm.*
8	$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4	1	19.1	14.0	8.0
		2	16.6	12.3	7.6
		3	18.6	15.0	7.8
		4	20.8	13.3	5.6
		5	20.6	14.3	6.6
		6	12.3	11.0	6.2
		7	20.1	12.6	6.0
		8	19.6	13.5	6.6
		9	16.8	12.5	6.7
		10	16.4	12.4	7.6
9	Compost	1	5.3	3.0	2.4
		2	5.8	3.9	2.5
		3	4.8	4.1	2.9
		4	5.9	4.9	3.1
		5	5.8	5.4	3.3
		6	6.1	4.3	2.9
		7	10.5	8.6	5.8
		8	10.2	8.3	4.4
		9	9.3	7.0	5.5
		10	8.9	6.6	3.1
33	Horse manure	1	12.0	9.7	5.0
		2	12.6	9.7	4.5
		3	14.9	10.8	5.3
		4	12.3	8.7	4.9
		5	11.3	8.6	4.0
		6	13.7	10.5	5.6
		7	12.7	10.4	6.3
		8	12.1	9.8	5.3
		9	10.2	8.1	4.2
		10	11.3	8.6	4.8
38	Chicken manure	1	12.0	9.0	4.5
		2	11.5	8.4	4.4
		3	9.8	8.3	4.3
		4	11.8	8.6	4.1
		5	10.3	7.8	3.8
		6	10.1	7.5	4.6
		7	12.8	8.6	5.4
		8	10.6	8.8	4.9
		9	12.2	9.5	5.0
		10	11.6	8.8	4.6
25	Dried blood	1	10.2	7.3	4.2
		2	9.2	6.2	3.7
		3	5.2	4.7	3.0
		4	5.8	4.5	2.3
		5	5.7	5.3	3.2
		6	10.5	8.2	5.2
		7	10.1	8.6	5.5
		8	10.3	8.1	5.7
		9	10.1	9.1	6.6
		10	10.5	9.2	5.3

TABLE VIII.—*Growth measurements under different shade.*

Bed No.	Date measured.	Shade.	Plants. 1	2	3	4	5
	1918		*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
15	October 6	Cloth	4.7	3.5	3.7	2.8	3.5
	7	do	5.7	4.1	3.9	3.1	4.7
	8	do	6.5	4.7	4.2	4.2	6.0
	9	do	7.5	5.3	4.3	4.4	7.0
	10	do	9.5	5.8	4.4	5.1	8.0
	11	do	11.8	6.0	5.0	5.3	8.6
	12	do	14.0	6.2	6.0	5.7	9.3
	13	do	15.8	7.4	6.7	5.8	10.2
	14	do	17.3	8.3	7.5	7.0	11.2
	15	do	18.6	9.5	8.4	8.0	12.9
	16	do	19.3	10.1	9.2	9.0	14.5
	17	do	20.2	10.9	9.5	9.8	15.5
	18	do	21.1	11.2	10.1	10.6	17.0
	19	do	21.5	12.1	10.4	11.2	18.5
	20	do	22.0	13.4	10.9	11.9	19.8
	21	do	22.5	14.7	11.8	12.1	20.5
	22	do	23.0	15.9	12.6	12.8	21.3
	23	do	23.6	16.8	13.2	14.0	21.7
	24	do	24.6	18.0	14.4	14.6	22.4
	25	do	25.6	19.6	15.0	15.9	23.5
	26	do	26.6	22.0	16.1	17.0	24.6
	27	do	27.9	23.9	17.5	19.1	26.6
	1918						
27	October 6	Cogon	3.8	4.0	3.1	3.0	3.2
	7	do	5.1	4.5	3.6	3.1	3.5
	8	do	6.3	5.6	3.9	3.5	3.8
	9	do	7.5	6.2	4.2	4.2	4.4
	10	do	8.7	6.7	4.8	4.5	5.1
	11	do	10.2	7.3	5.6	4.8	5.7
	12	do	11.6	7.7	6.3	5.3	6.8
	13	do	12.7	8.2	6.8	5.8	7.7
	14	do	13.5	8.6	7.2	6.0	8.2
	15	do	14.1	9.9	7.7	6.8	9.2
	16	do	15.3	11.1	8.1	7.9	9.7
	17	do	17.1	12.5	8.6	8.9	10.2
	18	do	18.6	13.5	9.1	9.5	10.4
	19	do	20.0	14.2	10.4	10.3	11.7
	20	do	20.6	14.5	11.2	10.5	12.8
	21	do	21.2	15.0	11.3	10.8	13.4
	22	do	22.2	15.8	11.8	11.3	13.8
	23	do	22.5	16.0	12.2	11.5	14.0
	24	do	22.6	17.5	13.2	12.4	14.9
	25	do	23.5	18.6	14.1	13.2	15.4
	26	do	24.6	19.8	15.7	14.4	16.4
	27	do	25.6	20.9	17.1	15.6	17.1
	1918						
2	Oct. 6	Nipa	4.6	3.0	3.4	3.6	2.9
	7	do	5.5	3.8	3.9	4.6	3.1
	8	do	7.0	4.6	4.1	5.6	3.9
	9	do	8.0	5.6	5.8	6.6	4.3
	10	do	9.1	6.0	6.7	7.3	5.1
	11	do	10.0	6.5	7.3	8.1	5.5
	12	do	11.0	7.2	7.9	9.3	6.0
	13	do	12.1	7.5	8.6	11.2	6.3
	14	do	13.8	8.1	9.0	12.9	6.6
	15	do	15.0	8.5	9.5	14.8	7.0
	16	do	16.5	9.6	11.1	16.1	8.1
	17	do	17.0	11.1	12.4	17.9	9.1
	18	do	18.1	12.0	13.6	18.1	9.6
	19	do	19.0	12.9	14.8	18.7	10.4
	20	do	19.7	13.5	15.7	19.5	10.9
	21	do	20.4	14.0	16.4	19.8	11.1
	22	do	21.3	15.2	17.1	20.2	11.5
	23	do	21.8	16.9	18.5	20.5	11.7
	24	do	22.1	18.4	20.0	21.0	12.2
	25	do	25.5	19.5	21.3	21.6	13.3
	26	do	23.1	21.0	22.2	22.2	14.6
	27	do	23.4	21.6	23.1	23.1	15.4

TABLE VIII.—*Growth measurements under different shade*—Continued.

Bed No.	Date measured.	Shade.	Plants. 1	2	3	4	5
	1918		*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
35	Oct. 6	Banana leaves	3.0	3.7	3.3	3.0	2.4
	7	do	3.5	4.5	4.0	3.1	2.6
	8	do	4.5	5.5	5.0	3.6	2.8
	9	do	5.6	6.1	5.5	4.3	3.2
	10	do	6.7	6.5	5.8	4.7	3.8
	11	do	7.4	6.9	6.3	5.1	4.0
	12	do	8.3	7.0	6.6	6.0	4.5
	13	do	9.2	8.2	6.9	6.6	4.8
	14	do	10.2	9.3	8.1	7.1	5.0
	15	do	10.8	10.1	9.2	7.7	5.2
	16	do	11.4	11.2	10.3	8.0	5.6
	17	do	11.6	11.6	10.8	8.4	5.5
	18	do	11.9	12.0	11.5	8.7	7.3
	19	do	13.0	12.4	11.8	9.6	8.1
	20	do	14.0	12.6	12.5	10.3	8.5
	21	do	15.6	13.0	13.0	10.5	8.7
	22	do	16.6	14.0	13.9	11.1	9.1
	23	do	17.5	14.2	14.5	11.5	11.3
	24	do	19.0	15.5	15.4	13.4	13.7
	25	do	19.5	15.6	16.1	14.3	14.3
	26	do	20.1	17.8	18.2	15.9	15.5
	27	do	21.5	19.9	20.5	17.1	16.5
	1918						
31	Oct. 6	Cogon	2.6	2.8	3.0	2.9	2.7
	7	do	2.8	3.7	3.5	3.8	2.9
	8	do	3.3	4.4	4.2	4.8	3.5
	9	do	3.6	4.5	4.9	5.6	4.3
	10	do	4.0	5.3	5.1	5.9	4.6
	11	do	4.5	5.6	5.7	6.6	5.4
	12	do	5.2	6.5	6.2	7.1	6.3
	13	do	5.7	6.8	6.5	7.7	6.9
	14	do	5.9	7.9	6.8	8.5	7.2
	15	do	6.4	9.1	7.1	9.7	7.5
	16	do	6.8	9.9	7.8	10.9	7.8
	17	do	7.0	10.8	9.3	11.5	9.2
	18	do	8.2	11.3	10.0	12.0	10.2
	19	do	9.3	12.0	10.7	13.5	11.5
	20	do	9.8	12.3	11.1	13.7	11.6
	21	do	10.4	12.9	11.4	14.1	12.1
	22	do	11.0	14.2	11.6	14.7	12.7
	23	do	11.8	15.1	11.8	15.0	13.1
	24	do	12.7	16.7	13.7	15.2	13.6
	25	do	13.4	17.1	14.9	16.1	14.0
	26	do	15.5	18.0	16.1	17.3	15.5
	27	do	17.2	19.3	17.0	18.1	17.0
	1918						
34	Oct. 6	Banana leaf	3.1	3.4	3.2	2.9	2.9
	7	do	3.2	3.6	3.3	3.1	3.1
	8	do	4.1	4.0	3.8	3.4	3.3
	9	do	4.6	4.3	4.6	4.4	3.4
	10	do	5.4	4.4	5.4	4.8	4.1
	11	do	5.8	4.8	5.9	5.6	4.7
	12	do	6.4	5.0	6.6	6.4	5.5
	13	do	6.7	5.2	7.3	7.0	6.2
	14	do	6.9	5.9	8.6	7.4	6.7
	15	do	7.7	6.4	8.8	8.3	7.5
	16	do	8.5	7.0	9.0	8.5	7.7
	17	do	9.8	7.4	10.0	9.0	8.2
	18	do	10.6	7.8	10.1	9.3	8.3
	19	do	11.4	8.0	11.2	10.5	8.6
	20	do	11.6	8.3	11.5	11.5	9.4
	21	do	11.8	8.6	11.9	12.1	10.1
	22	do	12.4	9.2	12.1	12.7	11.5
	23	do	12.6	9.9	12.5	13.1	12.1
	24	do	12.8	10.4	12.9	14.1	13.0
	25	do	13.1	11.1	13.2	14.3	13.6
	26	do	13.6	11.3	13.9	14.8	14.1
	27	do	14.5	11.7	14.8	16.5	14.6

TABLE VIII.—*Growth measurements under different shade*—Continued.

Bed No.	Date measured.	Shade.	Plants 1	Plants 2	Plants 3	Plants 4	Plants 5
			cm.	*cm.*	*cm.*	*cm.*	*cm.*
11	Oct. 6	Nipa	4.0	4.2	2.8	3.0	3.3
	7	do	4.9	5.3	3.6	3.6	3.8
	8	do	5.5	6.1	4.2	4.1	4.0
	9	do	6.2	6.5	4.5	4.7	4.8
	10	do	6.9	7.3	4.6	5.1	5.4
	11	do	7.3	7.6	4.8	5.4	5.9
	12	do	7.8	8.6	5.9	5.9	6.4
	13	do	8.4	10.3	6.7	6.5	6.6
	14	do	9.9	12.2	7.7	7.8	7.0
	15	do	11.4	14.0	8.5	8.9	7.5
	16	do	12.1	15.1	9.1	9.7	7.8
	17	do	13.6	15.9	9.6	10.4	8.7
	18	do	14.5	16.5	10.0	10.9	9.6
	19	do	15.6	16.7	10.4	11.3	10.6
	20	do	15.9	17.1	11.2	11.4	10.8
	21	do	16.0	17.5	12.0	11.8	10.9
	22	do	16.5	17.7	12.6	12.4	11.7
	23	do	16.8	17.8	13.2	13.0	11.8
	24	do	17.6	17.9	13.9	15.2	13.9
	25	do	18.5	18.0	14.8	15.0	15.9
	26	do	19.1	18.5	16.3	16.1	17.4
	27	do	19.5	19.0	18.0	16.5	18.9
13	Oct. 6	Cloth	3.2	3.1	3.6	3.5	3.2
	7	do	3.5	3.4	4.0	3.2	3.8
	8	do	3.9	4.2	5.0	3.6	4.7
	9	do	4.3	4.9	5.5	3.9	5.5
	10	do	4.9	5.3	5.9	4.3	5.8
	11	do	5.6	5.8	6.1	5.0	6.1
	12	do	6.2	6.3	6.8	5.7	6.7
	13	do	7.0	6.6	8.0	6.5	7.5
	14	do	7.6	7.0	9.0	7.0	8.2
	15	do	8.3	7.5	10.0	7.8	9.1
	16	do	8.7	8.3	10.9	8.2	9.8
	17	do	9.2	9.7	11.5	8.7	10.5
	18	do	10.0	10.3	12.2	9.5	10.8
	19	do	11.4	10.6	12.8	11.1	11.3
	20	do	12.3	11.2	12.9	11.8	11.8
	21	do	13.0	12.3	14.1	12.0	13.0
	22	do	13.5	13.2	15.3	12.8	14.0
	23	do	14.0	13.9	16.8	13.4	14.7
	24	do	15.1	14.7	18.6	15.0	15.6
	25	do	16.7	15.8	19.6	16.9	16.6
	26	do	18.5	17.0	21.3	18.9	19.0
	27	do	20.3	18.1	23.4	20.4	20.6
	1918						
25	Oct. 6	None	2.2	2.9	2.0	2.3	3.0
	7	do	2.4	3.1	2.3	2.8	3.1
	8	do	2.4	3.3	2.6	3.1	3.2
	9	do	2.4	3.6	3.2	3.4	3.4
	10	do	2.5	3.7	3.5	3.5	3.7
	11	do	2.6	4.0	3.7	3.7	4.3
	12	do	2.6	4.4	4.0	3.8	4.6
	13	do	2.7	4.7	4.2	3.9	5.1
	14	do	3.0	4.9	4.5	4.3	5.4
	15	do	3.3	5.3	4.8	4.9	5.8
	16	do	3.6	5.4	5.0	5.5	6.2
	17	do	3.7	5.7	5.1	5.8	6.5
	18	do	4.2	5.9	5.4	6.2	6.7
	19	do	4.3	6.3	5.8	6.4	6.9
	20	do	4.7	6.6	6.0	6.8	7.2
	31	do	4.9	7.0	6.1	7.4	7.3
	22	do	5.2	7.5	6.4	7.8	7.6
	28	do	5.5	7.6	6.6	8.4	8.0
	24	do	5.8	7.9	7.0	8.8	8.3
	25	do	6.5	8.3	7.9	9.4	8.9
	26	do	7.2	9.1	8.1	9.9	9.2
	27	do	7.8	9.8	8.7	10.3	9.7

TABLE IX.—*Weekly counts of the weeds in each bed.*

Date.	Methods of sterilization.	Beds.									
		1	2	3	4	5	6	7	9	13	22
Sept. 16	Hot water	7	5	7	8	10	9	11	6	5	4
23	do	42	91	100	95	59	100	86	98	140	85
30	do	50	80	95	78	47	150	16	150	70	106
Oct. 7	do	51	75	67	56	64	161	171	161	62	115
14	do	72	90	75	96	72	89	95	156	30	78
21	do	55	78	67	75	61	69	86	152	17	75
		10	11	12	14	16	17	20	23	25	29
Sept. 16	Roasting or pan frying	2	0	0	0	1	0	3	1	10	17
23	do	53	42	36	61	81	69	35	30	20	81
30	do	43	36	40	36	33	29	60	17	39	65
Oct. 7	do	31	25	16	10	25	40	54	19	41	17
14	do	40	10	12	9	10	18	15	4	50	20
21	do	51	15	10	17	18	25	11	13	30	12
		19	26	27	31	32	33	34	36	37	39
Sept. 16	Firing or burning	14	12	20	10	12	15	21	10	10	10
23	do	63	84	35	14	28	63	53	77	76	21
30	do	156	78	80	18	25	89	84	80	94	38
Oct. 7	do	101	92	132	20	95	101	79	35	91	27
14	do	94	69	19	111	20	85	46	65	75	29
21	do	63	40	17	57	18	30	25	50	48	46
		8	15	18	21	24	28	30	35	38	
Sept. 16	Control	15	20	18	25	17	11	15	16	15	------
23	do	115	160	175	95	49	81	147	189	161	------
30	do	200	185	135	65	86	79	176	175	153	------
Oct. 7	do	175	175	20	110	99	85	185	193	172	------
14	do	100	96	101	98	75	100	187	183	160	------
21	do	152	120	173	97	81	95	175	97	186	------

Actual counts of the weeds which appeared every week were made. Table IX shows that the beds 10, 11, 12, 14, 16, 17, 20, 23, 25 and 29 which were treated by roasting, or pan frying method had the least number of weeds. Controls 8, 15, 18, 21, 28, 30, 35, and 38 had the most number of weeds. Beds which were treated by hot water and firing, or burning methods had less number of weeds than the control but more than those which were treated by roasting, or pan frying method.

TABLE X.—*Temperature record under different shades.*

Date.	Weather condition.	Time.	Nipa.	Cloth.	Cogon.	Banana leaves.	Open.
1918			°C.	°C.	°C.	°C.	°C.
October 3	Clear	6	27	26	26	26	27
	do	12	31.5	32.5	31	31.5	36
	Cloudy	4	28.1	28.0	28.3	28.0	28.8
5	Cloudy	6	24	24.1	24.2	22.8	25.0
	Clear	12	31.8	32.5	31.5	32.0	32.1
	Fair	4	31.0	35.0	31.0	32.0	33.0
7	Cloudy	6	22.8	22.8	22.5	22.6	22.8
	do	12	30.0	30.1	30.0	30.0	30.2
	do	4	28.9	30.0	28.9	28.9	30.1
9	Cloudy	6	22.0	22.1	22.1	22.0	22.0
	Clear	12	30.0	31.0	28.9	28.9	28.9
	Cloudy	4	28.2	28.5	28.1	28.2	28.5
11	Cloudy	6	22.5	22.7	22.7	22.8	22.7
	Clear	12	30.2	32.2	30.2	30.2	32.8
	Cloudy	4	26.5	26.8	26.5	26.8	26.9
13	Cloudy	6	22.1	22.5	22.1	22.2	22.2
	Clear	12	28.9	30.9	28.9	30.5	32.2
	do	4	30.2	30.2	30.0	30.0	30.5
15	Cloudy	6	22.0	22.0	22.0	22.2	22.2
	Stormy	12	24.1	24.1	24.1	24.1	24.1
	do	4	22.2	22.2	22.2	22.2	22.2

The above record was taken by means of thermometers. A thermometer was hung under each shade at the beginning of the hours indicated under the column "Time." The covers were closed in position while the thermometers were hanging. After 10–20 minutes from the time the thermometers were hung the temperature recorded were read.

SUMMARY.

SHADE.

1. Shade is important in reducing evaporation; the retaining of the moisture enables the seeds to germinate quicker and more perfectly, the shade also protects the beds from washing by heavy rains.

2. Cloth shade seemed to serve better than any of the other kinds of shades tested in this experiment. Plate XIII–*b*. This shade is less dense than nipa, cogon or banana leaves. Though it allows most of the rain to pass through, it regulates the fall and thus prevents washing. Cloth shade does not require much time for putting over the seed beds or opening whenever more light is wanted. As soon as the planter can dispense with the shade the cloth can be stored by rolling it on a long straight pole. If kept in this way, the cloth will last several years.

Cloth shade seemed to favor the growth of the seedlings regardless of the effect of the fertilizers.

3. Nipa, cogon and banana leaves protect the seed beds from being washed by heavy rains, which alone justifies their construction. Plates XIV–*a*, XIV–*b*, XV–*a*.

4. It was observed that the plants in the shaded beds came up earlier and looked healthier than those in the beds without shade.

5. Different kinds of shades have different effects upon the germination of the tobacco seeds.

6. The controls (without shade) did not only show poor germination but also gave very stunted growth. Measurements showed that the seedlings under the shade produced more growth than those without shade.

7. Tobacco seeds could not be germinated with success without shade.

SOIL STERILIZATION AND DISINFECTION.

1. Damping-off is a disease which kills very young seedlings. It is caused by such parasitic fungi as *Rhizoctonia, Sclerotium, Phytophthora nicotiana* and *Phythium debaryanum.* This disease may cause serious damage to tobacco seedlings.

2. Avoid excessive moisture, shade, and thick planting in order to lessen the losses from this disease.

3. The addition of lime or dried blood seems to favor the attack of the disease. No effect of the damping-off was observed with the various fertilizers used in the experiment except with dried blood. Plate IX–*b*.

4. Soil sterilization and disinfection are recommended in combating damping-off. Of many methods tested during the course of the experiment, treatments with 1–50 and 1–75 formalin at the rate of ten liters per one square meter of bed, one per cent copper sulphate; hot water; roasting, or pan frying; and firing, or burning proved the most satisfactory. No sign of the disease was observed with these treatments. Copper sulphate of two per cent strength at the rate of 3.5 liters per one square meter of bed prevented germination of the seeds. Treatment of the soil with formalin at strength of 1–100, 1–150 or 1–200 did not kill the fungi. The latter treatments were no better than the checks. Treatment of the soil with 1–50 and 1–75 formalin at the rate of ten liters per square meter was very effective in controlling damping-off and weeds. The only objection to formalin treatment is its high cost and the time required for the soil to dry out.

5. Copper sulphate at strength of one per cent and formal-

dehyde at 1–50 and 1–75 are helpful in controlling weeds. Very few weeds were observed with these treatments before the time of transplanting.

6. Sterilization of the soil by hot water, roasting, or pan frying, burning, or firing proved very satisfactory methods of preventing damping-off. Roasting, or pan frying is most beneficial both in preventing damping-off and killing weed seeds and insect pests in the soil.

7. Hot water and firing, or burning treatments while they proved to be beneficial in controlling the disease did not show much effect in killing weed seeds. This is due probably to the fact that the hot water cooled off before it penetrated into the soil where most of the weed seeds are found. Weed seeds with a thick and hard coating could not be surely killed by the action of boiling water in a short period of time. Direct burning, or firing also did not prove helpful in killing the weed seeds because the heat could not penetrate to the depth of several inches where most of the weed seeds are.

8. According to the results obtained from the experiments, it is possible to entirely control damping-off disease by means of soil sterilization and disinfection.

FERTILIZERS.

1. The fertilizer experiments for tobacco seed beds would have to be carried on for at least three years to arrive at conclusive results. However, in this experiment the measurements taken before transplanting showed plainly the good effect of applying fertilizers to obtain stronger and healthier seedlings and at the same time, to increase the fertility of the soil intended for the seed beds.

2. It is well known that the fertilized tobacco seedlings grow more rapidly than those which have not been fertilized and this fact was well demonstrated by the seedlings in the fertilized beds. This is shown in beds 2, 4, 8, 10, 15, 17, 20, 26, 31, and 33 and by the daily measurements given in Table VII.

3. By comparison, beds 2, 8, 15, 17, and 20 were found to be not only equally good, but much superior to 31 which had no fertilizer. Beds 4, 10 and 33 were much inferior to 2, 8, 15, 17, and 20 but slightly better than 31. This showed that dried blood, NaNO3 + Ca(H4PO4)2 + K2SO4, (NH4)2SO4 + Ca = (H4PO4)2 + Ca(H4PO4)2 +K2SO4 and compost had a marked effect and that (NH4)2SO4, NaNO3, chicken manure and horse manure gave very little effect. This conclusion is further em-

phasized by comparing the measurements taken before transplanting. Table VII.

4. The plants in the unfertilized beds 11, 13, 31 came up later than those in the fertilized ones. Table XI.

5. Taking the averages from Table VII of the four tallest plants from each four beds with the same fertilizer, the following results were obtained:

Dried blood, average height of the seedlings....cm....	23
K_2SO_4, average height of the seedlings....cm....	18.8
Chicken manure, average height of the seedlings....cm....	14.8
$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4, average height of the seedlings..cm....	20.8
Horse manure, average height of the seedlings....cm....	17.6
Compost, average height of the seedlings....cm....	18.3
$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4, average of the seedlings..cm....	19.7
$NaNO_3$, average height of the seedlings....cm....	16.1
$(NH_4)_2SO_4$, average height of the seedlings....cm....	17.9
Control, average height of the seedlings....cm....	13.3

TABLE XI.

Fertilizer.	Days required to germinate under.				
	Cloth.	Nipa.	Cogon.	Banana leaves.	Control.
$NaNO_3$	5	6	—	—	11
Dried blood	5	5	7	—	7
K_2SO_4	5	7	—	6	6
$(NH_4)_2SO_4$	5	7	8	8	7
$NaNO_3$, $Ca(H_4PO_4)_2$, K_2SO_4	5	6, 5	—	—	12
$(NH_4)_2SO_4$, $Ca(H_4PO_4)_2$, K_2SO_4	5	—	8	6	7
Chicken manure	5	6	7	—	—
Horse manure	5	6	7	—	7
Compost	5	—	—	5	7
Control	9	11	11	—	11

6. Table XI and the accompanying graph, plainly demonstrate that tobacco seeds when grown under cloth cover and fertilized with $NaNO_3$, dried blood, K_2SO_4, $(NH_4)_2SO_4$, $NaNO_3+Ca(H_4PO_4)_2 + K_2SO_4$, $(NH_4)_2SO_4 + Ca(H_4PO_4)_2 + KSO_4$, chicken manure, horse manure and compost will germinate within five days or with a gain of four days over the control with no fertilizer.

7. Under nipa cover and fertilized with $NaNO_3$, dried blood, K_2SO_4, $(NH_4)_2SO_4$, $NaNO_3 + Ca(H_4PO_4)_2 + K_2SO_4$, chicken manure, horse manure, the tobacco seeds will germinate in from five to seven days or with a gain of from four to six days over the control with no fertilizer.

8. Under cogon cover and fertilized with dried blood, $(NH_4)_2SO_4$, $(NH_4)_2SO_4 + Ca(H_4PO_4)_2 + K_2SO_4$, chicken manure,

horse manure, the tobacco seeds will germinate in from seven to eight days or with a gain of from three or four days over the control with no fertilizer.

9. Under banana leaves cover and fertilized with $K2SO4$, $(NH4)2SO4$, $(NH4)2SO4 + Ca(H4PO4)2 + K2SO4$ and compost, the tobacco seeds germinated in from five to eight days.

10. Without shade, tobacco seeds when fertilized with $NaNO3$, dried blood, $K2SO4$, $(NH4)2SO4$, $NaNO3 + Ca(H4PO4)2 + K2SO4$, $(NH4)2SO4 + Ca\ (H4PO4)2 + K2SO4$, chicken manure, horse manure and compost required from six to twelve days to germinate.

11. From the results obtained in this experiment, it is clear that the germination of tobacco seeds can be hastened by the application of fertilizers and the use of shading.

12. The time gained by the use of fertilizers and shading is sufficient to justify their use.

RECOMMENDATIONS.

1. That a tobacco seed bed experimental project be provided for, to cover at least three years, particularly for the purpose of studying the best fertilizer for tobacco seedlings; that an appropriation be made for this purpose, so that the experiment can be planned in detail in advance, and carried out as planned.

2. That a systematic and careful application of commercial and natural fertilizers be carried out by every grower so as to determine the needs of his particular soil for seed beds.

3. That a tobacco grower should construct a properly protected seed bed.

4. That the necessity of shading for tobacco seed beds should not be overlooked.

5. That the greatest care and attention be given to the preparation of the seed beds.

6. That the great mistake of using too large a quantity of seeds to a limited area should be avoided.

7. That soil sterilization and disinfection be given more attention.

8. That the Government through the Bureau of Agriculture show the planters better proven methods of seed bed construction and soil sterilization and distribute gratuitously to the growers well grown seedlings and that the work be carried on under expert direction by an adequate force.

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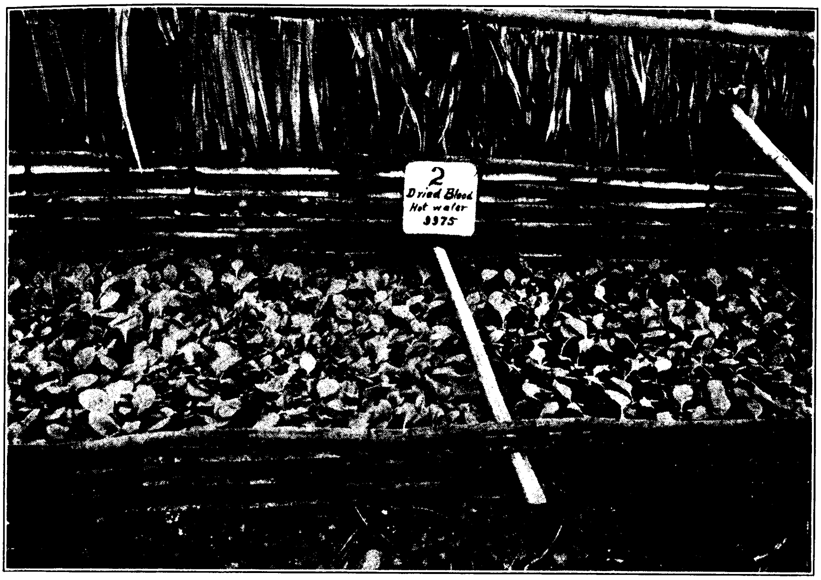
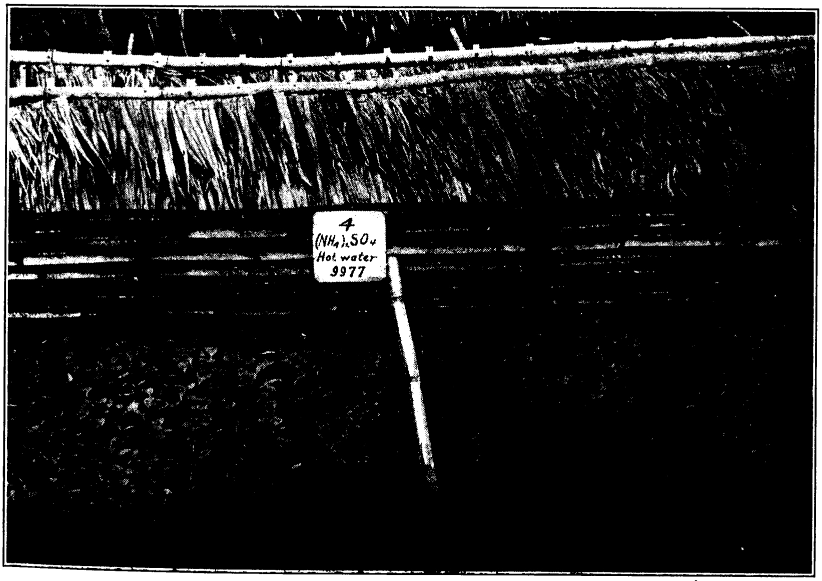
ACKNOWLEDGMENT.

The writer expresses his obligations to Dean C. F. Baker under whose direction this investigation was undertaken, Professor O. A. Reinking for his valuable criticisms, Mr. L. B. Uichanco for taking the photographs for the plates, and to Miss E. S. Yule for her corrections in English.

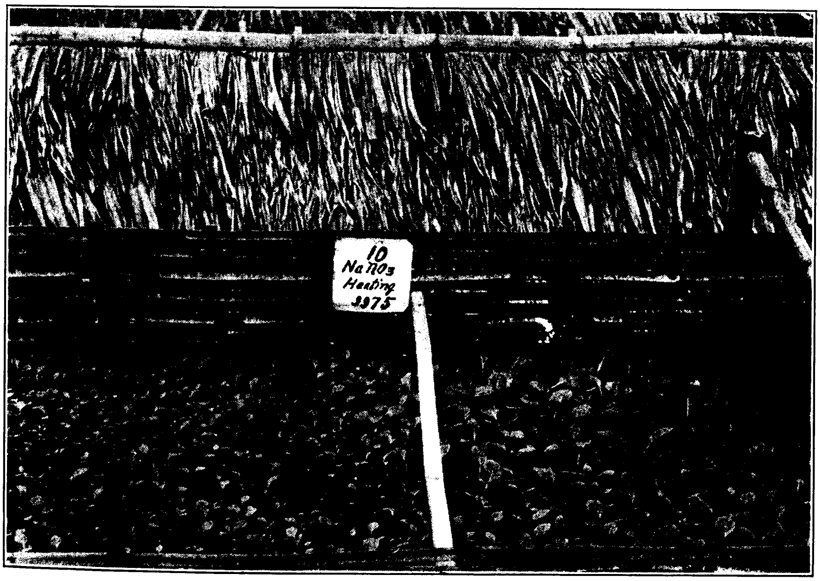


(a) Nipa shade-grown tobacco seedlings just before transplanting and after a severe storm. Seedlings on the right side were pricked.

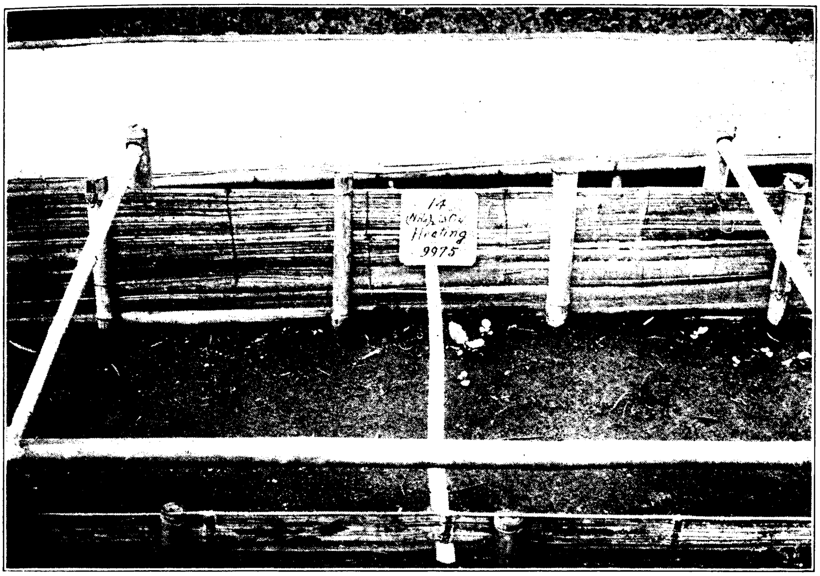


(b) Nipa shade-grown tobacco seedlings just before transplanting and after a severe storm. Seedlings on the right side were pricked.

(*a*) Nipa shade-grown tobacco seedlings just before transplanting and after a severe storm. Seedlings on the right side were pricked.



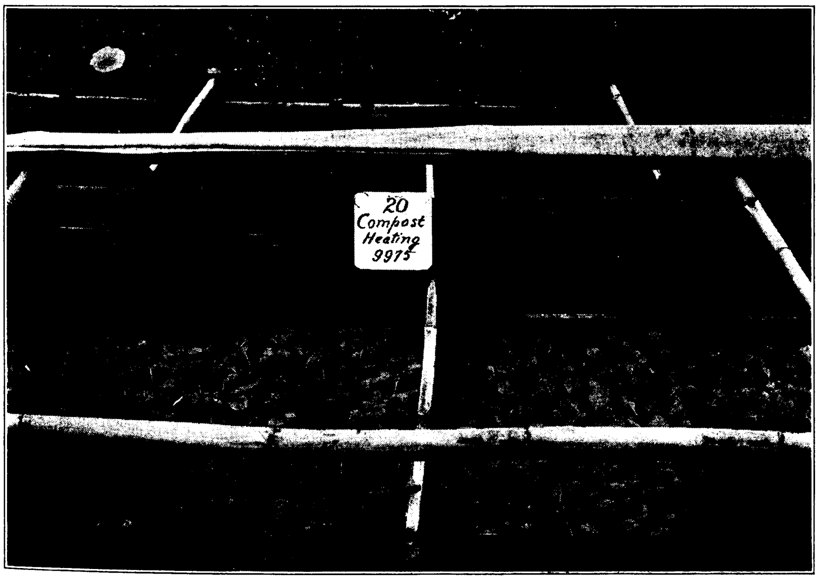
(*b*) Nipa shade-grown tobacco seedlings just before transplanting and after a severe storm. Pricked seedlings.



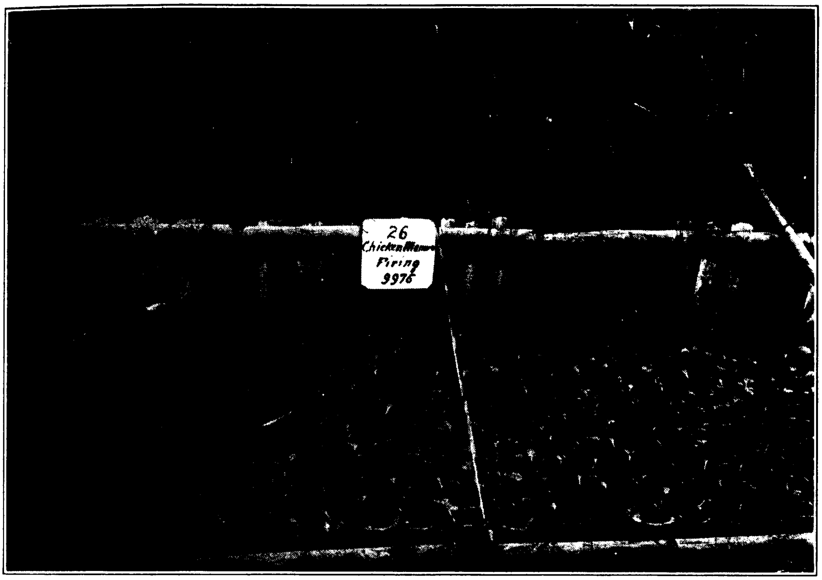
(*a*) Without shade-grown tobacco seedlings just before transplanting and after a severe storm.

(*b*) Cloth shade-grown tobacco seedlings just before transplanting and after a severe storm. Attacked by damping-off disease.

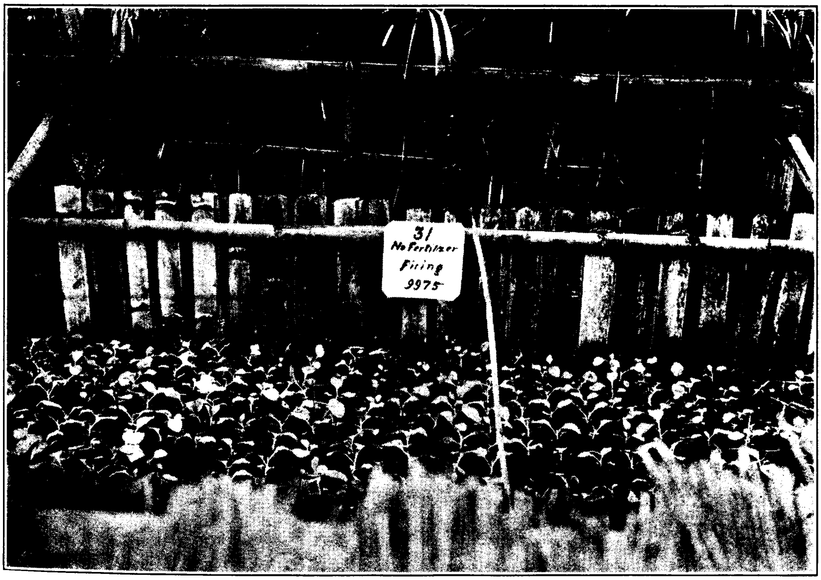
(*a*) Cloth shade-grown tobacco seedlings just before transplanting and after a severe storm.



(*b*) Cloth shade-grown tobacco seedlings just before transplanting and after a severe storm.



(*a*) Cogon shade-grown tobacco seedlings just before transplanting and after a severe storm. Pricked seedlings.



(*b*) Cogon shade-grown tobacco seedlings just before transplanting and after a severe storm. Pricked seedlings.

Banana shade-grown tobacco seedlings just before transplanting and after a severe storm. Pricked seedlings.

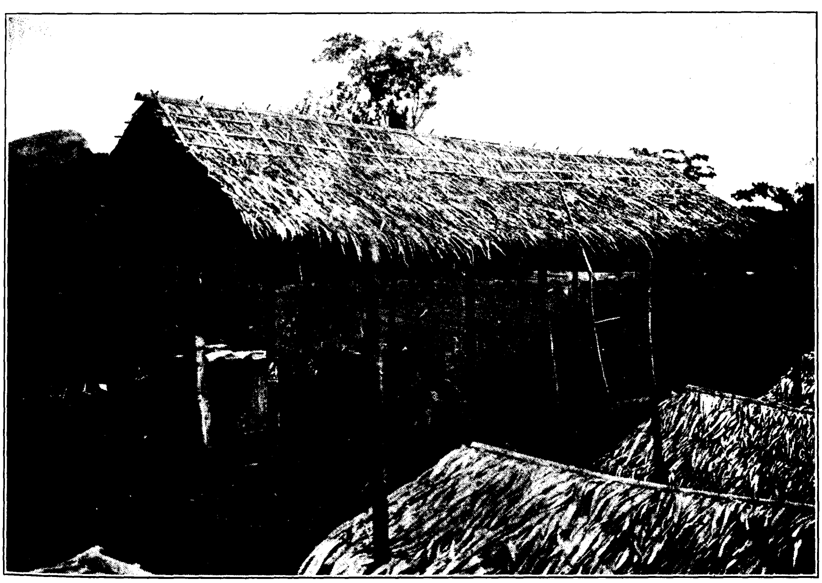
(*a*) Seedbed Type I, Nipa Cover.

(*b*) Seedbed Type II, Cloth Cover.

(*a*) Seedbed Type III, Cogon Cover.

(*b*) Seedbed Type IV, Banana leaf Cover.

(*a*) Seedbed Type V, Nipa Cover.



(*b*) Soil Sterilizer and Roller.

Method of burning the seedbed by firing or direct burning.

CURRENT NOTES—FIRST QUARTER.

NOTES By P. J. WESTER, Agricultural Advisor, Department of Mindanao and Sulu.

ADAPTABILITY OF PLANT DISEASES.

Originally a pest on the Arabian coffee, *Coffea arabica,* the adaptation of the coffee rust, *Hemileia vastatrix,* to Liberian coffee, *C. liberica,* has been a matter of record for some time in this part of the world, and the cause of no little disappointment and loss of capital to those who invested money in Liberian coffee plantations in the Dutch East Indies.

In a recent number of the *Florida State Horticultural Quarterly* there is now recorded another adaptation of a fungus from one hostplant to another that is still more remarkable.

The fungus in question, the Citrus Scab, *Cladosporium citri,* for many years was one of the serious troubles of the "rough lemon," *Citrus limonum* var, extensively employed in Florida as a stock for the cultivated citrus fruits. Then, it adapted itself to the grapefruit or pomelo, *Citrus decumana,* until now it is an equally serious pest on that species. Apparently an ambitious species with imperialistic tendencies, it was not content to prey on the citrus fruits alone but has also adapted itself to the avocado, *Persea americana,* a species widely separated from the citrus fruits.

The identity of the causative agent of the avocado scab was established by Mr. H. E. Stevens, plant pathologist of the Florida Experiment Station, several years ago superintendent of Lamao Experiment Station of this Bureau.

THE DEVELOPMENT OF NATIVE ECONOMIC VS. PLANT INTRODUCTION.

Much stress has been made within the past 2 years upon the importance of the improvement and the disemination of our native food plants in favor of plant introduction. This, of course, including not only the indigenous species, but those whose introduction is of long standing, such as the mango, lanzon, and mandarin, the adaptability of which is assured, and the fruit of which the people are accustomed to. This is eminently as it should be. There can be no question but that the greater part of the energies of government institutions engaged in the betterment of agriculture of a country should be absorbed in the development of those crop plants whose adaptability to a given country has been demonstrated, *but,* while "the right of way" is cheerfully given to such projects the introduction of new plants should not be neglected to the exclusion of the work with the plants already established. Practically every great plant industry is based upon plant introduction, frequently from very distant countries. To cite a few well known examples, with the exception of corn, all the cereals grown in America, are introduced from the old world, the potato grown so extensively in all temperate countries, especially in Europe, is of Peruvian origin. All the true clovers and the alfalfa, so important as forage plants in all temperate countries, are of old world origin. None of the great citrus centers throughout the world are where the respective citrus fruits originated. Para rubber is indigenous to Brazil, but nearly all the plantation rubber is produced in tropical Asia. Considering the Philippines, how many of our plant industries are based upon a truly native plant, or how many native species are even of fairly great importance to the people at large? Suppose no plants had ever been introduced into the Philippine Archipelago, on what would the population subsist and have its being? Rice and corn and all the important legumes excepting the Lyon bean, the coconut, sugar cane, tobacco, the camote, the cassava, the bamboo; all the more important fruits, the banana, mango, mandarin, lanzon, papaya and chico are of foreign origin. The only agricultural plant of major importance of native origin is abacá. There are several root crops, fruits and other economics, such as the tongo, sapang, the sago palm, banago, bauno, baniti, calapi, calpi, calamondin, cubili, galó, litoco, mabolo, marang, pili, tabú, several of which are of excellent quality and very promising, but the fact remains that none of these are of more than passing present day importance.

If fine, whole devoting ourselves to the development of all the plant material already at home let us gratefully remember all those who have from time to time introduced so many of our important plants; such important necessities as rice, corn and coconuts, to those who also add to our enjoyment, for instance the mango, mandarin, mangosteen and the lanzon. While money may easily be wasted on ill advised plant introduction work it is well to remember that the successful plant immigrant is as worthy and useful in its place as the "native born citizen," not infrequently more so.

NOTES ON PHILIPPINE CITRUS FRUITS.

Readers who have been interested in the previously published papers and notes on Philippine Citrus fruits in the Review may be interested to know that during an examination of the Citrus material in the herbarium of the Bureau of Science, Manila, the writer found one herbarium specimen collected in 1909 in the Batanes Islands that unmistakably is infected with Citrus canker.

The Batanes Islands are an isolated group of islands located north of Luzon between 21° and 22° N. latitude, and it would appear that the occurrence of the Citrus canker in this remote part of the Philippine Archipelago is additional proof that the disease has been present in the Philippines for a considerable number of years.

On the other hand it is also of interest to note that during an extensive trip through the Sulu Archipelago, with stops at many places between Jolo and Bongao, the writer failed to find any trace of Citrus canker. As a matter of fact the citrus trees in the Sulu Archipelago so far as noted do not seem to be affected either with any serious disease or insect pests. In Parangan especially fine looking mandarin trees were seen than were said to bear fruit of good quality.

In the Sulu Archipelago two quite distinct Citrus types were noted for the first time. One, the Duroga, an oblate fruit about the size of an orange, growing in large terminal clusters like the grapefruit, lemon colored, somewhat rough, the leaves are quite similar to those of the grapefruit, while the top of the tree is rather dense, branches having a distinct, drooping habit. The Duroga is apparently most closely related to *C. southwickii* Wester. Bankit is another fruit in Jolo resembling the Cabuyao, *C. hixtrix* DC., both in foliage and fruit, yet being quite distinct.

During an extended inspection trip by the writer through the Province of Bukidnon no trace of Citrus canker was discovered except in Kalasungay.

Except on Amai Kurut's plantation, Saguiaran, where canker was found this year by Prof. Otto Reinking, College of Agriculture, Los Baños, Lanao Province is still free from this disease so far as known.

Pink disease, *Corticium salmonicolor*, was noted by the writer on the lime in Mailag, and on Madre de Cacao in Dalirig, Bukidnon, in September, last year.

The Miaray, *Citrus miaray* Wester, described in this Review 1917 from trees discovered in Impolutao, Bukidnon, was last year found in two isolated municipalities southwest of Malaybalay. As yet there is no direct evidence of the occurrence of this species in the forest though the native inhabitants insist on this fact.

NOTES ON THE CARLUDOVICA.

The Carludovica, or Panama hat palm, *Carludovica palmata*, was introduced into the Philippines several years ago by the Bureau of Agriculture, and plants have been distributed to many points in the Archipelago within the last few years.

According to the *Agricultural News* (Barbados), the material for hat manufacture are obtained from young, undeveloped leaves, which are cut so that about 15 centimeters of the petiole is attached to the blade. Then, the large veins in the leaf are removed by a thin, sharp knife, after which the leaf is plunged into boiling water, for about 10 to 15 minutes. After boiling, the leaves are spread in the sun to dry for 2 to 3 hours and are then bleached for a day in a sulfur chamber.

Iron vessels should not be used in which to boil the leaves as the metal is said to stain them.

For cultural directions for the Carludovica see this Review, Vol. X, p. 90, 1917.

A POSSIBLE NEW MEAT SUPPLY FOR THE PHILIPPINES.

Every one who has traveled in the provinces in the Philippines and is at all inquisitive and observant knows that iguanas are considered "good chow" by the rural inhabitants, though most Caucasians would scorn such "humble" food. Yet, for this prejudice no good reason has ever been advanced except the belief that the iguana meat was "poisonous," which of course never was true. Why, in fact, should not the iguana furnish a wholesome food, considering its close relationship with the turtles which are eaten the world over wherever they occur? And now it would appear that we may have another abundant meat supply in the crocodiles that infest so many rivers in the Philippine Archipelago and render them more or less dangerous. At any rates the following is quoted from a recent issue of *Science* relative to the testing of alligator meat as a food in West Virginia, United States, for the benefit of those experimentally inclined.

In this connection it should be stated that the alligator of the Western Hemisphere is a species different from the crocodile of the Philippines, to which he is, of course, very closely related.

These (the alligators), were killed by cutting the cord at the base of the skull, and the flesh of the entire body was cut into pieces of suitable size for cooking.

The meat was first parboiled (though the necessity for this was doubtful) and was then fried in egg and cracker crumbs, very much after the manner of a breaded veal cutlet.

About thirty people, consisting of both men and women, mostly school teachers, members of the university faculty, and college students, partook of the repast, and all declared the meat to be 'delicious.'

There was considerable difference of opinion as to what the meat resembled: some thought it tasted like pork; some thought it like fish; one person said it suggested lobster; but all declared it to be most agreeable.

DANGEROUS PLANT PESTS.

According to *Science*, one of the most serious insect pests of Japan has been imported into the United States, and gained a foot hold in the State of New Jersey. A campaign of eradication of this dangerous insect authorized by the Congress of United States is now in progress, and in connection with which a local quarantine is proposed whereby the shipment from the territory of green sugar-corn, ripe tomatoes and peaches which might cause the spread of the pest is prohibited.

It is to be hoped that this dangerous insect pest can be kept out of the Philippines.

The insect was introduced in the vicinity of Riverton, N. J., probably during the last 5 or 6 years, and presumably from Japan, in soil around the roots of iris. The beetle has thoroughly established itself, and from some 600 acres infested when the insect was first discovered it has spread and at present occurs over 7,000 to 10,000 acres, with one or two outlying points of infestation, involving approximately 25,000 acres. It is reported to be one of the most injurious insects of Japan, and *its behavior in this country indicates exceptional possibilities for damage.*

The insect is a general feeder, attacking the grape, peach, plum, apple and cherry, as well as many ornamental plants. It has been found injuring the sweet potato and other truck crops, especially sweet corn. The beetles penetrate the tips of the ears of sweet corn much like the common corn ear-worm and could thus be widely distributed with the shipment of the corn to the various markets. The insect feeds freely on a variety of weeds, especially smart-weeds. As far as known it does not occur in other parts of the United States than in the area indicated.

In this connection the following is also quoted from *Science:*

The much-dreaded European potato wart disease for which the Federal Horticultural Board quarantined against further importation of potatoes in September, 1912, has been discovered in ten mining villages near Hazleton, Pa., by Professor J. G. Sanders, economic zoölogist of that state. Every effort of the state authorities, with the federal department assisting, is being directed to prevent the further spread of this insidious and most dangerous disease known to affect the potato. It appears that the disease has been established in some of these villages for at least seven or eight years, where it has been impossible to secure even the amount of seed planted in some gardens for the past few years. Only by accident was this disease discovered in these villages, which are largely made up of foreigners, who supposed that there was something affecting the soil and ruining the crop. It seems advisable that all the state authorities should inspect large centers of consumption where imported potatoes may have been purchased during the past 8 or 10 years.

In order equally to call the additional attention of the Philippine agriculturist to the danger to which he is exposed by the introduction of plant pests from foreign countries unless strict quarantine measures are enforced at all ports of entry, and to show what is being done abroad in order to prevent the importation of plant pests the following paper on the so-called "Black Fly," by Mr. Wilmon Newell, State Plant Commissioner, for Florida, United States, is quoted from the *Florida State Horticultural Society Quarterly:*

It is not with pleasure that we call attention to a serious menace to any agricultural or horticultural product of our State. It would seem that we have had troubles sufficient with Citrus Canker, and doubtless most citrus growers are congratulating themselves that the menace is apparently over and that the industry will henceforth be free from danger of destruction by new insects or diseases.

While the task of eradicating Citrus Canker has perhaps not progressed as rapidly as the public expected, those familiar with the magnitude of this undertaking, and with the difficulties which had to be overcome, feel that the battle has been steadily a winning one and that with sufficient coöperation and the absence of any further complicating circumstances the disease will be practically eradicated within the next 18 to 24 months.

However, at this point we would call your attention to the fact that, had you had an efficient Plant Board antedating the time of the introduction of Citrus Canker into Florida, say beginning in 1911, you would have had no Canker to fight and the cost of keeping it out would have been only a small per cent of the million dollars (approximately) which has been expended in the eradication work thus far.

Had there been a Plant Board in existence prior to 1911, you would naturally have expected the Board to have informed itself of this danger and to have given you warning. So now, you have a right to expect the Board to keep itself informed as to impending or imminent dangers and, if not able to completely protect you, to at least warn you of the danger in order that you may assist in your own protection.

Such a menace now threatens us. It is an insect known to the authorities at Washington as the "Spiny Citrus White Fly;" to the fruit growers of The Bahama as the "Blue Fly;" in Jamaica as the "Black Fly;" and to the Cubans as the "Mosca Prieta." The term "Black Fly" seems best to fit the insect, hence we will hereafter refer to it by that name. It belongs to the same family as our common white fly but the adult, instead of being white, is a deep blue gray in color; in fact, is to all appearances black. The larvae and pupae are jet black. Like all members of the Aleurodid family, the larvae secrete honey dew in abundance and infestation is always accompanied by heavy deposits of sooty mold. Imagine if you will, a lime tree, the under surface of every leaf covered with thousands of jetblack insects and the upper surface covered with a layer of black sooty mold, so thick that you can peel it off as you would a sheet of paper, and you can well imagine why this insect is called the Black Fly.

The Black Fly is primarily an insect enemy of citrus; limes, lemons and grapefruit being heavily infested. Other fruits, however, experience severe injury. The mango is also a favorite food plant. Among the other plants attacked may be mentioned the avocado, guava, pomegranate, Spanish lime, sapodilla, mamae apple, coffee, sour sop, papaya, sugar apple, jasmine, traveler's palm, plantain, hibiscus, acalypha, maypop, cherimoya, begonia and sweet bay.

Our first information of this pest came in the early part of 1916 when persistent rumors concerning the occurrence of Citrus Canker in The Bahamas resulted in the Plant Board sending Dr. J. H. Montgomery, of its inspection staff, to Nassau to investigate. Dr. Montgomery found no Canker in The Bahamas, but he did find the Black Fly in abundance on the Island of New Providence and that the destruction caused by it had been responsible for the rumors referred to. Though first noticed only twenty months before Dr. Montgomery's visit to Nassau, many citrus trees had died from its attacks and many others had been cut down by the owners after complete failure had followed their attempts to control the pest by spraying. Infestation by the Black Fly is invariably accompanied by rapidly increasing scale infestation so that the life of an infested tree is necessarily short.

I may add that, following Dr. Montgomery's return to Florida, we furnished Sir William Allardyce, Governor of The Bahamas, with numerous cultures of our white fly fungi which His Excellency introduced in the infested groves at different seasons. No indications were had of its attacking the Black Fly. We also furnished the Governor with the various formulae used in Florida for controlling white flies and scales, such as the miscible oil sprays, Yother's formulae, etc. These were used but without any satisfactory results.

At about the time Dr. Montgomery visited Nassau we learned, through Prof. A. L. Quaintance of the Bureau of Entomology, that the insect is of common occurrence in India and that it was known to occur in Jamaica. This led us, on May 24, 1916, to address a letter of inquiry to Prof. John R. Johnston, President of the Comision de Sanidad Vegetal at Havana, asking whether the insect occurred in Cuba. His reply, dated May 31, 1916, stated that the insect was first heard of in Cuba when the entomologist of the Commission, in August, 1915, received a few specimens from citrus trees in a dooryard near Guantanamo at the eastern end of the island; also that on a citrus survey made by the entomologist and himself in 1916 the infested area covered a radius of about two miles, citrus, coffee, mango and guava being affected. Prof. Johnston further stated that the government was making plans to restrict its spread and to eradicate it.

I may say here that the Cuban Government, under Prof. Johnston's direction, did make attempts to eradicate the pest at Guantanamo and it was hoped for a while that the attempt would be successful. However, a revolution in the eastern end of the island caused a complete cessation of the work for several months. We know little of the Guantanamo situation today, except that the pest has continued to spread, that the coffee industry is seriously endangered and the infestation is probably beyond the possibility of control.

In December, 1916, Prof. Johnston reported to us that the Black Fly had been found in the Vedado, a residential suburb of Havana. Prompt steps were taken by the Comision de Sanidad Vegetal to control the outbreak and infested trees and plants were periodically sprayed with kerosene emulsion.

By the spring of 1917 the Black Fly had infested other suburbs of Havana and had been discovered at Hoyo Colorado, a point about 60 miles southwest of Havana. So serious did the situation appear that the Plant Board at its meeting on June 9, 1917, instructed the writer to proceed to Cuba and investigate the situation. Owing to the delay in securing a passport this trip could not be made until October, 1917. Arriving in Havana on the night of October 22d I was fortunate to meet Mr. Harold Morrison, foreign explorer of our Federal Horticultural Board Mr. Morrison had just returned from Jamaica and the Canal Zone. From him I learned that the Black Fly had been known in Jamaica for some 7 or 8 years and that he had recently found it at both ends of the Panama Canal Zone, namely at Colon, Cristobal, Ancon and Balboa Heights.

During my stay of a week in Cuba I was accorded every courtesy and assistance by the Hon. Secretary of Agriculture, Dr. Eugenia Agramonte, and by Prof. John R. Johnston, now Chief of the Office of Plant Sanitation of the Department of Agriculture.

The conditions I found in Havana would strike terror to any Florida fruit grower. The black fly had spread to every portion of Havana and its suburbs, with the exception of a few business blocks on the Prado. Everywhere, on lime and mango trees, one saw the Black Fly eggs, larvae and pupae in abundance. Continued spraying with kerosine emulsion had not resulted in even a temporary control of the pest and its spread was steadily continuing. It may be said, however, that the labor and equipment used in the spraying work was not conducive to an efficiency which would meet with the full approval of a Florida horticulturist.

HOW THE FLY COULD REACH FLORIDA.

The pest apparently first came to Jamaica from India, perhaps on plants shipped to the Botanical Gardens at Kingston. From this point it apparently went to The Bahamas and to Guantanamo. It came to Havana either from Guantanamo or Jamaica and probably from the latter found its way to the Canal Zone. The point I wish to impress upon you is this, that within 7 or 8 years this pest has found its way from India to the western hemisphere and has established itself literally all around us. Also that it has followed all of the principal commercial lines of intercourse in the West Indies. Havana is but 8 hours by boat from Key West. Can we believe for an instant that after the record it has made as a traveler it will fail to make this short jump of less than a day's travel.

The transportation of infested plants to Florida would establish the pest at once. We are importing no plants from Cuba now. Our port inspector at Key West, Mr. E. L. Gehry, has already taken infested plants from passengers arriving there from Havana.

The adult flies live for several days. There can be no doubt as to the possibility of flies entering freight cars in Cuba and being transported via the car ferry to Key West. Cars from Cuba, several dozens of them, reach Key West from Key West to Jacksonville.

Passengers from Cuba and the West Indies will insist upon bringing bouquets and plants back to the United States with them and they resort to innumerable ingenious devices to get them past our inspectors at Key West and Port Tampa. Schooners and fishing vessels from Cuba land at various places along the Florida coast, often at points where there is no customs official or plant quarantine inspector. There is nothing to prevent vessels bringing infested material.

Eggs of the Black Fly are found upon the fruit of infested trees and though there is no evidence that the insect can live upon fruit after hatching from the egg, there remains the possibility of eggs being transmitted on fruit and, after hatching, of the larvae finding their way on to a host plant.

WHAT THE PLANT BOARD HAS DONE.

The Board has prohibited the importation of all plants and parts of plants; fruit, vegetables and manufactured articles alone excepted, from all islands and countries where the Black Fly is known to occur. It has also declared the Black Fly to be a "public nuisance" and has provided, in the various sections of its Rule 26 (Plant Board Circular No. 26, issued November 20, 1917) for the handling of any infestation which may be discovered in Florida.

Following the writer's return from Cuba in October, 1917, representations were made to the Cuban Government which resulted in renewed activity in attempting to control the pest in Cuba, the Board believing that the subjugation of the pest in Cuba offered the best possible means of protecting Florida against invasion. The Cuban Congress in November, 1917, at the direct request of President Menocal, appropriated $50,000 for the fight against the Black Fly. Promises were given us of the immediate destruction of all infested plants and trees within a certain distance of all railway lines and yards and additional inspectors and laborers were employed on the work under Prof. Johnston's direction. The Cuban Government also requested our assistance in organizing the work somewhat after the plans used in Florida in connection with Citrus canker eradication. Our general inspector, Mr. Frank Stirling, spent practically all of January in Cuba on this mission and in February we sent two of our experienced men, Messrs. L. Russell Warner and H. D. Bollinger, to Cuba. They are there now, Mr. Warner for the purpose of organizing the nursery inspection work and Mr. Bollinger in charge of the field inspection and eradication of the Black Fly in infested premises.

Realizing the danger of the pest becoming established in Florida and particularly on the Florida Keys, where our lime industry would be immediately jeopardized, the Board at its December, 1917, meeting ordered that the Florida Keys be given a thorough inspection. Through the liberality and assistance of the Florida East Coast Railway a power houseboat with quarters for a crew of inspectors was fitted out and the inspection of the Keys commenced on January 15th of this year under the direction of District Inspector A. L. Swanson. This inspection, which was made for both Canker and Black Fly, was commenced at the northern end of the Keys and gradually carried towards Key West. The inspection of the Keys has now been completed without either Canker or Blanck Fly being found. It is to be remembered, however, that the danger of introduction still exists.

The foregoing summarizes, with the omission of some minor details, what the State Plant Board has done and is now doing and, under present war time conditions, about all that the Board can do. Since America entered the war we have lost 129 of our trained employees, most of whom entered the military service direct, and it is indeed a difficult task to continue the Canker eradication work and other protective measures here at home without taking up a campaign against an insect enemy in a foreign country.

WHAT THE GROWER CAN DO.

The avenues through which the Black Fly may reach Florida are so numerous that it can hardly be expected that any system of quarantine can keep it out permanently. If we add to this the consideration that the Plant Board is severely handicapped by loss of experienced men for military service and that this handicap will steadily grow during the period of the war I think we are sound in the conclusion that the Black Fly will soon establish itself in Florida. In any fight against an insect pest or disease the Plant Board is no more than half the fighting force. The horticulturists of the State constitute the other half, and very likely the most important half. Not only must the Board have their coöperation in all measures which it undertakes, but they must be ever on the alert to detect this pest and to report anything suspicious to the Board. Above all things else, the growers should adopt such practices as will reduce the opportunities for the pest to spread when it is introduced.

So long as we are able to maintain our nursery inspection work at its present efficiency and so long as the laws and rules regarding the certification and movement of nursery stock are complied with, there appears little danger of the Black Fly being disseminated on nursery stock. The larvae and pupae are so striking in appearance that there can be no excuse for an inspector overlooking them, even when they are present in small numbers. When a Florida nursery is found infested with the Black Fly the action of the Board will be drastic and it will be quick. We also hope it will be effective. We are confronting, as you can readily see, a situation where strict compliance with the laws and rules regarding the movement of nursery stock may be the means of averting a calamity, and it is clearly the duty of every patriotic horticulturist and citizen to do his full duty in seeing that these rules are complied with by all private citizens as well as nurserymen.

In case the pest is introduced other methods of dissemination will assume relatively greater importance. Particularly will this be true of the movement of vehicles and persons from infested properties or areas to non-infested ones. Field equipment, such as picking baskets and bags, field boxes and workmen's clothing will be agencies just as effective and sure in spreading the Black Fly as they were in spreading the Citrus White Fly.

Most of those present are familiar with the sanitary measures which we have been advocating for packing house and grove owner as a precaution and safeguard against the spread of Citrus Canker and other diseases. These measures include the disinfection of field boxes, the desinfection as far as possible of all picking equipment between properties, the fencing of citrus properties and prohibition of trespassing and visiting in citrus groves. All of these measures constitute excellent insurance against the spread of any Black Fly infestation which may occur and I warn you now that this infestation must necessarily occur before it can be discovered and steps taken to abate it. Labor and other conditions are not going to be favorable to the grower in the months to come but, regardless of conditions and difficulties, the fact remains that the more these precautions are practiced by those interested in our fruit industries the more protection will we have against a danger which in the light of all available information, will be as big a menace as Citrus Canker itself.

A NEW RUBBER.

The pessimist who predicted the arrival of synthetic rubber has been with us practically since the first rubber estate was planted, and no little thought and money has been expended in an effort to produce synthetic rubber. In fact it is now some years since the discovery was coincidently made in England and Germany though the process never developed to the point where it became a financial success.

It now appears that an American has discovered that fish-scale, said to be the world's largest single waste product that remains unutilized, may be converted into a rubber that is actually superior to natural rubber.

Says *The Scientific American* (New York):

* * * But when he found that it (the fish-scale) was a cellular mass, of tubular structure, as resilient as rubber but much tougher and that it made no difference at all what kind of a fish it came from, his interest in it ceased to be one based on general principles. He at once tried it out as a base for his cherished reënforced rubber, and found that it worked like a charm; it made the rubber tough, without robbing it of its elasticity.

This of itself would have been sufficiently pleasing; but the final consummation, which came later, by sheer accident, made it look like the proverbial three-tenths of a dollar. Rubber is hardened, or vulcanized, by treating it with sulfur. To make a long story short, the inventor discovered that fish-scale would take the same sulfur treatment, with the same result. So after he has rubberized his fish-scale and got a tough, elastic fabric, he can vulcanize the combination, and get a hard, tough, elastic fabric.

The most exhaustive tire tests have no effect upon his optimism save to increase it; and indeed, when a man begins to talk about a rubber that shall be far harder and far tougher than rubber has ever before been made, without loss of resiliency, it would seem that he has something to talk about.

Just how much this new discovery will affect the price of plantation rubber it is yet difficult to say, though one may anticipate a further decline in the product. While it is probably true that the bonanza days of rubber are over never to return it is equally true that new uses for rubber are discovered almost daily. While rubber plantations will never again return the fabulous profits that a few years ago resulted in the tremendous expansion of the rubber plantation industry, yet rubber growing has come to stay as one of the great tropical plantation industries, such as tea, coffee, copra, and the various textiles.

THE PHILIPPINE

Agricultural Review

VOL. XII SECOND QUARTER, 1919 No. 2

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ILLUSTRATIONS.

SEVENTEENTH ANNUAL REPORT OF THE BUREAU OF AGRICULTURE.

MANILA, *February 16, 1918.*

SIR: I have the honor to submit herewith the Annual Report of the Bureau of Agriculture for the fiscal year ended December 31, 1917.

PHILIPPINE AGRICULTURE.

GENERAL SUMMARY.

Among the activities of the Bureau of Agriculture for the year of 1917, deserving of special attention, are: *First;* the big food production campaign carried on by the Bureau under the direction and supervision of the Secretary of Agriculture and Natural Resources, including unprecedented activities in seed and plant distribution, a campaign for rice seed selection, the establishment of nurseries and demonstration plots, home gardens, increased interest in livestock, especially hogs and poultry, and a general awakening of the people to the seriousness of the food situation due to the world war. *Second;* the remarkable advancement made in the establishment of rural credit societies among the small farmers of the Islands, which has exceeded the expectations of even its most enthusiastic supporters. *Third;* the elimination of the locust plague, a condition never before attained in the history of the country. *Fourth;* the satisfactory progress of the inspection and grading of fiber and the establishment of stripping machines for Maguey fiber and the campaign for increased production of this important product. Increased prices for copra, coconut oil, fiber, corn, livestock, rice and all farm products with the possible exception of sugar, have given an increased prosperity to the farmers and to the country as a whole, which bids fair to advance materially during the coming year. Failure to check the ravages of rinderpest is the one drawback for the year of 1917, the loss of work animals proving a serious handicap to agriculture, and the prevalence of the disease absolutely prohibiting any attempt at establishing the much needed coöperative work animal insurance provided by Act No. 2573.

THE FOOD CAMPAIGN.

The energies of the Bureau throughout the year have been centered on the food campaign as the one matter of most pressing importance to the country, due to the war in Europe and the possible food shortage. The appointment of a Government Food Commission which took over the direction of the big campaign for increased production of food products did not lessen the activities of this Bureau, but rather served to stimulate effort, and there has been the heartiest coöperation in carrying out the plans for food production as outlined by the Food Commission and under its immediate supervision and direction, not only in creating interest in increased livestock production, home gardens, poultry, field demonstrations, coöperative plots, nurseries, lectures by the field men and chiefs of divisions of the Bureau, but also by the distribution of seeds and plants on a scale never before attempted by the Bureau of Agriculture, and by the inauguration of a campaign for rice seed selection by forces of trained men in the farmer's fields at harvest time, this campaign extending to most of the leading rice producing provinces of the Islands. Some idea of the magnitude of the seed distribution of this Bureau may be gained from the statement that during the year 1917 a total of 77,527.5 kilos of field and garden seeds were sent out, consisting of 2,931,894 in separate packages besides the seed distributed in bulk. This seed was secured at an approximate cost of over ₱34,000 and an estimated retail value of about ₱300,000. During the past year 6,676 tropical fruit trees of various species, 41,005 coffee seedlings representing 10 varieties and 108,447 various other plants and cuttings were distributed from the Lamao experiment station alone, and 688,709 various kinds of economic plants, cuttings, bulbils and suckers were sent out from the Singalong station.

RURAL CREDIT.

As previously stated, the remarkable growth and activity of rural credit associations throughout the provinces have exceeded the expectations of its most enthusiastic champions, and have proven one of the most gratifying and far-reaching achievements of the Bureau during the past year. The movement was in its infancy during the closing days of 1916, but eight rural credit associations having been formed, up to January 1, 1917. On January 1, 1918, there were 84 regularly organized associations with a combined capital stock of ₱409,880, of which ₱41,483 had actually been paid at the time of incorporation, which sum

A successful Home Garden. Gapan, Nueva Ecija.

has been greatly increased, a conservative estimate placing the paid up capital of these associations at close to the ₱100,000 mark at the close of 1917. In addition to the associations already incorporated, 142 other associations were organized during the year, the capital of which has not been entirely paid in, thus for the present delaying their incorporation. The year's results are encouraging. A means has been found whereby the small farmers may be enabled to help themselves by coöperation. Only a fair start has been made as yet but a knowledge of the plan is spreading rapidly and is being readily accepted. It is sure to grow if carefully managed because rural credit meets an urgent and pressing need.

LOCUST EXTERMINATION.

It is a source of great satisfaction to be able to announce that the Islands are now free from locust invasions and have been thus free for a period of several months. On July 28, 1917, the Archipelago was declared free of locusts, and except for a few scattered swarms that were promptly destroyed upon their appearance, the country has been free ever since, and from September 22, 1917, no locust swarms have been reported anywhere in the Archipelago, a conditon that has not existed before during modern times.

THE FIBER INDUSTRY.

Fiber grading and inspection during the year were conducted in a most satisfactory manner. During the year 34 grading stations and 101 grading establishments were designated, an increase of four stations and four establishments over the previous year. Of the 101 establishments, only 24 still use special house marks for each grade of the Government standard. Government inspectors during the year inspected, stamped and approved 1,291,851 bales of abaca (Manila hemp), 113,579 bales of maguey and sisal and 1,553 bales of pacol and canton. A total of 21,228 bales of abaca and maguey were rejected as not being up to the proper standard. A grand total of 1,406,983 bales of fibers of all classes were produced during the year, an increase of 101,831 bales over the total of the previous year. In order to stimulate the production and increase the quality of Maguey fiber, two Prieto fiber extracting machines were purchased and installed at the Singalong experiment station, where extensive experiments and tests were made before sending the machines to the provinces for demonstration work. The results obtained were very satisfactory, and fiber experts assert that these machines will give good results and greatly increase the maguey industry throughout the Islands and place it on a more staple basis.

CROP CONDITIONS.

The following report on crop conditions is for the year ending June 30, 1917. The figures given are preliminary and are subject to more or less alteration in the final estimates of the statistical section.

The agricultural year, June 30, 1916, to June 30, 1917, was an exceptionally good one for nearly all staple crops. During the year only one typhoon of importance visited the Islands, passing over the northern part of Luzon and the Babuyanes group. Storms of lesser degree were reported in northern Mindoro, northern Samar, southern Sorsogon, Balintang Channel and a few other localities, but little damage to crops resulted. Heavy rains fell during the year in nearly all parts of the Islands, but particularly in Mindanao, the Visayas and Northern Luzon, causing rather heavy damage to sugar cane, tobacco and corn, although the damage by rains and floods was not so great as in the previous year. The greatest damage reported was that of the sugar crop in Negros and Panay, yet the excessive rains there were favorable to coconuts, abaca, rice and maguey.

In last year's annual report the prediction was made that in view of good crop prospects and probable advance in prices, the total value of the nine staple products of the Islands for the year 1916–17 would come close to the ₱200,000,000 mark. It is gratifying to state that this production has been more than realized, the total value of crops for this period being ₱234,000,000. This remarkable increase as compared with the ₱181,700,000 for the previous year of 1915–16, ₱160,419,060 for 1914–15, ₱165,013,832 for 1913–14 and ₱178,639,668 for 1912–13, is due to some extent to increased production, but in a greater degree to the great advance in prices.

Rice.—During the year there were harvested, in round numbers, 1,939,000,000 liters of rough rice, worth ₱72,500,000, which represents an increase of over 23 per cent above last year's production and nearly 30 per cent over the value of the crop of the previous year.

Abaca.—Next in value comes abaca, with a production of about 155,730,000 kilos, which is only an increase of about 1 per cent in production over the previous year, yet showing a total value of ₱60,722,000 which is an increase of nearly 42 per cent over the value of the previous crop.

This picture shows the southern end of Provincial Agricultural Inspector Aguilera's small home garden. The garden is so complete in vegetable crops that the owner's table is well supplied with the vegetables raised every day. The two small boys shown in the picture, sons of the Provincial Agricultural Inspector, greatly helped in the upkeep of the garden. Note the vegetable products shown here.

Coconuts.—The total value of this crop amounted to ₱32,860,000 or ₱8,430,000 more than was paid for the previous crop, the yield being 887,000,000 nuts and 42,600,000 liters of tuba. Of the total number of nuts, 63,360,000 were used for food and the remainder were used for copra and coconut oil, producing 186,227,000 of copra and 2,600,000 liters of oil. Compared with the previous year, there is an increase of 31 per cent in copra and 3 per cent in oil.

Sugar.—The production of sugar was 365,000,000 kilos of crude sugar and panochas, worth ₱32,850,000, which shows a decrease of 2 per cent as compared with the crop of 1915–16, due mostly to continuous heavy rains.

Corn.—This crop also registers a decrease of nearly 5 per cent in production compared with that of last year, but the crop is worth approximately 20 per cent more than that of last year, the total value being ₱17,640,000.

Tobacco.—The total tobacco production was 47,000,000 kilos worth ₱11,637,000, which is an increase of 14 per cent in production and a gain of ₱4,378,000 in value over the crop of the previous year.

Maguey.—The production of maguey this year was 23,629,000 kilos, valued at ₱4,962,000, an increase of 76 per cent in production over the previous year and of 184 per cent in the value, a creditable showing indeed, and one which shows the possibilities and growing importance of this valuable product.

Cacao and Coffee.—These are crops of relatively minor importance but both show in increased production for the year. The yield of cacao was approximately 600,000 kilos, and of coffee 800,000 kilos, with a value of ₱382,000 for cacao and ₱397,000 for coffee.

CROP PROSPECTS.

From present indications, the new agricultural year of 1917–18 will be the most successful year ever recorded for all crops with the possible exception of sugar. It is estimated that the total rice production for the coming year will be close to 30,000,00 cavans of rough rice if the season continues favorable, yet in spite of the extraordinary increase in production during the past year and the promises of even greater production for 1917–18, there is a steady advance in the price. Prices of cleaned rice per cavan in December, 1916 in the following rice centers, were: Nueva Ecija, ₱6 to ₱6.20; Tarlac, ₱6; Pampanga, ₱6 to ₱6.20; Bulacan, ₱6.20 to ₱6.40; Iloilo, ₱6.60 to ₱7. In the same month of 1917 the prices were:

Nueva Ecija, ₱7.40 to ₱7.50; Tarlac, ₱7.50; Pampanga, ₱9.50 to ₱10; Bulacan, ₱7.50 to ₱8; Iloilo, ₱7.50 to ₱8.40, an advance for the year ranging from ₱1.70 to ₱2.50 per cavan.

The serious damage to abaca and coconut plantations by the floods and typhoons of 1915 and early in 1916 have about disappeared, owing to favorable weather conditions since that time and to the care given plantations by the people who were encouraged by the constantly advancing prices. Many of the growing coconut trees are again coming into bearing and greatly increased production is predicted for 1918. It is also hoped that abaca production will show a satisfactory increase.

Considerable areas are being planted to maguey, a crop which is receiving particular attention at this time, owing to an ever increasing demand for this fiber, consequent profitable prices, and its adaptibility to adverse climatic conditions. It is expected that many new areas will come into production during the year and under these splendid prospects an increase of at least 25 per cent in production may reasonably be expected.

Heavy production of tobacco is also expected. This crop is receiving great attention in many districts where it has heretofore been produced only on a small scale. Seed beds are already transplanted and the young plants are growing fine in most localities, all of which promise a large yield for 1918.

A normal crop of corn is expected, which will equal and may possibly show a slight increase over the figure for 1917.

Despite present unfavorable conditions in the sugar-producing districts of Negros and Panay, it is believed that the next crop will show an increase of from 5 per cent to 10 per cent over the crop of 1916–17, as fairly good conditions are reported from the other sugar districts where large areas are in cultivation.

BUREAU OF AGRICULTURE.

PERSONNEL.

There were no changes in the Directorate of the Bureau of Agriculture during the year of 1917. During the fiscal year, 14 American employees were appointed, of whom 6 were permanent and 8 were temporary. In the American personnel 32 employees were separated from the service through resignation during the year, 13 being from the permanent service and 19 being temporary employees, a reduction of 7 in the permanent personnel and 11 in the temporary list.

During the same period 521 Filipino employees were appointed, 80 being permanent and 441 were temporary, and

Coconut grove at San Ramon, Zamboanga.

Field men of the Demonstration Division and Bureau of Agriculture Employees taken at Lamao Experimental Station, Bataan.

there were separated through resignation 450 employees, of whom 20 were permanent and 430 were temporary, or an increase of 60 in the permanent personnel and an increase of 11 temporary employees. The increased force in the permanent personnel was due largely to the increased activities in the food production campaign and the rural credit section. It was also necessary to employ many livestock inspectors on account of the seriousness of the outbreak of rinderpest which continued unabated throughout the year.

ORGANIZATION.

There were no important changes in the organization of the Bureau during the year, only one new section being created, that of records section, under the administrative division, necessitated by the increased duties and importance of this work. Aside from this, the organization for the year has been practically that adopted August 1, 1916, at the suggestion of the Efficiency Committee and is as follows:

ADMINISTRATIVE DIVISION.

General service section.
Accountancy section.
Records section.
Property section.
Publications section.
Statistics section.
Construction and repair section.
American colonies section.

ANIMAL HUSBANDRY DIVISION.

Improved breeding section.
Animal selection and distribution section.
Poultry selection and distribution section.

VETERINARY DIVISION.

Disease control section.
Quarantine and meat inspection section.
Veterinary research section.

PLANT INDUSTRY DIVISION.

Agronomy section.
Horticulture section.
Pest control section.

FIBER DIVISION.

Fiber investigation section.
Fiber inspection section.

DEMONSTRATION DIVISION.

Agricultural demonstration section.
Coöperative organization and marketing section.
Rural credit section.
Insurance section.

ADMINISTRATIVE DIVISION.

GENERAL SERVICE SECTION.

The business of this section which in fact corresponds to that of the office of the chief clerk in most bureaus, which includes the general supervision of the stenographic work, dictation of official correspondence, general transportation supervision, the making up of the estimate for the annual appropriation and the allotting of the same, keeping the efficiency records of all Bureau employees, supervision of property, accountancy and records, directly responsible to the chief of the Administrative division, rental of buildings, light, water, janitor service, etc., has been carried forward during the past year in a very creditable manner. Mr. Iram P. Short, first assistant chief of the administrative division retired from the service February 28, 1917, and Mr. Francisco Guerra was promoted to this important position, and Mr. Mariano Chavarria was appointed to the position of second assistant chief of the division, vacated by Mr. Guerra's promotion.

ACCOUNTANCY SECTION.

Eleven clerks were appointed to this office and eight were separated therefrom during the year. There are at present two vacant positions, one at ₱960 and one at ₱780 per annum.

This section has recorded expenditures by projects and submitted monthly statements therefrom to the chiefs of divisions and sections but this was discontinued on October 1, 1917. During the rest of the year only monthly statements showing the financial condition of each division were submitted.

This section is divided into sub-sections as follows: Collection and disbursement, auditing, requisition, colony accounts, bookkeeping, and general service. Each clerk is assigned to a particular work in each sub-section but sometimes it was necessary to shift them from place to place where the work needed an immediate attention.

At the beginning of the year the Insular Auditor inaugurated a new system of classifying and journalizing accounts and keeping books. This system increased considerably the work of the bookkeeping subsection.

On June 22 to September 4, 1917, the Chief Accountant visited the American colony at Momungan to instruct the new assistant colony agent in keeping books and recording transactions as well as to find out the origin and cause of the ₱10,452.98 accounts receivable (sales of produce). While at Momungan, the colonists account-current ledger of Momungan was checked with that of Manila. A pass book showing September 1, 1917, balances of their indebtedness was also issued to each colonist as it was learned that none of the colonists knew the status of their indebtedness to the Government. The cash account of the colony agent was audited and it was found out that there were many disallowances in prior year which were never adjusted on account of not knowing what to do and how to adjust. These disallowances were adjusted and passed by the chief accountant. Under the old system of accounting, the merchandise account could not be checked up, so a new system of keeping merchandise and produce account by means of card was introduced. This was approved by the Insular Auditor. A physical inventory of merchandise, produce, and fixed assets was then made. The ₱10,452.98 stated above originated from an inadequate system of recording transactions installed. The Auditor adjusted the amount and a new system of accounting was introduced.

The following table indicates the number of warrants, etc., prepared during the year:

Warrants	15,130
Journal vouchers	1,200
General vouchers, paid by the cashier and disbursing officer	1,164
Official receipts issued	16,280
Delivery orders issued	91
Regular requisition, Bureau of Supply	149
Rush requisition, Bureau of Supply	147
Regular requisition, Bureau of Printing	203
Rush requisition, Bureau of Printing	21
Direct orders	574
Work orders and miscellaneous orders	671
Approximate number of items on requisition for which cards were prepared	5,500
Number of sheets of salary abstract	200

Number of sheets of sundry abstract	600
Number of sheets of journal	500
Number of sheets of project ledger (discontinued)	293
Number of sheets of subsidiary ledger	282
Number of sheets of general ledger	158
Number of Bureau bills	1,100
Number of sheets of memorandum re disallowances	2,550
Number of kilos of sweet potatoes sold at Manila	1,594
Number of kilos of peanuts	1,815

During the year, there are about 2,550 traveling expense accounts of the Bureau of Agriculture employees that showed disallowances, although Service Manual was issued to each field man in charge.

RECORDS SECTION.

During the year there has been an increase of 108 per cent in the correspondence handled by this office over that of the preceding year. The work of the section has been increased greatly, due to the activities of the food production campaign and the rural credit section. A spirit of excellent coöperation has prevailed among the employees of the section, a fact very essential to successful administration.

No change has been made in the system of recording (vertical system) adopted by this Bureau four years ago. Although the system is not so efficient as that of the numbering system, yet the result has been satisfactory. The advantage of this system over that of the numbering system is that it requires much less money and personnel to carry out the work of the section.

Correspondence.—During the year there has been a total of 256,135 communications sent and received of which 230,405 letters were outgoing and 25,730 incoming, as against a total of 122,592 communications sent and received during the preceding year, an increase of 133,543 or 108 per cent. Letters from school children and forms from our field men are not included. There were 11,797 letters delivered by messengers to different Departments and Bureaus in the city as against 7,352 in the preceding year. The cost for the transmission of correspondence has been ₱7,189.64 for letters and ₱2,693.92 for telegrams, a total of ₱9,881.56, as against ₱7,330.36 in the preceding year, an increase of ₱2,551.20.

Personnel.—During the first quarter when the section was still attached to the general service section its personnel consisted of one record clerk, one assistant record clerk, 7 clerks, and two messengers. On April 1, 1917, the section was separated from the general service section, and its personnel, until the closing of the year, consisted of one section chief, one assistant chief, eleven clerks and two messengers. During the year there were 10 appointments and four separations.

PROPERTY SECTION.

Personnel.—At the beginning of the year, the personnel of the property section was composed of one chief, an assistant chief, three clerks, one semi-skilled laborer and eight laborers. On January 8, the chief retired from the service and the Assistant succeeded him as chief of the section. One clerk and one laborer were appointed on March 16 and 23 respectively. On April 1, the semi-skilled laborer was promoted to chauffeur. On June 1, one clerk transferred to the fiber division leaving a vacancy which was not filled until September 1.

Plan of work.—This section is in charge of the property of the Bureau of Agriculture. It accounts for the same and supervises all transactions in connection therewith. A system of ledger cards is used to represent the property accountability of the Bureau of Agriculture. These ledger cards are checked monthly with the books of the Bureau to insure the accuracy of the property accounts. In order to insure the correctness of the status of the property located at the various provincial stations as represented by the ledger cards, station superintendents are required to submit semi-annual inventories of equipment and animals at their respective places. Non-expendable property issued to employees is accounted for through memorandum and invoice receipts. Expendable property is likewise accounted for through a medium of supplies' cards which are in continuous check with the existing stock. No issue of supplies or equipment of whatever nature is made without properly approved requests. To facilitate the work of the section pertaining to the issue of supplies, equipment, etc., and to regulate the work on an efficient basis, issue of stationery, equipment, etc., to central office employees is made once a week only. Through this medium the work of the storeroom is being standardized. Thus, while one day is set for the issue of stationery, etc., to the central office force, the remaining working days of the week are set apart for the preparation for shipment of supplies, equipment, animals and plant materials to the field employees of the Bureau and to private parties throughout the Archipelago.

All shipments of whatever nature, whether intended internally or for foreign ports are cleared through this office. While the routine clerical work is a little more than usual, the shipment of seeds and other plant materials were more than double as compared with the past year. The purchase of merchandise for the American colony has also become a notable item in the work of this section.

PUBLICATION SECTION.

The work of this section embraces the publication and distribution of the Philippine Agricultural Review, a publication in English, issued quarterly; the Philippine Farmer, a monthly publication in English and Spanish; the publication and distribution of all bulletins, circulars, pamphlets and press notices; the supervision of the Bureau of Agriculture library; Bureau photographic, planotype and mimeograph work and miscellaneous transactions.

Press items.—No accurate record has been kept of the number of items given to the Manila papers during the year. However, the market, locust and rindespest reports have been given to press representatives who call at the central office, and a copy of each regular report was also mailed to 21 provincial newspapers.

Philippine Agricultural Review.—The regular distribution of the review averaged 941 copies distributed every quarter. The number of paid subscription amounted to 156.

A total number of 152 foreign and local periodicals were received in exchange for the Review.

An average of 660 free copies were distributed quarterly to Government institutions abroad and to private individuals.

The quarterly distribution of Review for 1917 was as follows: Foreign countries, 319; United States and Territories, 341; Philippine Islands, 281.

FOOD PRODUCTION NUMBER.

The Philippine Farmer.—The editing of this publication has been carried on as usual by the chief of the section, as well as the supervision of mailing the same. A change was made during the year from the former plan of issuing this publication in equal number of English and Spanish, and it has been regularly issued one-third of the total number in English and the remaining two-thirds in Spanish.

Bulletins and circulars.—During the year but one new circular, No. 36, "The Vegetable Garden," by A. M. Burton, was published, 10,000 copies in English being printed. Numerous reprints were made of former circulars and bulletins of which the supply had become exhausted.

Planotype.—During the fiscal year of 1917 delivery was made on a total of 108 orders amounting to 16,140 printed copies.

Mimeograph.—During the same period there were 584 work orders for the mimeograph with a total of 514,020 printed copies.

Library.—A total of 1,665 bound volumes and 6,614 pamphlets were on hand at the close of the year 1917. Owing to the fact that the librarian was granted leave of absence to visit the United States, the cataloging has been delayed. Only 180 separate publications were catalogued during the year and 411 cards have been added to the list. During the same period 70 volumes of periodicals were bound. Many more volumes are complete and ready for the bindery.

Photographic.—A total of 5,003 prints were made during the year, 1,240 photographs have been enlarged, 138 lantern slides were made, also 50 colorings and 32 transparencies. A total of 427 plates, 23 films, 20 rolls and 48 cut films were developed.

STATISTICS SECTION.

The force of the section at present consists of one chief, two junior topographical draftsmen; two junior stenographers, twelve permanent employees and two temporary copyists.

Routine work.—The routine work of the section has been confined, as always, to the compilation of the returns contained in the reports submitted by municipal presidents as required by legislation. There are at present in the Philippines 901 municipal presidents of localities who submit four quarterly and two semi-annual reports, and 56 governors of provinces and sub-provinces who submit 12 monthly reports, each year, making altogether 5,080 reports received by the section with a total of 669,126 replies. The transcription of these replies into tables requires a considerable amount of work and time. Once these replies are arranged in tables by crops and by animals, local measures are reduced into legal ones and the average yields per hectares, the average prices and the total values are found. If one bears in mind that tables for nine kinds of crops and six kinds of animals are prepared for each one of the 901 localities, it can be seen that the tabulation of these replies is an enormous task.

During the year, there has been a considerable amount of correspondence, between this office and the offices of the municipal and provincial governments, on account of the delay in submitting the reports they were required to make by legislation. The return for correction or further information of reports has involved also an extra work that increased greatly the number of letters transacted. The drafting branch of this section has shown also a remarkable activity during the year. On account of the food campaign carried on by the Government, this section has been requested to prepare maps bearing information on the matter, and several elaborate maps were prepared for the offices of His Excellency the Governor-General, the President of the Senate, the Speaker of the House of Representatives and the Department, as well as numerous signs and much other miscellaneous work.

Distribution.—The compilation of returns for 1916, was completed during the early part of February of this year. Immediately after, this section received a considerable number of requests therefor that has indicated a keener desire on the part of the public to know the agricultural wealth of these Islands. Numerous copies were distributed as well as many letters bearing miscellaneous questions on crops and animals have been answered.

CONSTRUCTION AND REPAIR SECTION.

This section has charge of the up-keep and repair of all Bureau transportation and machinery, repair and manufacture of office furniture and equipment and the construction and repair of buildings belonging to the Bureau of Agriculture. This station recevied and accomplished 176 serial and work orders for repair and manufacture of office furniture, etc. There were 66 repair orders and 55 furnish orders of bicycles, 69 repair orders and 76 furnish orders for motorcycles and 22 repair orders and 11 furnish orders for automobiles, during the year. In operation and maintenance for six (6) passenger automobiles and two (2) White trucks during the year, for gasoline, oil, grease or lubricants and auto accesories, the total expenditure amounted to ₱11,241.87.

AMERICAN COLONIES SECTION.

Of the total of 60 homesteaders in the American colony at Momungan at the establishment of the colony, 33 remained at the close of the year 1917. A transcript from the records of the accounting section of the Bureau of Agriculture shows that in accounts current with these colonists the Government has advanced to them for various purposes the total sum of ₱96,044.31. Of this they have repaid in all, the sum of ₱45,994.66, leaving a balance due of ₱50,049.65. The total cash funds available for the colony at the close of the year 1917, was ₱19,350.22. The value of colony building is ₱6,319.70, equipment ₱1,627.30, merchandise ₱11,128.52.

The total organization expense for the colony is ₱28,219.22. Up to the present time no attempt has been made to reduce this organization expense, the produce and payments turned in by the colonists being applied to the reduction of their individual indebtedness to the government, designated as "Accounts Current."

As will be noted in the beginning, many of the colonists have left the colony, having given up the struggle or been separated from the colony as undesirables. The accounts of a few of these settlers have been remitted by executive action. An attempt is being made to effect some sort of a settlement with the others on liberal terms. The departure of these colonists has left vacant homesteads, and a decision was made during the past year by the Honorable, the Secretary of Agriculture and Natural Resources, to admit Filipino colonists to these homesteads on practically the same terms and conditons as were made to the original homesteaders. As a result a few Filipino homesteaders have been admitted to the colony and more would be added if funds were available. The colony can hardly be designated as a prosperous one, yet considering the disadvantages and discouragements incident to any pioneering project, they have done fairly well, and it is hoped that their worst difficulties have been overcome and that those who remain as well as those newly admitted, will prosper in the years to come.

ANIMAL HUSBANDRY DIVISION.

General remarks.—The demand for livestock has been exceedingly large and this demand could only be supplied to a limited extent during the greater part of the year. Owing to the plan of establishing stations in the provinces in connection with the food campaign during the last three months of the year, the sales had to be practically discontinued in order that there should be sufficient breeding stock on hand for these new stations. These stations will in the main be of a temporary character and primarily for the production and distribution of swine and poultry, but might also comprise public breeding of large animals.

During the year one new station was established at Cebu and another will soon be in operation at Iloilo provided funds are available. The breeding station at Virac, Catanduanes, will be discontinued but the work in other localities throughout the Islands will be greatly extended and conducted on a much larger scale if present plans are carried out.

The above plan presupposes the necessity of the importation of livestock in the shortest possible time and regardless of cost. A shipment of Indian cattle from India was received in Manila last April by a local firm. A part of this shipment was for the Bureau of Agriculture. The unsatisfactory conditions on shipboard, as well as the time consumed on the voyage to Manila, resulted in the livestock arriving in very poor condition. However, the demand for them was so great that not withstanding their conditon and the high prices demanded, there was a rush for them by livestock raisers, before and immediately after they were immunized to rinderpest and the quarantine was raised. At the present time there is still a long list of persons who urgently request this kind of cattle.

The results relative to the importation of fowls from the United States, were satisfactory, but the same cannot be said of the Cantonese chickens imported from China, where dealers do not interest themselves as to whether the chickens are good, bad or indifferent, and send the birds out improperly crated. As a result many fowls are lost by being stolen in transit and many die while under confinement. At present the animal husbandry division has standing orders for poultry and swine from the United States and Australia which it is expected will arrive during the next year. There is a notable shortage of eggs and poultry throughout the Archipelago as evidenced by numerous reports received and also by the great increase of from 40 per cent to 50 per cent in prices in the Manila and provincial markets.

The correspondence of the division has increased greatly over that of previous years, due to the fact that the people are every day becoming aware of the importance of the livestock industry in connection with food production. Their inquiries have largely been concerning care and management, feeds and feeding, public breeding, and the purchase and sale of poultry, cattle and hogs. But little interest has been shown by farmers in the breeding of horses, sheep and goats.

A few articles in regard to swine and poultry were prepared by the division and published in the Philippine Farmer, which aroused considerable interest among readers of the paper. Several trips of inspection were made by both the chief and the assistant chief of the division to various stations during the year. There have been many conferences with farmers and prominent officials on subjects pertaining to the work of animal husbandry.

Purchase and sale of animals.—During the past year there were sold by the Bureau, 54 cattle, 3 carabaos, 174 swine, 16 goats, 3 sheep, 400 poultry, bringing in a total revenue of ₱9,872.50. During the same period the livestock purchased consisted of 54 horses and mules, 161 cattle, 95 carabaos, 6 swine, and 61 poultry, a total cost of ₱30,742.52. For other branches of the Government the Bureau purchased 32 horses, 13 cattle at a cost of ₱7,366.

Feeds and feeding.—The increased work of the animal husbandry division has prevented much research work as regards feeds and feeding. The price of imported feeds is absolutely prohibitive and therefore must be substituted by products of local origin, and even these products are at present so high priced as to seriously suggest the need of government legislation and control. There is a noticeable shortage of feeds for livestock throughout the provinces. The price of corn has increased during the year from about 6 centavos at the beginning of the year, up to 10 and even 12 centavos at the close. Palay and tiqui-tiqui have likewise advance materially in price. Copra meal is coming into more general use. Tests of feeding meal from several factories were made at Alabang during the early part of the year with very satisfactory results. The amount of forage produced at Alabang this year was larger than could be consumed on the farm. We were therefore enabled to supply the Bureau of Prisons with 9,119 kilos, the Philippine Oil Company 30 tons and an equal amount to the veterinary division. There is still on hand at Alabang a surplus of Japanese forage cane available for other stations. The pastures at La Carlota and Trinidad have been in good condition throughout the year.

Public livestock breeding.—This project is very popular among the people and is attracting a great deal of their attention. Many applications for bulls, boars and stallions are being constantly received from private parties and municipalities, which could not possibly be filled this year and unless the number of animals is increased next year the same conditions will prevail.

The policy of requiring municipalities certain requirements befor being allowed to have animals for public breeding purposes has greatly ameliorated the death rate and condition of the animals for public use. However, when compared with animals under the charge of Bureau employees they are poor; for the latter not only have the animals in better condition but also have shown and given much better results. This fact proves conclusively that unless they can be placed directly in the hands of Bureau employees it is always best to sell them. Notwithstanding, the work has been satisfactory and decidedly better than in previous years as may be seen from the inventory given below of the public breeding animals together with their location and breeding records.

Location.	Property number of sire.	Kind of sire.	Number of services.	Number of offspring.	Remarks.
Albay:					
Bicol farm	123	Stallion	33	11	
Do	B-12	do	2	3	
Do	D. of A.	do	17	8	
Do	A-21	do		2	
Do	412	Bull			
Antique:					
San Jose	B-1	do			
Batangas:					
Batangas	B-98	Stallion	70	16	
Do	197	do	89	30	
Do	219	do	87	22	
Do	67	Boar	61	1,023 pigs	Dead.
Do	357	do	239	1,951 ,,	
Do	329	do	111	350 ,,	
Lipa	73	Stallion	66	14	
Do	B-79	do	82	29	
Do	398	Bull	16	3	
Do	199	do	12	12	
Bulacan:					
San Miguel	352	Boar	16	5 liters	
Cagayan:					
Tuguegarao	864	Stallion			
Do	3,791	Bull	39	29	
Batanes Island Basco	B-91	Stallion			
Capiz:					
Odioñgan forest station	386	Boar			
Cavite:					
Indang	311	do			
Cebu:					
Cebu	A-21	Stallion	52		
Do	194	do	62		
Do	190	Boar	15	3	
Do	305	do	12	26	
Do	191	do			Dead.
Do	328	do		2	
Do	399	do	1		
Do	258	do	1		
Do	327	do	82	59	
Do	188	do	21	30	
Do	187	do	24	36	
Do	306	do	67	32	
Do	307	do	53	32	
Do	325	do	39	62	
Do	309	do	26	29	
Do	304	do	53	39	
Do	303	do	17	45	
Do	308	do		2	
Ilocos Norte:					
Bacarra	330	Boar	25	5	
Dingras	192	do	8	8	Dead.

An imported stallion bred at Alabang Station.

Location.	Property number of sire.	Kind of sire.	Number of services.	Number of offspring.	Remarks.
Ilocos Sur:					
Currimao	385	Boar	3		
Lagangilang	236	do		7	
Sinait	398	do	82	3	
Vigan	397	do	10		
Cabugao	275	do	47		
Magsingal	229	do	21		
Lapog	440	do			
Iloilo:					
Iloilo	446	Stallion	13		
Do	419	Bull	17		
Do	420	Billy	14		
Do	170	Boar	48		
Do	87	do	73		
Do	367	do	5		
Do	368	do	20		
Do	424	do	3		
Do	386	do	7		
Isabela:					
Angadanan	230	Boar	20		
Tumauini	233	do	9		
Laguna:					
Calamba	319	Boar	29	8	
Sta. Cruz	252	do	31	18	
Do	214	Stallion	15		
Mindoro:					
San Jose	421	Boar	2		
Do	416	Bull	2		
Mindanao and Sulu:					
Do	153	Bull			
Do	414	do			
Do	A-8	Stallion			
Do	421	do			
Do	B-137	do			
Momungan	287	Boar			
Misamis:					
Mambajao	254	Boar			
Mountain Province:					
Benguet	441	Bull	20	4	
Do	436	do	30	6	
Do	B-102	Stallion	33	5	
Do	B-1	do	1		
Do	300	Bull	130	25	
Do	241	do	52	10	
Do	276	do	50	10	
Do	225	do	20	4	
Do	269	do	20	4	
Bontoc	358	Boar	2	5	
Do	359	do	2		
Nueva Ecija:					
Muñoz farm school	119	Stallion	34		
Do	3786	Bull	14	1	
Nueva Vizcaya:					
Bayombong	400	Bull			
Occidental Negros:					
La Carlota	118	Stallion	11		
Do	77	do	65	2	
Do	276	Boar	7		
Do	237	do	1		
Do	236	do	1		
Oriental Negros:					
Dumaguete	254	Boar	3		
Baiz	420	Bull	40	6	
Guihulngan	260	Boar	6		
Zamboanguita	252	do	5		
Dumaguete	442	Stallion	56	27	
Do	864	do			
Larena	122	do	26	10	
Do	185	do	28	16	
Do	427	Billy	12	8	
Pampanga:					
Mexico	422	Boar			
San Fernando	384	do	54	5	
Pandacan quarantine station	412	do	25		
Do	441	do	4		
Do	329	do	8		
Do	429	Stallion	4		
Do	530	do	3		

Location.	Property number of sire.	Kind of sire.	Nnmber of services.	Number of offspring.	Remarks.
Pangasinan:					
Rosales	248	Boar			
Do	249	do			
Villasis	331	do			
San Carlos	310	do			
San Fabian	442	do			
Umingan	443	do			
Rizal:					
Alabang stock farm	516	Stallion	12		
Do	95	Boar	1		
Do	356	do	21		
Do	384	do	13		
Do	Lit. 250	do	2		
Do	Lit. 222	do	3		
Do	Lit. 255	do	2		
Samar:					
Catbalogan	403	Boar			
Calbayog	404	do			
Catarman	405	do			
Sorsogon:					
Masbate	3784	Bull			Sold.
Do	3785	do			
Union:					
San Fernando	436	Stallion	107		
Bangar	274	Boar	13		
Naguilian	314	do	16		
Bauang	315	do	20	1	
San Fernando	316	Boar			
Bacnotan	317	do	13	2	
Zambales:					
Iba	123	Boar			Dead.

Alabang stock farm.—The activities of this farm have been practically the same as in previous years but the farm has progressed very slowly, principally, on account of the reduction of laborers, there being fewer laborers this year than in the past years.

The cattle fences have been in repair the entire year. As the bamboo posts decay they were replacd with new bamboo posts as concrete posts were not available. On three occasions during the third quarter the floods carried away several parts of the fences and this caused a great deal of inconvenience.

For the most part, the general routine was to keep grounds and sides of the roads clean, the trees pruned, and the irrigating ditches kept in proper condition. Portable colony houses, drinking and feed boxes, pig and chicken crates were built. The necessary repairs were made to farm buildings, carts, brooders, incubators, farm implements, machinery and water pipes. The old Spanish bridge was rebuilt during March to facilitate the work in the farm and inspection. A concrete muffler had to be built for the 50 horse-power oil engine as the one made of brick was not strong enough to withstand the pressure of the exhaust from the engine.

The pumping of the necessary irrigation water, the grinding of corn and mungo for the mixed feed and the cutting of forage cane for the cattle and pigs has been all the work in which the engines were engaged this year.

Trinidad stock farm.—Mr. Bert Duckworth, acting superintendent of the Trinidad stock farm is the only salaried employee in this project.

The superintendent visits the nearby townships to encourage the natives to breed their animals to the Bureau stallions at the stations. Only five mares were bred to the stallion during the year.

A number of animals were treated for various ailments free of charge. There were also some horses and cattle castrated during the period.

The work has been carried mostly on the reconstruction of the cattle corrals and the building of driveways leading thereto, on fence repair and the changing of wooden posts to cement posts. Range burning received also considerable portion of the time of the station's force which consists in the average of six laborers and one capataz.

A very lamentable accident happened to the superintendent of this station near the end of the third quarter in which he suffered severe injuries in the legs due to a fall from the Bureau rig while an official duty. This necessitated the sending of one of the central office force as we were already short of field men.

At many times during this year there were plans by some Government officials, not of this Bureau, to transfer this station to some other branch of the Government. It is sincerely believed that such would be very unwise as the retention of this station by the Bureau of Agriculture is very necessary and important for the well-being of the Mountain Province, its vicinity and the country as a whole.

HORSE PROJECT.

Alabang.—The horse project at this station is not important. There are only 2 native mares, one American-Australian stallion, 6 geldings and two colts. All the horses were in good condition at the end of the year.

La Carlota.—In spite of due care and attention which were given our horses, the dreadful disease of surra again appeared at this station after its occurrence in 1915. Our Arab stallion, property No. 118, died of the disease. The other horses were found upon blood examination to be entirely free from the animal parasite *Trypanosoma evansi*, the specific cause of surra.

If it is possible, a new Arabian stallion will be sent over to take the place of the one which died.

The horses at this station have received an everage daily ration of about six pounds of palay or corn per head, in addition to the green forage they could eat. Two horses died during the year and one male colt was dropped on September 12, 1917.

CATTLE PROJECT.

Alabang.—The cattle were in fair condition throughout the year. Of the cattle received during the second quarter, the Multani were put in the old Indian pasture and the Nellore in the large pastures with the others. Many of them were received with sores and bruises and were treated daily until recovery. The young bulls and steers were kept in the pasture near the old laboratory building and have remained in good condition throughout the year.

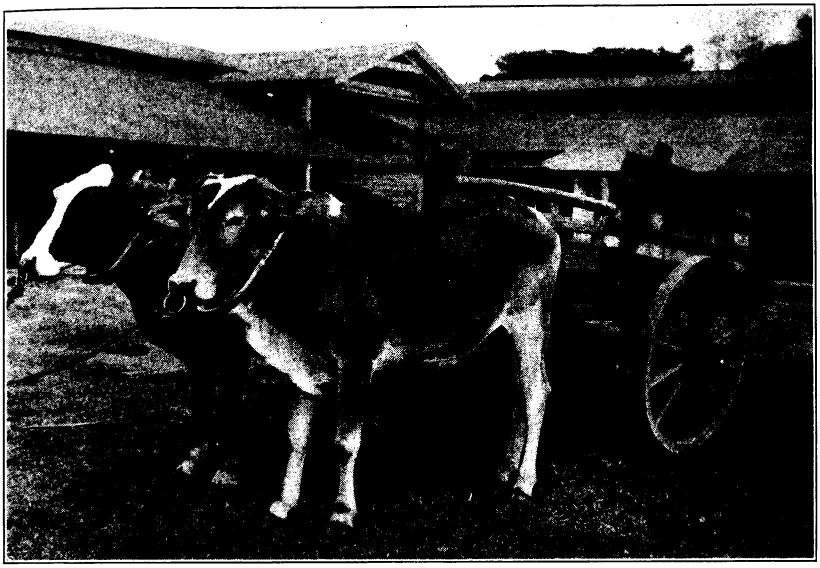
Owing to the heavy rains during July the young cows with their calves had to be caught and placed in a shed with cement floor to protect them from the severe weather. As a result there occurred accidents with two cows which were lamed very badly from slipping on the floor and they died on account of said injury. The milch carabaos which arrived at this station on June 17 are in fair conditon. Sixty one calves, 30 male and 31 female, were dropped and 7 died during the year.

La Carlota.—On account of the abundant rainfall during the months of May and June, the grass in our Indian cattle pasture has grown quite luxuriantly, there being always green feed for the cattle. The small shrubs which grew all over the field were dug out from time to time, in order to give the edible grasses a better chance to grow. The animals are daily inspected in the pasture, and salt is given them twice a week. Nearly all the herd is at present in fine condition.

Among the Chinese cattle at the beginning of this year there were 4 cows and 10 bullocks, eight of the latter being Indo-Chinese. Two of the cows and one of the Indo-Chinese bullocks were sold at auction on account of old age.

The grade cattle have been pastured daily on the open land and given salt twice a week as usual. As there was abundant grass in the pasture even during the entire dry season, the good condition of the animals has been maintained.

Trinidad.—The cattle at this station remained in good condition during the year. They were all free from the usual insect pests.



(*a*) Products of Alabang—Four-year-old Grade or Mestizo work bullocks.

(*b*) Products of Alabang—Pure-bred Indian (Nellore) bulls. Two years old.

SWINE PROJECT.

Alabang.—During the first semester the swine made a good showing. The brood sows produced normally and their litters were of the average in number. However, the majority of the suckling pigs died during the second semester, supposed to be due to the old age of their sires and dams, especially of those imported from the States. To increase the vitality of their future offspring the old boar property No. 93 was replaced with boar property No. 356. All boars, sows and weaned pigs are in perfect condition.

It is intended to utilize for the growing pigs next year all available space to give them a larger area in which to pasture and to allow them more exercise. The reason for this is that the yards will be better supplied with green grass and there will be the advantage of less danger from infection with kidney worms. The empty lots can then be plowed and later planted to sorghum, peanuts or some other legume or plant that is desirable for hogs.

The average number of pigs per litter is seven pigs and the production of males and females has been about even. Four hundred sixteen were dropped and one hundred ninety died during the year.

Trinidad.—On April 10, 1917, six (1 male and 5 female) Berkshire pigs were sent to this station. One female pig out of this shipment died on May 19, 1917. Thirteen (7 male and 6 female) were dropped and six (1 male and 5 female) died during the year.

La Carlota.—At present we have two breeds of swine at this station, consisting of Berkshires and Duroc-Jersey. These animals are being fed twice daily with rice, corn, sweet potatoes, and allowed to run on pastures of guinea grass, peanuts and sweet potatoes.

Some of the animals which had been suffering from paralysis in the past have been cured. At present we have a couple of animals which are still affected with the same trouble, but these too are showing some improvement as they are being given small doses of nux vomica internally, in addition to the external treatment of camphor or soap liniment applied occasionally on their afflicted parts.

GOAT PROJECT.

Alabang.—The goats at this station have reproduced normally and are at present in good condition. Although only few requests have been received during the year when compared with other livestock, still we are unable to supply the demand owing to the small number of goats in the herd. Thirty two kids were dropped and three died during the year.

La Carlota.—The goats at this station are doing fair but the raising of goats, according to advices, does not appeal to the people in this neighborhood. It is desired to transfer these goats to Alabang as soon as the foot-rot disease is found to be completely eradicated. Twenty-five kids were dropped and three died during the year.

SHEEP PROJECT.

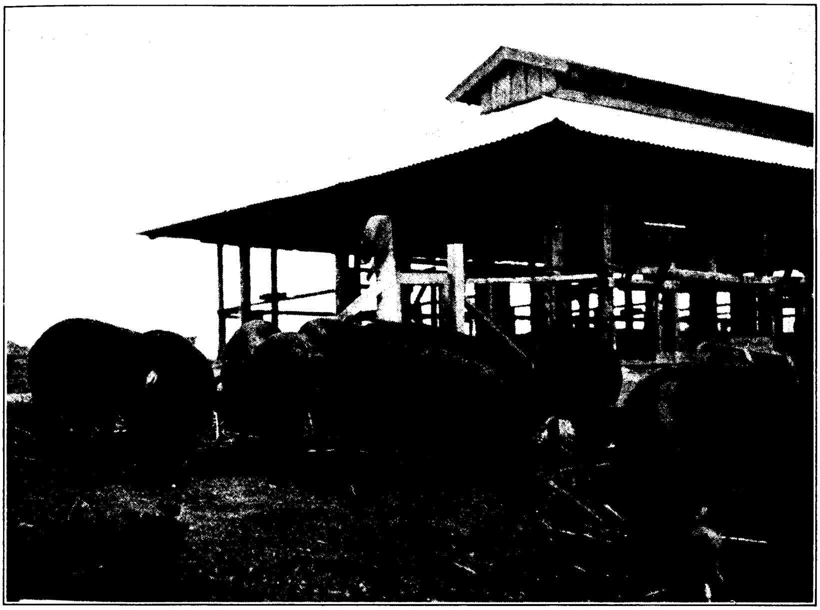
La Carlota.—Many of the animals that were affected with foot-rot in the past rainy season were cured. Much attention is being given to this trouble to prevent any further losses. The sheep are now in fair condition and are gradually increasing, notwithstanding the effect the foot-rot had on them during the past years. Nineteen were dropped and one died during the year.

POULTRY PROJECT.

At the beginning of the year this project comprised the raising of chickens at Alabang, La Carlota, and Trinidad but the work was extended near the end of the third quarter to Cebu and Batangas. The results obtained, with the exception of Alabang, were satisfactory but it is believed that there is still room for improvement. In round numbers the poultry at Alabang increased 20 per cent, at Trinidad 160 per cent and at La Carlota 560 per cent.

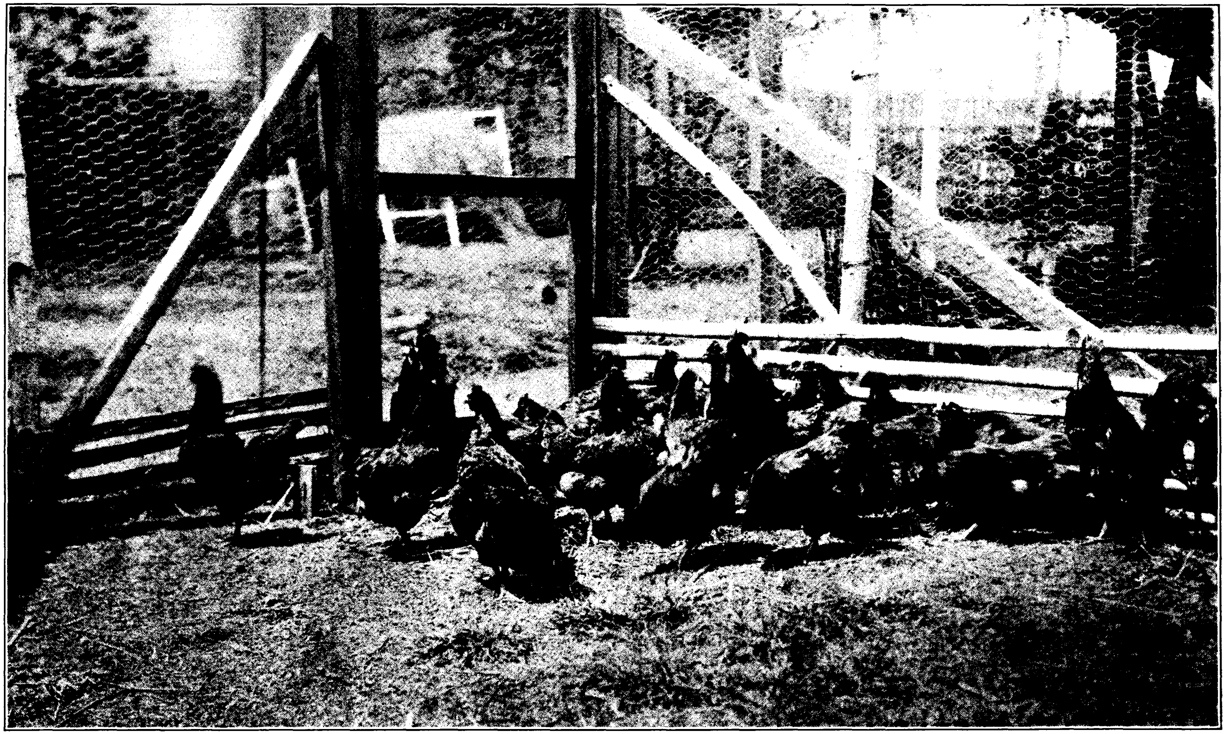
Alabang.—At Alabang the hens laid well with an average of 92 per cent of fertile eggs. The feeding of animal matter had a decided influence in the increase of the fertility and production of eggs and this can be easily explained by comparing the analysis of an egg with that of the substance fed. On the other hand, recent experiments carried in the States have shown that animal protein is more easily assimilated by poultry than vegetable protein and this is responsible for at least the increase in production of eggs. However, there is the danger of over-feeding animal matter which should be avoided as the poor results at Alabang in raising chickens is supposed to be partly due to over-feeding of animal matter.

The incubators with the exception of the Petaluma have given satisfactory hatches. The bad results obtained from the latter were very likely due to improper management. For the reason



(*a*) Products of Alabang—Young Berkshire sows.

(*b*) Products of Alabang—Young Berkshire boars.



Products of Alabang—Rhode Island Red chickens.

(*a*) Products of Alabang—Barred Plymouth Rock chickens.

(*b*) Products of Alabang—Artificial incubated chickens in artificial brooders.

Products of Alabang—Indian Runner ducks.

that the hot water incubators gave better results than the hot air incubators it was deemed proper to increase the number of hot water incubators.

According to reports, very poor results were obtained from the fireless brooders and their use was entirely stopped this year. Proper management is believed will give the desired results and it has been decided to give them another trial next year. Slightly better results were given by the hot water brooders, but they can not be classed with the mother hen, the chick of which made a good growth in the second quarter considering the bad weather which then prevailed.

The mortality of chicks and adult chickens increased materially the second semester and the cause of it was attributed mostly to chicken pox and roup.

The regular moulting season seems to begin during the end of July with the Cantonese and August with the American birds. This was very noticeable as the good production of eggs begins to decrease during that time. The fertility of eggs was also slightly affected during this period.

The Indian Runner Ducks which arrived last April have done wonderfully well, considering the conditions to which they were subjected while en route from California to Manila. They begun to lay three days after their arrival and the change of climate has not altered their good name as good layers.

This duck, as its name implies, originated in India. From there it was taken to England and later to the United States in which countries the strain was improved to its present state. This duck is noted for its laying qualities and it is expected that it will, in years to come, be popular as a table duck. The drake weighs about 4½ pounds and the duck a trifle less. They are fawn, gray or white in color but the former is the most popular variety and is what the Bureau has at Alabang. They are non-sitters, very much like the "Taguigs" ducks in conformation, very hardy, first-class foragers and are quite domesticated. To produce fertile eggs it is claimed that it is necessary to supply the bird with swimming water and we might add that the water should be kept as fresh and clean as possible.

This year the sales of eggs amounted to ₱1,981.19. There was an increase of about 10 per cent in the average production of eggs per individual hen.

La Carlota.—The results obtained from poultry at this station have been very satisfactory and beyond expectations. However, as a center for the distribution of poultry, it has not met the approval of many officials for the reason that it is not centrally located.

Trap nests are being used for the hens, so that we have a complete record of the number of eggs laid by each individual hen of each breed at this station.

Our grown chickens are being given a grain ration of palay and corn, and in addition, fish and shells are also given from time to time; the young chicks are fed on a ration of part hard boiled eggs, milk, and ground corn or rice middlings.

Trinidad.—The Black Minorca chicken has been found to be more delicate than the White Leghorn. At both La Carlota and Alabang, the results were very unsatisfactory, when compared with those at this station and the adaptation of this chicken in this country will have to be presumably done by first introducing them in this region where it seems to be better adapted than in regions of a lower level, and then gradually distribute them to other provinces. The only logical reason for this adaptation is the climate, which is cool.

VETERINARY DIVISION.

PERSONNEL.

On December 31, 1916, there were on the rolls 18 veterinarians (of whom 8 were Filipinos and 10 Americans), 24 American livestock inspectors (including 5 without salary), 375 Filipino livestock inspectors, 1 American clerk, 2 Filipino clerks and 1 American foreman.

On December 31, 1917, the force consisted of 24 veterinarians (of whom 15 were Filipinos and 9 Americans), 15 American livestock inspectors (including 6 without salary), 346 Filipino inspectors, 1 American clerk and 3 Filipino clerks. This constitutes an increase of 7 Filipino veterinarians and 1 Filipino clerk and a decrease of 1 American veterinarian, 9 American livestock inspectors, 29 Filipino inspectors and 1 foreman (American).

ADMINISTRATION.

Importation from foreign ports.—During the year a very few cattle were received from Spain and Australia for dairy or breeding purposes and nearly 500 cattle of Indian breed were admitted via Singapore.

Small numbers of cattle and carabaos were imported for slaughter or work purposes from Pnom-penh, Saigon, Hongkong and Singapore.

Interisland shipments.—During the year 20,194 cattle and

3,007 carabaos arrived at Manila from interisland ports. This is an increase of over 5,000 cattle from the 1916 figures which in turn were far above those of any previous year.

Inspections for which fees were charged.—During the year 142,545 animals of all kinds were inspected on arrival at the city of Manila, for which fees amounting to ₱18,658.20 were charged and collected. Of these animals 110,760 were swine.

Postmortem inspections in Manila matadero.—There were 125,716 animals of all kinds inspected at the Manila matadero during the year, 1,400 being condemned, and 124,307 passed for food.

COMBATING OF ANIMAL DISEASES.

Rinderpest.—The severe outbreak of this disease, which assumed such serious extension in 1916, continued with unabated virulence throughout the current year. The recorded number of cases and deaths, 33,971 and 26,951 respectively, are in fact considerably in excess of the 23,808 cases and 18,251 deaths reported in 1916. As was stated in the last preceding annual report, these figures represent only such cases and deaths as were discovered by members of the veterinary force or voluntarily reported by owners or local officials. This being the case, the apparent increase of rinderpest cases and deaths in 1917 may perhaps be due to more complete returns rather than to an increase in the actual losses.

It was apparent from the beginning of the year that the appropriation for the veterinary division was entirely insufficient to even enable us to carry the force through the year, to say nothing of the increases that might become necessary from time to time to control new outbreaks. On May 11, 1917, the Emergency Board made an allotment of ₱250,000 in addition to the ₱140,000 appropriated by Act No. 2672 for the rinderpest campaign. This has enabled us to continue in the service the personnel on hand at the beginning of the year and to make such increase from time to time as the situation required.

The following table shows the incidence of rinderpest cases and deaths during 1917 by three month periods:

Rinderpest cases and deaths by quarters.

	New cases.	Deaths.
First quarter	6,245	6,325
Second quarter	9,376	7,762
Third quarter	9,198	7,573
Fourth quarter	7,152	5,291
Total	33,971	26,951

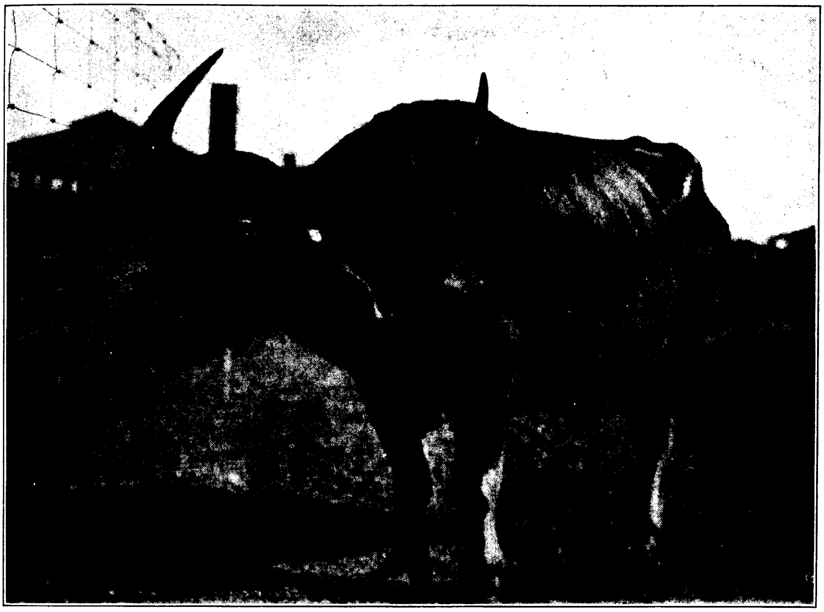
Our records show that during the year 448 new outbreaks occurred, counting each municipality declared infected or reinfected during the year as a separate outbreak. This number compares unfavorably with the 319 towns which became infected during 1916.

The year opened 18 provinces and 87 municipalities infected; and ended with 23 provinces and 115 municipalities infected. The total number of provinces infected during the year was 30, or 7 more than during 1916.

These provinces that became newly infected during the year accounted for 14,466 of the new cases and 11,585 of the deaths. Some of these provinces such as Mindoro, Department of Mindanao and Sulu, Leyte, Sorsogon, and Samar had not been infected with rinderpest for several years. During those free years there had been born thousands of animals which were more or less highly susceptible and which would naturally more readily fall prey to the disease than the older animals which had acquired more or less immunity during previous attacks. Other provinces such as Laguna, Oriental Negros and Nueva Vizcaya had had rinderpest during more recent years but in a comparatively mild form and therefore had many susceptible animals that would quickly fall victims to an outbreak as virulent as that of the past year.

It has not always been possible to trace the source of these new infections. This can be readily understood when one takes into consideration the fact that not only carabaos and cattle, but also swine, sheep and goats are susceptible to rinderpest and that these latter animals often have the disease in a mild, obscure form. In the southern islands communication between the various islands is by means of small sailing vessels, which frequently have a few pigs or goats aboard. As they can land at any place along the coasts it can be seen that they might scatter the infection in a manner which would be almost impossible to trace.

The Department of Mindanao and Sulu has been entirely freed from rinderpest. The veterinarian of the Bureau of Agriculture detailed there was given a free hand by the local authorities and received not only their fullest coöperation but also that of the Constabulary which was detailed to assist him. As a result the province was completely cleaned in a few months time. At the present writing it appears that the disease is gradually being brought under control in the other newly infected provinces and also those that were infected at the beginning of the year. The



(*a*) Carabao sick with rinderpest, Pandacan Quarantine Station, Pandacan, Manila.

(*b*) Pig sick with rinderpest at Pandacan Station, Manila.

prospects are therefore brighter of making a considerable reduction of the area infected and also of the cases and deaths during the coming year.

During the past year two serum laboratories operated by private individuals were established. The serum produced by these laboratories has been under the supervision and inspection of this office, all bottles having been stamped with the mark of this Bureau before being removed from either laboratory and put on the market for sale. We have produced but a very limited quantity of serum ourselves during the past year. One reason for this was the presence of foot-and-mouth disease at Pandacan, for several months, which rendered the production of serum at that place impracticable owing to the danger of spreading this disease throughout the provinces by means of contaminated serum.

Another reason was the fact that both of the private serum producers had access to a large number of cattle suitable for the production of serum at a much smaller cost than the same could be obtained by this Bureau. It was therefore found that the limited quantity we could produce would be but very little cheaper than the serum obtained from the producers. During the past year considerable quantities of antirinderpest serum have been used in the various infected provinces; Bulacan, Rizal, Laguna, Cavite, and Pangasinan having been the largest consumers. The most insistent demand came from those provinces and municipalities which had recently become infected and where the disease was causing a heavy mortality. These were the places where the greatest results were expected from serum and where in reality the least satisfactory ones were obtained. This can be accounted for by the fact that as there had been no severe outbreaks of rinderpest in many of these places for several years a considerable number of susceptible animals had been produced in the meantime; also the disease during the present outbreak was of a very virulent type. Also, another factor was that after the animals had been injected with serum there was a tendency toward laxness as far as quarantines and isolation were concerned. The majority of people unfortunately expected too much from the serum; many were of the opinion that the immunity conferred would last as long as a year and in nearly all places the opinion was prevalent that serum conferred an immunity lasting from two to six months. As a matter of fact experience has shown that serum cannot be depended upon to confer an immunity for a much longer period than 10 days. Antirinderpest serum when injected into an animal produces no reaction and its action is maintained only up to time that the antibodies have been eliminated by the natural body processes, after which the animal is again susceptible to infection. In many individuals this elimination is very rapid as we have records of many animals which came down with rinderpest within a week after the injection of serum. Many authorities claim that antirinderpest serum does not prevent infection with rinderpest. Holmes, in India, has expressed the following opinion, "It appears to me that the infection can be taken into the system immediately after the serum injection, and that it produces its reaction at the time when the immunity is decreasing." Stockman, in the Transvall, came to the following conclusions "That serum alone cannot be depended upon to give absolute immunity for a much longer period than 10 days, therefore the injections must be repeated three times with that interval to protect an animal for a month (the outside limit of infection). To ensure success, the serum must be injected to all the cattle likely to come in contact with the infected; it will, of course, save serum if the infected herd can be properly isolated from its neighbors." In the report of the proceedings of the Eighth International Veterinary Congress the following statement is made in regard to Professor Arloing's experience in Egypt. "Professor Arloing could not acquire in Egypt, a conviction upon the practical value of serum. Certain results seem to indicate that this serum but prolongs the incubation period; in other cases it prolongs the duration of the infection. In a large estate there were 45 deaths after 4 injections of serum."

Ward in his "Experiments on the Efficiency of Antirinderpest Serum" states, "That antirinderpest serum does not prevent infection with rinderpest. On the contrary, animals infected with serum and exposed to rinderpest soon contract the disease and pass through a more or less modified attack." Our experiences coincide with that of the authorities quoted above. Therefore it is well not to expect astounding results from the use of serum, and especially so when administered in districts where the rinderpest is of a high virulence. The method employed in India of mixing the animals which have been given serum with the sick ones to induce a mild infection could not be generally employed in the Philippine Islands. The reason is that the cattle and carabaos of this country are more highly susceptible than those of India and therefore disastrous results might follow this procedure. It is possible that fairly good results might be obtained with this method in the Ilocos provinces where the *present* rinderpest infection is very mild, but it would be out of the question to attempt it in places where we have rinderpest of a greater virulence.

At the request of the First Assistant Director of Agriculture the sum of ₱50,000 out of the ₱250,000 allotted by the Emergency Board was set aside for the purchase of serum and the sale or distribution of this in such manner as the Bureau of Agriculture might deem advisable. Serum to the amount of ₱5,990.88 has been distributed free of charge. Of this amount ₱1,297.90 is for serum injection free of charge to sick animals to test the efficiency of the serum as a cure; the remainder was injected free of charge among the animals of people who claim that they were too poor to afford the cost of the serum. In this connection it might be stated that the testing of the efficiency of serum as a cure coincided with the results previously obtained by several workers, namely that serum has no curative value for infected animals. Considerable quantities of serum have been injected at half price and there are on hand at the end of the year 860 liters of serum in cold storage.

The chief veterinarian does not recommend the free distribution of serum nor its sale at half price for the reason that the results obtained from serum are not commensurate with the expenditures involved. The immunity conferred is too short to be of any real value in the eradication of the disease. On the whole it is safe to say that the people in the provinces who have had experience with antirinderpest serum do not now have the same faith in its efficacy which they possessed a year ago. As there are people who still have a great deal of faith in the value of serum and desire to use it as an additional protection to their animals they may be at liberty to do so and may themselves purchase the serum direct from the producers and thus relieve this Bureau of a great deal of unnecessary expense and trouble.

Immunization.—On March 9, 1917, the Philippine Legislature enacted Act No. 2679 appropriating the sum of ₱250,000 to carry out the provisions of Act No. 2548 "for the immunization of cattle and carabaos to prevent the spread of rinderpest in the Philippine Islands." The funds appropriated by this Act provided for the salaries and traveling expenses of the technical personnel, acquisition of instruments and medicines required, purchase of animals for virulent blood, and for aid to the "insurance fund" of provinces in which immunizing stations are established.

Most of the immunizing operations during the year were carried on in the Province of Pampanga. This was due to the fact that the immunization of cattle and carabaos was begun in that province in 1914 and had been steadily continued through the years 1915 and 1916. The stations were already established, the personnel trained, and the people accustomed to the work. The governor of this province has also taken a very active interest and devoted a great deal of his time to popularizing and extending the work of immunization. The immunizing stations at San Fernando (with a substation at Santa Rita) and Macabebe (with a substation at Apalit) were in operation at the beginning of the year. Work was commenced at Lubao in July and at Angeles in September. The San Fernando and Macabebe stations were temporarily closed in June as the people had to use their animals during the rice planting season; they were however, reopened in September. During the months of November and December none of the stations could be run at full capacity owing to the rice harvest and the beginning of the sugar milling season. The number of carabaos and cattle immunized in Pampanga during the year was 4,648, with a total mortality from all causes inside the station of 187 or 4 per cent.

At Iloilo the total number immunized was 1,280 of which 947 were carabaos imported from Indo-China and 333 native animals. The mortality from all causes was 51, or a trifle less than 4 per cent. At the Pandacan quarantine station there were immunized 1,263 carabaos and cattle, 8 sheep and 2 goats. Only 300 of these were native animals the rest being carabaos imported from Cambodge and cattle from India and Hongkong. The total mortality among the carabaos and cattle was 36 or 2.8 per cent. None of the sheep or goats died.

The total number of animals immunized at different stations during the year was, therefore, 7,191 and the total number of deaths occuring from all causes from the time of entrance until the release of the animals was 274 or 3.8 per cent of the number admitted to the stations. Several deaths occurred from such causes as colic, tetanus, abortion, paralysis, and injuries accidentally received. But the most difficult problem was presented by the animals that were already in the period of incubation of rinderpest, though apparently normal at the time of arrival at the station, and one, two, or three days afterwards came down with the disease. It was possible to save but a small percentage of these animals. At the present time we know of no good practical way of absolutely eliminating this factor. As yet no test has been discovered which will show whether an apparently healthy animal is already infected with rinderpest. We have tried keeping the animals under observation for some days before submitting them to the simultaneous inoculation. The people do not like this very well, however, as they consider the three weeks period required for immunization a sufficiently heavy burden. Until some reliable test may be discovered it will therefore be necessary to rely on the skill and judgment of the veterinarians in charge of the various stations, always bearing in mind that cases of this kind are bound to occur in spite of their most careful and painstaking inspections.

Of the imported animals received during the year at the Iloilo and Pandacan stations nearly every shipment has on arrival been found to be infected with rinderpest. This accounted for the majority of the deaths in these shipments. Four different lots of cattle, totaling 195 head, imported from Hongkong were upon arrival found to be badly infected, as a result of which 30 head succumbed. Considering the fact that each lot had several animals that showed very typical symptoms of rinderpest on arrival, it is strange that no evidences of disease were noted at the time of embarcation as the steamer run between Hongkong and Manila is only about 60 hours. We have no control of the inspection at the ports of embarcation. The importers bear all the losses and it should therefore be part of their business to use all possible precautions to obtain clean shipments of animals. One shipment of cattle from India came down with foot-and-mouth disease three days after arrival; two different shipments of carabaos from Cambodge (Indo-China) were also found upon arrival to be infected with this disease. Animals become greatly debilitated from this disease, and it was therefore necessary to hold these shipments for several weeks before subjecting them to immunization against rinderpest. When such animals then do react to the inoculation they very frequently pass through a pretty severe course of the disease. These facts show that clean shipments of imported animals are the exception rather than the rule, and it has therefore not been possible to admit them to the "immunization insurance" provided by Act 2548.

During the past four years 30,131 carabaos and cattle have been immunized against rinderpest by the Bureau of Agriculture. These animals live in rinderpest infected districts, are not subjected to quarantine regulation and have had ample opportunity to contract the disease. To the best of our knowledge less than

1 per cent of these animals have subsequently contracted rinderpest. Owners of immunized animals are very quick to report any ailments with which they may suffer. Several times our veterinarians have been called upon the pretext of rinderpest and have found some minor ailment and frequently nothing noticeably wrong.

Experience seems to indicate that immunized suckling calves lose their immunity after a year or thereabouts. If true, this is not a very serious defect, as these animals can easily be returned for immunization at the end of this period and still not cause the owner much inconvenience as even then they would not be old enough to work. Further experiments are being conducted to test the immunity conferred upon suckling calves by simultaneous inoculation. These will be reported upon in detail when more definite conclusions have been arrived at.

Experiments are also being conducted to determine the duration of the immunity in animals which showed no reaction after the simultaneous inoculation. A detailed report will be made upon the conclusion of the experiments. It may be that they will justify a modification of the present methods of immunizing against rinderpest.

The rapid extension of the immunizing campaign has been greatly delayed by the shortage of our veterinary personnel. Owing to the severity of the rinderpest outbreak it was necessary to keep the majority of our force on quarantine work, and even then we were not able to supply more than about half the number of veterinarians that various provinces and municipalities requested be sent to assist them.

During the coming year it will be possible to make further extensions of the immunizing work; the decrease in the severity of the rinderpest infection in several provinces will release some veterinarians from quarantine work, and the graduation of the 1918 class from the Veterinary College of the University of the Philippines as well as the arrival of Filipino graduates from veterinary colleges in the United States will also help to release some of our older men for immunizing. At present two more veterinarians are in training for this work, who will be placed in charge of stations as soon as possible.

Governors of two of the provinces which had become newly infected, and where rinderpest was at the time running a severe course, personally came to Manila to request the immediate establishment of immunizing stations in their respective provinces, hoping by this means to rapidly check the disease. It was explained to them that immunization could not be counted on to produce any marked or rapid improvement in the situation unless a large station were established in every infected municipality and that this was absolutely out of the question owing to our lack of technical personnel. Furthermore, that even if the men and equipment were available for the immediate construction of several stations the prospects of obtaining very favorable results—viewed from the standpoint of the layman—were rather gloomy, owing to the fact that as the disease was present in a virulent form, dozens of animals already in the incubation period would be brought to the station, and a high mortality could in all probability not be avoided. The people seeing a high death-rate would naturally attribute this to the immunization, as it is rather difficult for the layman to comprehend the fact that an animal may be already infected with the organism of rinderpest though apparently in good health. The work of immunization would therefore stand a good chance of becoming discredited in those sections. It is also rather a slow process, about 200 animals per week being the maximum number that one veterinarian can properly care for. The disease would, therefore, have run its natural course in a badly infected locality before a large percentage of the animals could have been immunized. As has been repeatedly stated in previous reports the proper time to immunize is before the rinderpest assumes a virulent character.

Recommendations.—Immunization properly applied is the surest method for the control of rinderpest, and with judicious extension will be one of the prime factors in the eradication of this disease. Care must be taken, however, not to lead the public to believe that it will accomplish the miracle of bringing about the eradication of rinderpest in a short time and without the necessity of observing the fundamental principles of sanitation and hygiene. All the measures at our disposal must be properly and carefully applied in order to keep the disease well under control and thus give hope of ultimate success in its eradication.

Rinderpest is enzoötic in many sections of the Islands and it will take time, perseverance, and patience to stamp the disease out in these centers. This means that the people will also have to learn that they will have to spend some money for the protection of their animlas and not depend upon the Government to pay for everything. The people of America and Europe spend yearly for the protection and treatment of their animals many times what their respective governments expend for animal disease control. When anything is wrong with the stock, a practicing veterinarian is called in just as a physician is called in to attend a sick member of the family. In this country even those people who can well afford it are disinclined to spend any money for the services of a professional man to treat their animals. Such things as the free distribution of serum do not tend to remedy this matter.

If the Government fosters the continuation of this spirit the outlook for the veterinary profession in this country is not very bright. The Government is now urging young men to study veterinary medicine, principally by calling attention to the lucrative opportunities that are waiting for the members of this profession. As a result the matriculation in the College of Veterinary Science has increased several hundred percent and there are also several Filipino students at Veterinary Colleges in the United States. It is undoubtedly true that for the next four or five years the Government will be able to give these graduates employment, but after that time it is unlikely that it can continue to provide for all the men that will graduate in succeeding years. Consequently, if the opportunities for private practice do not increase greatly within the next few years the time will come when veterinarians will find themselves unable to make a livelihood in their chosen profession. In order to gradually accustom the owners of animals to seek professional services for their livestock, it is, therefore, recommended that veterinarians of th Bureau of Agriculture be allowed to engage in private practice with the proviso, of course, that it must not interfere with their official duties. It is our opinion that livestock owners will thus come to realize that the sums spent for professional services is money well invested. Hundreds of animals die each year from common ailments which could be saved if the people became accustomed to seek veterinary assistance.

Foot-and-mouth disease.—On March 2, 1917, a shipment of 354 Indian cattle, 8 sheep, and 2 goats arrived in Manila from Singapore. These animals had been purchased in India and sent to Singapore in small lots and were held at that place until the total number had arrived and a steamer chartered to convey them to Manila. Some of these cattle had been in Singapore for 3 months. They were embarked February 25th and were five days en route to Manila. Inspection on board ship upon arrival revealed no sign of disease. They were, however, taken to the Pandacan quarantine station for detention and observation prior to immunization against rinderpest. On

March 5th some of the animals presented clinical evidence of foot-and-mouth disease and within 18 days the entire herd was infected, and the majority passed through a severe attack of the disease. It is evident that the shipment had become infected immediately prior to embarkation at Singapore as the disease did not become clearly evident until 8 days after that time. It was not feasible to order the slaughter of these cattle as they were valuable animals imported for breeding purposes; they were, however, put into the strictest isolation and all possible precautions taken to prevent the escape of the infection from the quaranine station. But as was feared from the beginning this proved to be an impossible task. There were at the time over, 1,000 head of cattle within the quarantine station, beside the shipment in question there being about 600 Indo-Chinese cattle and 100 native cattle on hand. Within two weeks after the appearance of the foot-and-mouth disease practically all the animals in the station were infected. Feed had to be brought for all the animals and left near the limits of the station and it was therefore impossible to keep the place absolutely isolated. In some manner the infection did escape as the disease was discovered in some carabaos in the city of Manila the first week in April. The virus had become greatly attenuated, however, as the disease in Manila did not run a severe course and among carabaos was especially mild. Neither did it spread any further than to the adjoining towns of Rizal Province. Infected and exposed animals were carefully isolated and regular and careful inspections carried on in the infected and suspected areas. By the middle of September the disease in Manila and vicinity had been brought under control.

In some inexplicable manner the foot-and-mouth disease was carried to San Jose, Mindoro, making its appearance there the first part of September. It has been confined to San Jose and immėdiate vicinity and according to the reports received from our veterinarians had practically been brought under control by the end of the year. No other provinces became infected during the year.

Two shipments of carabaos from Saigon also arrived infected with foot-and-mouth disease; one shipment of 68 head on October 23, 1917, and another of 71 head on November 11, 1917. As these shipments were small they were more easily handled and placed in strict isolation, and therefore did not cause any further spread of the infection.

Contagious pleuro-pneumonia.—No cases of this disease have been reported during the year. The quarantine notice issued some years ago by the Honorable, the Secretary of Public Instruction, placing the barrio of Sisiman in quarantine to prevent the possibility of this infection being spread from Australian animals imported for slaughter to other points in the Philippine Islands, is still in effect.

Surra.—No special campaign against this disease has been undertaken during the year owing to the heavy demands made by the rinderpest campaign upon the personnel of the division and the absence of any known preventive or curative for this disease. Surra is known to be widely disseminated in the Islands and numerous reports of the loss of animals from this cause have reached this office.

Glanders.—Cases of glanders among horses have been found from time to time during the year in the city of Manila and ordered destroyed. As this disease is readily communicated to man, and with invariably fatal consequence a vigorous campaign for its eradication from the city should be undertaken. This of course demands adequate personnel. In this connection, it should be noted that no cure for glanders is known and the destruction of the infected horses, frequently bitterly opposed by the owners, is the only practicable course.

Hog cholera.—This disease is known to exist in all the swine raising regions of the Archipelago and undoubtedly causes serious losses each year. No reliable statistics have been obtained as to the number of cases and deaths. The custom of allowing hogs to run at large and forage for themselves is the very thing that keeps the disease continually alive and, as with rinderpest, greatly increases the difficulties of bringing it under control.

Owing to the large outlay of money that would be required and the present heavy demands upon the personnel of the Division the undersigned does not recommend the manufacture of anti-hog-cholera serum at the present time.

Anthrax.—Cases of this disease have occurred during the year in northern Mindanao and around the shores of Laguna de Bay, but the known losses have not been sufficiently serious to warrant withdrawning men from the rinderpest campaign to combat them.

Hemorrhagic septicaemia.—No cases of this disease have been brought to our knowledge during the year, which is not surprising as the regions where this disease is most liable to cause trouble have been relatively free from rinderpest and hence less closely under our observation.

LIVESTOCK IMPORTATIONS.

The year witnessed a further decline in the importation of live animals from foreign ports, due rather to the scarcity of tonnage and excessive freight rates than to any lack of demand in the local market. The shortage of imported animals for slaughter and of the importation of chilled and frozen meat, as well, accounts for the marked increase, noted elsewhere, of native cattle and swine shipped to Manila for slaughter.

During 1917 of the 4,618 cattle arriving at Manila from foreign ports 3,812 were from Pnom-penh, 497 from Singapore, 195 from Hongkong, 100 from Saigon, 11 from Australia and 3 from Spain. During the year 185 carabaos arrived from Pnom-Penh, 57 from Singapore and 71 from Saigon. No changes were made during the year in the General Orders regulating the importation of animals.

ILOILO QUARANTINE STATION.

Three lines of work were conducted at this station during the year: Quarantine and immunization of work animals arriving from French Indo-China, immunization of local animals, and the slaughter of Indo-Chinese cattle for local consumption. During the year 220 cattle and 498 carabaos arrived from Pnom-Penh. During the first quarter of the year 104 cattle were slaughtered for food.

SISIMAN MATADERO.

This station, which is used exclusively for the slaughter of Australian cattle, was closed throughout the year owing to the suspension of importations from that country. Mr. G. J. Wilson has been stationed there during the entire period to care for the Bureau property at the station.

SAN LAZARO IMMUNIZING STATION.

This station has been loaned to and used by the College of Veterinary Science, University of the Philippines, during the entire year.

VETERINARY RESEARCH LABORATORY.

Mention was made in the Annual Report for 1916 of a new pneumonia discovered in swine. During the past year additional work has been done with this disease. It has been found that its causative agent is a "pseudomonas." The symptoms are quite similar to the chronic form of swine plague and the lesions are also very similar to this disease. The organism is easily cultivated on artificial media; and is also pathogenic to rabbits and Guinea pigs, causing a severe septicaemia when injected subcutaneously, the animals succumbing in from two to three days. A method for immunizing against this disease is being worked out and so far favorable results have been obtained. A detailed report will be made when more conclusive results have been obtained.

A disease in cattle in the Philippine Islands similar to Anaplasma marginale has been found and a full report published in the Philippine Agricultural Review, Vol. X, second quarter, 1917. This disease does not appear to be the cause of any considerable loss among cattle in the field.

In the Philippine Agricultural Review, Vol. X, third quarter, 1917, an article was published on "Experiments on the treatment of rinderpest with various drugs." Owing to the fact that frequently, people come to this Bureau with the statement that they have cures for rinderpest, it was decided to perform a series of tests with several drugs and publish the results. During the past year we have allowed three different men to try out their cures at the laboratory, and in each case their remedies proved worthless in curing the disease. These men were allowed to administer the remedies themselves and were given entire charge of the animals undergoing treatment. Two men were given three animals apiece and one man was given two animals. In every case the animals died of rinderpest and upon autopsy presented typical lessions of this disease. Two of these men left the laboratory fully convinced that they did not have a cure for rinderpest; one man made the statement that he could cure rinderpest in the field but not in the laboratory. The question naturally arises as to whether he was treating rinderpest while in the field or merely some slight digestive disorders. Another point which has to be considered is the fact that men who profess to have cures for rinderpest ordinarily try them out in localities where the disease is present in rather mild form and where the normal recovery is from 50 to 70 per cent. Therefore it is easy to see that if they are at all shrewd, they can eliminate the fatal cases and in this way obtain a high percentage of cures, providing the material they use is administered in small enough doses and is not too injurious to the animal.

The drugs used in the experiments performed at the laboratory were as follows: (1) Eosin; (2) Medicinal Methylene Blue; (3) Cacodylate of soda; (4) Atoxyl; (5) Quinine sulphate; (6) Camphorated oil; (7) Creolin; (8) Permanganate of potash; (9) Ergot; (10) Iodine; (11) Potasium Iodide; (12) Gentian violet;

(13) Arecolin hydrobromide; (14) nuclein; (15) Formalin; (16) Chlorazene; (17) Castor oil; (18) Alcohol; (19) Fluid extract of Nux Vomica; (20) Fluid extract of Gention; (21) Cannabis Indica. None of these drugs presented any curative value for rinderpest.

A considerable amount of work has been done on locating the various seats of rinderpest virus in the animal body. It has been found that the liver, spleen, lymph glands, intestinal tract and heart muscle are highly virulent. Extracts made from these tissues can be used for virulent material in immunization and hyper-immunization. These experiments have been reported on and will appear in the Philippine Agricultural Review, Vol. X, fourth quarter, 1917.

Work is also being conducted upon a new method of immunizing against rinderpest, which up to the present has been giving very favorable results. By this new method the animals pass through the immunization without developing any symtoms or ill effect from the disease, and are rendered highly immune to subsequent exposures to sick animals and injections of virulent material. A full detailed account of this method will appear when it has been perfected to such an extent that it can be made public.

Work is also under way attempting to devise methods for immunizing against surra, glanders, swine plague, hog cholera and hemorrhagic septicæmia in cattle with good prospects in view for some if not all of the above-mentioned diseases.

DEMONSTRATION AND EXTENSION DIVISION.

AGRICULTURAL DEMONSTRATION SECTION.

Administration project.—Under this project falls the direction of the agricultural demonstration work, the direction of all demonstration stations, the conducting of food production, rice seed selection and tobacco campaign and all other campaigns which deal with the improvement of crops.

At the beginning of the year, there were employed nine Americans and forty-two Filipinos. Two Americans were separated and one transferred to another division during the year, while two Filipinos were also separated from the service, one transferred and two resigned. There were 18 tobacco inspectors appointed under Act No. 2692 and 21 new assistant agricultural inspectors appointed during the year. At the close of the year, there were, therefore, six American and eighty Filipinos in the employ of the demonstration section, located as shown in the table below:

Provinces.	Employees.		
	Americans.	Filipinos.	
Central office, Manila	4	3	
Cebu		3	
Bohol		2	
Iloilo and Capiz	1	3	
Antique		1	
Batangas		4	
Mountain Province		4	
Nueva Vizcaya			(2)
Isabela and Cagayan	1	3	(3)
Ilocos Norte, Sur, Abra, La Union and Amburayan		8	(7)
Tarlac		1	
Bulacan		3	
Cavite and Bataan		2	
Ambos Camarines		2	
Rizal		1	
Laguna		4	
Pangasinan		3	(5)
Nueva Ecija		2	(1)
Pampanga		2	
Mindoro		1	
Samar		2	
Leyte		1	
Surigao		1	
Misamis		1	
Oriental Negros		1	
Sorsogon		1	
Albay		1	
Zambales		1	
Tayabas		1	
Total	6	62	(18)

NOTE.—Figure in parenthesis indicates tobacco inspector.

Of the personnel credited to the central office, one American was on leave in the United States, one was in charge of the Momungan colony in Mindanao and another was in charge of the Singalong Propagation station. One American and one Filipino were detailed as traveling inspectors to supervise the work of the fieldmen.

From the first of the year until June 22, 1817, Mr. E. F. Southwick was in charge of the supervision of the work of this section. From June 23d to the end of the year, Mr. Southwick was on leave in the United States and the supervision of the work was left to Mr. Mariano Billedo, who has since acted as chief of the demonstration and extension division.

During the year, the activities of this section were greatly extended partly due to the establishment of provincial as well as municipal nurseries, the tobacco production campaign, the food production campaign, and later on the rice seed selection campaign. For the purpose of helping provincial officials in the food production campaign, one assistant agricultural inspector was assigned in almost every Christian province in the Islands.

The employees of the demonstration and extension section are the field agents of the Bureau of Agriculture. They gather, disseminate and distribute material and information beneficial

(*a*) Portion of the Municipal Garden and Nursery at the Plaza of Magsingal, Ilocos Sur, planted with native cowpeas. In the germinating shed 1,037 seedlings of various fruit trees are found at present.

(*b*) School boys gardening in the Food Campaign.

Varieties of rice grown at Alabang, Rizal.

to the farmers, make actual demonstrations of better agricultural methods and modern implements through coöperators and demonstration stations. They introduce new plants and seeds that are of economic importance for distribution to the farmers. They also supervise the placing and maintaining of breeding animals for public use.

Food production campaign.—Although this campaign has been a part of the work of the field employees since the beginning of the demonstration work in the provinces, yet the campaign of last year was more extensive and the result more encouraging than any in the past. The number of vegetable gardens planted under the direction of the field employees was a great deal larger than ever before. Provincial as well as municipal gardens were established on public grounds in many of the provinces, partly for the production of vegetable seedlings for distribution and partly for the demonstration of the proper methods of growing vegetables.

Rice improvement campaign.—This campaign was carried on along two distinct lines, that is introducing Bureau improved seed, and selecting local varieties for seed purposes. The selection of rice seed constituted the major part of the work undertaken during the year. This line of the work was greatly emphasized, especially when the Department of Agriculture and Natural Resources inaugurated a more extensive campaign by employing foremen and laborers for the rice producing provinces. The selection of rice seeds was a success, especially in provinces where cheap labor enabled the farmers to coöperate heartily with the inspectors in the seed selection.

Tobacco production campaign.—This campaign was carried along in connection with the work of the field employees, but the passage of Act No. 2692 enabled the demonstration section to appoint eighteen tobacco inspectors to help carry on the work started by the assistant agricultural inspectors. The increased planting of tobacco this year in the Ilocos Provinces and in Pangasinan can be accounted for partly by the good price paid for tobacco last year but mostly by the campaign inaugurated by field agents of this section.

Public breeding work.—This work properly belongs to the animal husbandry division, but a certain phase of the work has been handled by the field inspectors of the demonstration section. The placing and maintaining of the breeding animals, such as boars, bulls and stallions, were left to the discretion of the inspectors. In fact, when an animal for public breeding was placed in the charge of an inspector, he was held responsible for the care and success of the same. Cebu, Ilocos Sur, Ilocos Norte, La Union, Pangasinan, Pampanga, Bulacan and Iloilo have made the greatest progress in animal breeding as supervised by this section. During the year 1917, there were 50 boars stationed in the above-mentioned provinces in charge of the field employees of this section, for breeding purposes. Two of these boars died. The other stock for breeding consisted of five stallions, two bulls and one billy. The breeding work has progressed satisfactorily and a great demand for breeding animals has been aroused among the farmers.

Cebu demonstration project.—The prevailing weather conditions during the year have been unfavorable. There was too much rainfall with the result that corn planted in low lying districts was badly damaged.

Corn plots, as a whole, were poor due to flood and, in some cases, to excessive moisture. There were altogether eighteen plots planted to native, yellow and Moro corn, but the crop was very poor. One of the plots gave an average of thirty cavans per hectare. Corn crop all over the district was poor and the price per cavan abnormally high.

The tobacco crop was fairly good as a whole. Fine tobacco was raised in the plots in Minglanilla and Argao. Selected seeds from Isabela were used in all cases. The superior quality of the leaves produced over that of the local variety has caused a great demand for seeds.

One plot of Hawaiian sugar cane was harvested during the first quarter and the points available were bought for distribution to new coöperators. There were altogether nine plots of sugar cane planted in Minglanilla, Talisay, Mandaue, Consolacion, Danao, Lugo, Bugó and Mambaling. All the plots were planted to Louisiana striped, save in Mambaling where the native variety was used. The sugar cane plots have grown very poorly and some were entirely a failure. The ratoon crop at Talisay was fair. The sugar cane crop, as a whole, was poor, excepting where planted in well drained land.

The prevailing high price of maguey has served as a stimulus for the farmers. Maguey was planted in all sections at the hill sides and near the seashores. In some cases, lands which were formerly planted to sugar cane or corn, were planted to maguey. Ten thousand sisal bulbils were also planted.

The most salient feature of the work in this district was the progress made in public breeding. At the close of the year there were sixteen boars and two stallions stationed in this district. This work has progressed very rapidly since an assistant has been placed to look after it. Not less than 361 mestizo pigs were raised during the year.

Tabonoc demonstration station.—The Province of Cebu appropriated ₱2,000 for the establishment and maintenance of this station. The work was started last May. In this station, there were planted vegetables on a large scale, manga seeds, chico, kapok, mabolo, nangka, papaya and santol and 5,000 coconuts to be planted along the provincial road. The five plots of corn planted last May have made a fair showing and farmers were surprised to find some corn producing from two to three well developed ears to the stalk. Rice plots were also planted at the station, giving fair results.

Iloilo and Capiz demonstration project.—The weather conditions throughout the year were exceedingly unfavorable. Plots that were planted to corn had to be replanted several times, while others had to be abandoned. The weather was favorable, however, for the planting of more rice than in any previous year.

There were altogether fifteen corn plots handled throughout the district during the year. The corn crop all over the district was a poor one, as a whole.

Twenty rice coöperators in Capiz and Iloilo, of the Apostol, Conner, Cruz, Inantipolo and Roxas rice varieties, were handled. The results of these plots were not reported at the end of the year.

During the last quarter, the efforts of the personnel of this project were concentrated on the selection of rice seed. In the Province of Capiz alone, there were 2,646 gantas of rice selected, while in Iloilo 20,408 gantas were selected for 1,082 owners. Great interest in this work was shown by both the municipal officials and farmers, especially in the Province of Iloilo. In many cases, councilors and lieutenants of barrios, at their own request, were given instructions to fit them for instructors, and, where area to be covered by one foreman was large, these men personally supervised the work without remuneration. There was no record kept of the amount of seed selected under the supervision of these public spirited men. The rice crop in the district was a great deal better than in any previous year. Many farmers, encouraged by the favorable weather and suggestion of the inspectors, planted a second crop of rice, for the first time, right after the first crop was harvested. The rice planted looked promising at the end of the year.

The prevailing wet weather in Capiz was taken advantage of by the farmers in planting coconuts and hemp, and by attending lectures on food campaign, poultry raising, stock raising and selection of seeds.

The breeding work in this project progressed satisfactorily. There were 6 boars, one Nellore bull, one stallion and one Spanish goat stationed in this district for breeding purposes.

Iloilo demonstration station.—During the first quarter of the year, there were planted at the station $\frac{1}{4}$ hectare of guinea grass, $1\frac{1}{2}$ hectares of velvet bean, $\frac{1}{5}$ hectare of peanuts, $\frac{2}{5}$ hectare of cowpea, a plot of Isabela tobacco and about 15,000 kapok seeds planted. The corn plot planted during the preceding quarter was harvested. There were 4,000 selected ears for seed purposes and about 2,500 ears of feed corn. Another crop of corn was harvested during the third quarter producing an average of 30 cavans per hectare. Corn planted during the latter part of the year was damaged by excessive rain.

The tobacco planted at the station last year produced an average of 31.2 leaves per plant. About 45 per cent of the tobacco produced could be classed as first-class in size, but the remainder, as second and third.

A small nursery was also installed at the station where chico, banana, kapok and other fruit trees were planted for distribution purposes. A tobacco seed bed was also planted for distribution purposes.

One of the great attractions at the station was the presence of large Yorkshire boars. Seventeen young pigs were sold for breeding purposes.

Batangas demonstration project.—As a whole, the general field crops of Batangas suffered from drought and strong winds during March, April, August, October, November, and December. The municipalities that have suffered most were, Bolbok, Batangas, Loboo, Bauan, Taal, Lemery, Alaca, Balayan, Tuy, Lean, Nasugbu and Calatagan.

During the year, there were 54 coöperators in 14 municipalities for Moro corn. The results of these plots, due to climatic causes, were discouraging, except in two plots, one in Lipa and another in Rosario which gave an average of 60 cavans per hectare. The corn crop, as a whole, in the province was very poor.

Six coöperators of Bureau rice, such as Inantipolo, Apostol and Cruz, were also handled, but the results, due to drought and strong winds, were discouraging. The rice crop in the whole district was a great deal better than the preceding year.

The selection of rice seed, which was one of the important works carried out during the year, has given satisfactory results. Both upland and lowland varieties of rice were dealt with. The inspectors of the Bureau of Agriculture and the laborers paid by the Department of Agriculture and Natural Resources were given a hearty coöperation by the farmers. There were two methods adopted in the disposition of the seed selected by laborers paid by the Government, one was by giving the whole amount of seed selected to the owner for future planting and the other by getting one fourth share of the seed selected. The amount of seed selected in both methods was considerable. The farmers, who were helped in the selection of seed will become rice coöperators this year.

Batangas municipal nursery.—This was established on May 26, 1917, with an appropriation of ₱680. From this nursery 11,350 vegetable seedlings and 2,000 assorted fruit trees, including coffee, were distributed since its establishment. Great interest was shown by the municipal officials and a bigger appropriation for the year following was contemplated.

Lipa demonstration station.—The whole farm force of the station has been busily engaged in putting every bit of ground under cultivation. During the year different farm crops, such as rice, corn, camote, gabe, potato, ginger, papaya, banana and other vegetables were planted. Rice, corn and forage plants suffered much from drought.

The coffee work was the most important carried at the station in order to revive the coffee industry of Lipa. During the middle of the year, there were at the nursery 19,400 seedlings, 9,900 of which were sold during the year and the rest to be disposed of during the following rainy season.

A model orchard was also planted with 367 Excelsa and Liberian coffee seedlings. The trees were spaced four meters apart temporarily shaded with native tañgantañgan, which, by the way, made a good demonstration by itself. Anas were planted for permanent shade.

The Bureau of Agriculture furnished the Lipa farmers 12,092 coffee trees, free of charge.

Antique demonstration station project.—The weather condition in this project was favorable for rice. The stand of rice of both the upland and lowland varieties was such that there were not enough laborers to harvest the crop at the proper time and it was estimated that there was a loss of from 10 to 15 per cent of the total crop. A great deal more rice was produced than formerly.

Several rice coöperative plots were secured, varying in area from one to four hectares. Apostol, Cruz and Inantipolo were the varieties used. The lowland rice coöperative plots did not show satisfactory results, owing to the fact that the planting was too late. The coöperators were satisfied with the crop obtained and seeds were selected from the plots for future planting.

The selection of rice seed of the local varieties was also carried among the farmers. In San José and Sibalom, there were 250 gantas so selected and the owners will become rice coöperators next season. The selection of local seed among the farmers was a difficult task on account of the mixed varieties that were planted.

Lectures were delivered whenever there was a gathering and the subjects discussed were rice and corn culture, seed selection, vegetable home garden, the improvement of poor soil, the planting of bananas and other fruit trees, and the improvement of livestock. It was estimated that there were more than 2,000 people that attended these lectures.

The demonstration station of San José.—About three hectares of the station were planted to Apostol and Cruz varieties of rice. This area produced about 100 cavanes. The average yield previously was 15 cavanes per hectare. The land was rather poor and had to be planted with cowpeas and other leguminous plants to improve its quality. All of the rice seed produced will be sold only for seed purposes.

Moro corn was also planted at the station, but gave poor results on account of caterpillars and strong winds. Other crops planted at the station were sweet potatoes, lyon beans and cowpeas for distribution among the farmers.

Mountain Province and Nueva Vizcaya demonstration project.—This project was under the direct charge of Mr. W. H. Cropper, assistant agricultural inspector, until his resignation at the end of the third quarter. Mr. Cropper was succeeded by Mr. Juan Gaerlan, agricultural inspector. Messrs. Macario Guerzon, Modesto Dirige and Leon Calika, all assistant agricultural inspectors, were the assistants of Mr. Gaerlan.

Messrs. Victorino Cruz and Ernesto Cuisia, tobacco inspectors, were appointed for Nueva Vizcaya during the third quarter.

For lack of personnel, there was no agricultural demonstration work carried in the Subprovince of Benguet. Tobacco demonstration was carried on in Nueva Vizcaya by two tobacco inspectors.

The weather condition throughout the district was rather unfavorable, due to excessive rainfall especially in the northern districts of the Mountain Province.

Due to the adaptability of this district to coffee, a great deal of time and effort was concentrated in furthering the growing of this crop. Nurseries had been established, plants distributed and planted, old trees were pruned, cultivated and mulched under the supervision of the inspectors. New varieties of coffee were also introduced and from all appearances they thrived well. There were 54,465 coffee seedlings of the Robusta and Arabica varieties, 34,700 of which were planted in Lepanto and 19,765 in Bontoc planted during the year.

The tobacco campaign has given good results. In Bontoc Subprovince 50,050 seedlings were planted and in Lepanto 21,571.

Catanduanes (Albay) demonstration project.—Mr. E. H. Koert, assistant agricultural inspector, has charge of the Bicol breeding station and he carried demonstration work only when his work at the breeding station allowed him. The only demonstration work he could perform was the growing of vegetable seedlings and other plant materials for distribution among the farmers, and vegetable garden as a model. The sale of vegetables at the station amounted to ₱47.20.

Isabela and Cagayan demonstration project.—The tobacco crop as a whole was rather poor and less tobacco was produced owing to the excessive rains during November and December, 1916, and also during the harvest period. There were 71 coöperators representing an area of 63 hectares. In many cases the tobacco coöperators were also corn coöperators.

There were 69 corn coöperators representing an area of 96 hectares. The coöperators obtained an average of 39 cavans per hectare, while in general only about 22 cavanes per hectare was produced. The corn crop, as a whole, was good.

The rice crop in Isabela was considered very poor and the few coöperators were discouraged. In Cagayan the rice crop was better and the few coöperators obtained an average of 49 cavanes per hectare, 9 cavanes more than the general average.

During the months of June, July, and August, 1,465 liters of seeds were purchased, 900 liters of which were sent to Cagayan, 120 liters to the Bureau of Agriculture, 80 liters to Juan Bunoan, 30.5 liters through the mails and 58.5 liters to 160 persons.

The tobacco seeds planted during September were almost all destroyed by rain and floods. It was estimated that only one-third of the total seedlings on the seed beds was saved.

The inspectors in this project were also appointed as special forest officers for the issuance of gratuitous timber licenses for tobacco drying sheds. In Isabela 2,586 of these licenses were issued, while in Cagayan 1,267. However, not more than 600 were energetic enough to build drying sheds during the year.

During the first month of the year the Valley was visited by a swarm of locusts, but the activity of the officials and citizens prevailed.

About 43,000 packages of vegetable seeds were distributed during the last quarter. Notwithstanding the excessive rains and floods, it was estimated that 10,000 would be benefited by the home gardens planted.

Ilocos Norte, Ilocos Sur, La Union, Abra and Amburayan demonstration project.—During the first quarter, the climatic conditions in this district were unfavorable. It was hot, dry and windy and with only a few showers. Due to this unfavorable condition, it was impossible to plant much corn and sugar cane. However, the weather was favorable for the rice crop.

The number of rice coöperators in this project was 27, representing an area of 86,930 square meters. The average production of these plots was not reported at the end of the year.

Of the nine corn coöperators handled, the production ranged from 30 to 100 cavanes per hectare. The maximum yield was obtained in one of the plots at Narvacan.

Owing to the fact that the tobacco inspectors were appointed late, there were only 26 tobacco coöperators handled. All of the plots were growing nicely. In the whole district, there was great interest in tobacco and a great deal more tobacco was planted during the year than in any previous year. Thirty demijohns of Isabela tobacco variety furnished by the Tabacalera Company were distributed in the district.

A total of three provincial and eighteen municipal nurseries were in operation during the year in this project. The materials and labors were furnished gratis by the people concerned. These nurseries were somewhat abandoned during the last quarter, due to the food production and rice seed selection campaigns.

One of the most important works carried on in this district was the food production campaign. About ten sacks of vegetable seeds were distributed. All the assistants assigned in this project were mobilized in this work, and, with the hearty coöperation of the provincial, municipal, Insular officials and the people, the campaign produced good results. Home gardens, municipal gardens and provincial gardens were all in evidence.

The rice seed selection campaign was emphasized more this year than in any year before, especially when the Department of Agriculture and Natural Resources hired laborers to carry on the work. This line of work was very successful and the local officials as well as the farmers coöperated heartily.

The public breeding work in the project progressed satisfactorily. There were fourteen boars, (one of which died), and one stallion in use in the whole district.

Tarlac demonstration project.—Owing to the lack of funds, this project was not attended to until the last month of the year, when Mr. Juan Naui, assistant agricultural inspector of the Department of Agriculture and Natural Resources was placed in charge. Mr. Andres Elviña, assistant agricultural inspector of the Bureau of Agriculture was detailed as assistant.

The only work accomplished in this project was the selection of rice seeds on large scale as adopted by the Department of Agriculture and Natural Resources. This work was carried on in the municipalities of Tarlac, Victoria, Paniqui, and Camiling. Being a new work and probably partly due to the scarcity of labor and the abundance of good crops, good coöperation was not available, except in the municipalities of Paniqui and Camiling.

Bulacan demonstration project.—During the first four months of the year, it was rather dry and windy, but later on the weather was favorable for sugar cane, corn, and rice.

Of the fourteen plots of corn handled during the year, those planted at Quingua gave the best results. Severo Marcelo, one of the coöperators, produced 21⅓ cavanes on ¼ hectare, or an average of 85.3 cavanes per hectare. Another coöperator, Inocencio de Vera, produced 41 cavanes from ½ hectare, or 82 cavanes per hectare. The other eight plots at Quingua had to be sold green and produced an average of ₱85 per hectare. The corn planted during the dry season was rather poor, but the main crop was good.

There were 20 rice coöperators handled during the planting season, but, due to the fact that one of the inspector in charge was transferred, some were dropped. The results of these plots are not reported as yet.

Two sugar plots of Demerara 1,335 and H–20 were planted at Bocaue and San Miguel. At the time the two transferred inspectors left these two districts, these plots were making a good growth.

The food production campaign was one of the important works carried in this district. Lectures emphasizing the need and means of increasing production of cereals, vegetables, secondary crops and poultry were discussed. Thousands of packages of vegetable seeds were distributed. Local officials, as well as the masses have responded enthusiastically and home gardens were multiplied.

Being a rice producing province, the selection of rice seeds was the most important work carried in this project by the inspectors. This line of work was especially emphasized when the

Secretary of the Department of Agriculture and Natural Resources hired laborers and foremen to push this work. The work was successful.

The Province of Bulacan appropriated ₱1,500 for the establishment and maintenance of a station at Malolos. The first corn crop raised was interplanted with cowpeas and peanuts, in order to improve the rather poor quality of the soil. About four-fifths of the total area of the station was planted to rice during the rainy season. The varieties used were Apostol, Roxas, and Cruz, and also Macan, a local variety. A good crop of rice, considerably better than adjoining fields, was produced.

The nursery has maintained several seedlings of the local varieties of fruit trees, such as mango, chico, tamarind, mabolo, papaya, cacao, ate, etc., etc., most of which were distributed from time to time.

Bataan and Cavite demonstration project.—The weather in Bataan during the first four months of the year was rather hot, and rice as well as corn plots planted in the previous quarter suffered severely.

The rice crop in the district was good as a whole especially the lowland, but the upland was slightly damaged due to drought. The results of the ten coöperative plots, (lowland Bureau rice) handled during the year ranged from 31 to 52 cavanes per hectare, while in general the average production was about 20 cavanes. The rice varieties used were Apostol for lowland and Inantipolo for upland. Each coöperator has selected two cavanes of seed for next season.

There were also 20 coöperative corn plots planted during the year. Those planted early in the year suffered from drought, but the main crop was good. Sincamas plots were also maintained to demonstrate the advantage of proper cultivation.

The most important projects carried on during the year were the food campaign, rice seed selection and the establishment of a small provincial nursery. In the food campaign lectures on agricultural topics were discussed and vegetable seeds distributed. In the seed selection of rice, many farmers were helped, but the majority could not afford to select, due to good crop and scarcity of labor.

The demonstration station of Balanga.—This was established with an appropriation of ₱150. It was the smallest nursery established during the year in any province in the Islands. Due to the limited space of the nursery, no other work but the propagation of plants for distribution could be undertaken.

Ambos Camarines demonstration project.—The agricultural demonstration work in this province was started last April, when the provincial board appropriated the sum of ₱1,000 for the establishment and maintenance of a nursery. Mr. Eugenio R. Abrigo, agricultural assistant, was placed in charge and Mr. Hilarión Francisco, assistant agricultural inspector, as assistant.

The weather condition was favorable throughout the district, but during October a flood occurred which destroyed rice in low lying district.

Being a rice producing province, the most important work carried in this project related to the improvement of this crop by the introduction of the improved Bureau varieties, better cultivation and seed selection from local varieties. Fifteen coöperators of Apostol, Roxas and Conner varieties were secured. The results of these plots will be reported later.

The demonstration station was planted to different vegetables, cowpeas, corn and peanuts all the year around. The results obtained were all satisfactory. Cacao and coffee were also planted in the nursery for distribution purposes. The lowland portion of the nursery could not be planted to rice, since the province could not furnish a work animal.

The food campaign carried in this project produced satisfactory results. Every municipality had its garden where vegetable seedlings for distribution to the farmers were maintained. The provincial and municipal officials coöperated efficiently with the inspectors. Vegetable seeds were distributed by the thousands in packages.

The rice seed selection campaign, as outlined by the Secretary of Agriculture and Natural Resources, was also carried in this province. The farmers, as well as all officials concerned, were enthusiastic about this work. Coöperation could not be had on a large scale, due to the scarcity of labor.

Rizal demonstration project.—The weather was so warm during the first quarter that agricultural operation on a large scale could not be undertaken. The weather was favorable, however, for rice.

The three plots of rice which were not reported in 1916 produced good results. The Apostol variety gave an average of 42 cavanes, while the Cruz variety 65 cavanes.

Much attention was devoted to the selection of rice seed of the 1916–1917 crop. Municipal officials, as well as numbers of agricultural societies coöperated heartily in this work and 68 cavanes of rice were selected for 117 farmers.

Most of the garden days celebrated in Rizal were attended by the inspectors. Vegetable seeds, plants and circulars were distributed and agricultural topics discussed.

The sugar cane demonstration plot at Pasig has produced 5,000 points of yellow Caledonia, 4,900 of Louisiana striped, 4,000 of H-309 and 1,000 of H-69, and also ₱12.00 worth of cane sold. All of the points were distributed to farmers in Pasig, Mariquina and San Mateo. All of these canes have grown satisfactorily.

The selection of rice seed on a large scale as outlined by the Department Secretary was also carried out with success.

The campaign for producing more food stuffs was also carried on with vigor and thousands of packages of vegetable seeds were distributed.

Laguna demonstration project.—The weather during the first quarter was hot and dry, with a shower every ten or fifteen days in the lowland, while in the upland, there were frequent rains. The drought during August affected somewhat the upland rice, but the lowland was good in every respect. Weather conditions also favored all other crops.

Being decidedly a rice producing province, the most important work carried in this project was that related to the improvement of cultivation and increase in production of rice. Instruction in seed selection on a large scale was successfully carried out and the inspectors were kept busy attending and instructing the farmers in this line of work. During the first quarter, a total of 387 gantas of seed rice were selected by the inspectors and the farmers. Three thousand gantas of all of these seeds were used in planting last season. The two plots of rice harvested during the first quarter have an average of 59 cavanes per hectare, while, in general, about 35 cavanes were obtained. There were 32 rice coöperators maintained during the year, producing from 57 to 156 cavanes per hectare. The selection of rice seed on a large scale was also carried out during the last quarter with good results.

An excellent crop of corn was harvested by 8 corn coöperators handled in the district, with a yield ranging from 40 to 86 cavanes per hectare. By carrying a vigorous food production campaign, the farmers throughout the province have harvested an excellent crop of sweet potatoes, squash, garlic, gabi and other vegetables. Gabi was selling at twenty-five to thirty-five centavos per sack. Vegetables were so abundant that farmers had difficulty in disposing of all of their products.

Santa Cruz demonstration station.—The work at the station has been carried out successfully, especially during the first quar-

Cacao tree about 4 years old carrying 65 fruits, Pagsanjan, Laguna.

ter of the year. During the third quarter, the ground was too wet to work, but later on the station was put in good condition. Large amounts of vegetable seeds and seedlings, and also coffee, were raised for distribution among the farmers. One-half hectare of native yellow corn gave a yield of 41.5 cavanes of shelled corn. Vegetables were planted on a large scale. The gabi plot planted at the station produced an average of 160 cavanes per hectare. At the end of the year, there were planted at the station one-fourth hectare of tomatoes, one-fourth hectare of Irish potatoes, one-fourth hectare of different varieties of beans, one-fourth hectare of American sweet corn and a plot of vegetables. One hundred Liberian coffee seedlings were also planted all of which were in excellent condition at the close of the year.

Pangasinan demonstration project.—On account of the prevalence of locusts in the first two months in the Province of Pangasinan, as well as in the neighboring provinces, the entire field force of this project was loaned to the pest control section for detail in the locust work. Very little attention could therefore be given to agricultural demonstration work during the said period.

From the beginning of the year until the middle of March, the weather was dry, but afterwards the weather changed favorably for the farmers. The early planted tobacco plants were affected by the drought, but the late ones have produced better results. The tobacco crop produced was considered greater than the year previous. The tobacco plot, consisting of 12,000 square meters, has yielded two thousand manos.

Due partly to the high price paid for tobacco last year and principally to the campaign carried by the assistant agricultural inspectors, as well as tobacco inspectors in this province, a considerable area has been planted, an area estimated to be more than that corresponding to the previous year. There were twenty-one coöperators handled during the year. The tobacco seedlings planted so far were growing nicely.

During the year, there were twenty-two coöperative plots of rice maintained. All of these plots have shown up satisfactorily and the yields, some of which were expected to be exceptionally good, will be reported as soon as threshed out. All of the seed used in these plots was selected. The selection of rice seed was carried to its full extent this year, especially when the Department of Agriculture and Natural Resources employed foremen and laborers for this purpose. About twenty-thousand farmers were helped in the selection of rice seed. The local officials, as well as the farmers, were greatly interested in this work and good coöperation by those in charge of the work was given. The rice crop, as a whole, in the province was considered better than the preceding year.

The food production campaign was also one of the most important works carried during the year. Several lectures on several occasions were given with large attendance and thousands of package of vegetable seeds were distributed. The masses have responded enthusiastically in this campaign and fine home gardens were found almost everywhere. There were two hundred and sixty garden coöperators handled during the year.

Nueva Ecija demonstration project.—Three inspectors were stationed in this project for the purpose of making a campaign in increased production, as well as improvement of the quality of tobacco. Due to the campaign carried out in the province, larger area was planted to this crop than in any previous year. The quality of the crop produced was better and the quantity increased. Great interest among the farmers was manifested and large areas were already planted at the end of the year.

The campaign for food production, as well as selection of rice seed was also carried out in this province. The farmers were interested in the selection of seed, but due to a bountiful crop of rice and the scarcity of laborers, not much cooperation could be rendered.

Pampanga demonstration project.—As in the case of many of the other projects, the weather condition in Pampanga during the first quarter was dry, as a whole. The planting of secondary crops could only be carried in places where irrigation was available. The weather was, however, favorable for sugar cane, rice and the main crop of corn.

The number of Moro corn coöperators handled during the year was seven in all. This corn has made satisfactory showing and in one of the plots an average of 72 cavanes per hectare was obtained. Farmers were, however, reluctant in planting this on a large scale, due to its susceptibility to weevil attacks and other pests. Other plots handled were two plots of Momungan sweet potatoes, five plots of peanuts and two of sugar cane and six plots of rice. The plot of sugar cane was for the purpose of demonstrating to the people the advantages of selected points, introduction of foreign variety, wider distance in planting and irrigation. The plots were a success and people were convinced of the practicability of changing the old method of planting. Most of the rice coöperators were satisfied with the yields obtained, while others were disappointed, due to negligence in weeding their rice fields. The yields will be reported later.

Other important works carried during the year were the food production and the rice seed selection campaigns. Both of these campaigns were a success. In the food campaign several lectures were delivered in all the municipalities and tens of thousand of packages of vegetable seeds distribtued to the farmers. The provincial, as well as municipal officials coöperated effectively in this campaign and, as a result, many fine home gardens were maintained. The rice seed selection campaign was also a success.

Mexico demonstration station.—The establishment and maintenance of this station were furnished by the municipality of Mexico until the fourth quarter, when the province appropriated an amount of money to carry the work on a larger scale. The station was increased to four hectares in area and three work animals were purchased. Three laborers were maintained by the province and one by the Bureau of Agriculture.

Part of the station was planted to vegetables all the year around and considerable of the product was sold in the market. At the end of the year, there were found plots of Moro corn, Iowa Ideal and native corn, sugar cane plots of both native and imported varieties, plot of different vegetables and numerous seedlings of different fruit trees in the nursery. This station promises to be one of the best stations of the demonstration division.

Bohol demonstration project.—The weather conditions throughout the year were favorable to rice, but for corn, it was rather unfavorable. There was too much rain.

The most important works carried during the year were food production campaign, seed selection campaign and the establishment of the provincial nursery. Lectures were delivered in all accessible municipalities and vegetable seeds and seeds and seedlings were distributed. Almost every municipality had its vegetable garden and home gardens were numerous.

In the selection of rice seed the intelligent farmers were greatly interested since accounts of the results of rice plots in Laguna Province has reached them. Many farmers were helped in seed selection and in spite of the fact that the work was new to the people, it was successful. In the Bohol rice colony alone, 98 cavanes were selected or one cavan per each colonist. In connection with this work, the provincial board allotted ₱10,000 for the purchase of selected seeds to be resold later to the needy farmers. The rice crop was good. Besides rice, corn seed was also selected.

The establishing of the provincial nursery in the municipality of Carmen was started last May. The provincial board appropriated ₱1,500 for its maintenance. The station contains 14 hectares of cogon land.

Mindoro demonstration project.—The most important works carried in this district were the food production campaign and selection of rice seed. The food campaign could be considered the most effective, since most of the vegetables used in Calapan and neighboring towns were formerly either imported from Manila or from Batangas. Lectures were delivered in many places urging the people to raise enough vegetables for their own use. Vegetable seds were distributed with planting instructions. As a result of the campaign, many home gardens were maintained.

Due to the lack of personnel, the campaign of rice seed selection was only carried in Calapan. Many farmers were instructed in this line of work.

Notwithstanding the fact that the provincial board of Mindoro was the first province to appropriate money for the establishment and maintenance of a nursery, yet for some reasons or other, the work had to be delayed until December, when the provincial board finally purchased the piece of land intended for the nursery. Work on sheds and plots was only started at the end of the year.

Samar demonstration project.—The work carried during the year was for the food campaign, rice seed selection and the establishment of the provincial nursery. In the food campaign, lectures on different agricultural topics were discussed and vegetable seeds distributed. In the selection of rice seed, many farmers were also helped, but due to the lack of good means of transportation, the sphere of the work was limited from Calbayog to Catbalogan. Preparatory work in the nursery, such as fencing, building sheds and digging stumps was accomplished. The work was greatly handicapped, owing to the fact that the provincial government failed to obtain even a single work animal.

RURAL CREDIT SECTION.

Eight rural credit associations were incorporated between October 1916, when the work was started, and January 1, 1917. During the year 1917 seventy-four more associations were incorporated and 142 other associations were organized, the capital of which has not been entirely paid in, so these have not yet incorporated.

The 82 associations in existence January 1, 1918, are distributed as follows:

Provinces.	Municipalities.	Capital stock.	Capital paid at incorporation.
Abra	Bangued	₱3,400.00	₱ 850.00
Antique	Barbaza	5,000.00	250.00
	Bugasong	10,000.00	1,220.00
	Dao	5,000.00	270.00
	Lauaan	2,000.00	130.00
	Pandan	5,000.00	270.00
	Patnongon	3,000.00	266.00
	San Jose	5,000.00	270.00
	San Remigio	1,000.00	94.00
	Sibalom	1,000.00	270.00
Bataan	Balanga	1,000.00	250.00
	Orani	1,000.00	250.00
	Samal	1,000.00	250.00
Batangas	Batangas	1,500.00	375.00
	Ibaan	500.00	125.00
Bohol	Balilihan	5,000.00	1,000.00
Bulacan	Bigaa	1,000.00	280.00
	Bocaue	600.00	150.00
	Bustos	5,000.00	250.00
	Marilao	5,000.00	274.00
	San Miguel	10,000.00	1,380.00
Cagayan	Aparri	10,000.00	500.00
Cavite	Dasmariñas	2,500.00	302.00
	Imus	2,000.00	290.00
	Malabon	4,000.00	250.00
	Naic	1,000.00	250.00
	Rosario	3,000.00	250.00
	Tanza	1,000.00	250.00
Ilocos Norte	Bacarra	2,040.00	810.00
	Badoc	1,600.00	400.00
	Bangui	1,168.00	292.00
	Banna	2,000.00	478.00
	Batac	1,360.00	340.00
	Burgos	1,000.00	250.00
	Dingras	5,000.00	266.00
	Laoag	10,000.00	1,040.00
	Paoay	2,760.00	690.00
	Pasuquin	1,360.00	340.00
	Piddig	1,064.00	266.00
	San Nicolas	1,320.00	330.00
	Sarrat	1,808.00	452.00
	Salsona	2,280.00	570.00
	Vintar	2,080.00	520.00
Ilocos Sur	Lapog	1,000.00	250.00
	Narvacan	1,000.00	250.00
	Santa	1,000.00	250.00
	Santa Maria	1,000.00	250.00
Isabela	Ilagan	10,000.00	540.00
Laguna	Cabuyao	10,000.00	714.00
	Pangil	4,000.00	230.00
Leyte	Caibiran	5,000.00	412.00
Misamis	Jimenez	10,000.00	1,905.00
	Misamis	10,000.00	755.00
	Tagaloan	10,000.00	570.00
Mountain Province	Tagudin	10,000.00	600.00
Nueva Ecija	Cabanatuan	1,000.00	250.00
	Lupao	840.00	210.00
	Muñoz	1,200.00	300.00
	Nampicuan	2,000.00	580.00
	San Isidro	10,000.00	510.00
	San Jose	500.00	126.00
Pampanga	Mexico	8,000.00	2,000.00
	Santa Rita	10,000.00	1,330.00
Pangasinan	Alcala	10,000.00	540.00
	Binalonan	10,000.00	706.00
	Calasiao	10,000.00	568.00
	Malasiqui	10,000.00	1,138.00
	Manaoag	10,000.00	556.00
	Mangaldan	10,000.00	510.00
	Mangatarem	10,000.00	504.00
	Pozorrubio	10,000.00	900.00
	San Carlos	10,000.00	1,128.00
	San Nicolas	10,000.00	1,254.00
	Tayug	10,000.00	502.00
	Villasis	5,000.00	270.00
Rizal	Binangonan	10,000.00	500.00
	Mariquina	5,000.00	250.00
	Montalban	10,000.00	520.00
	San Mateo	10,000.00	500.00
	Taytay	6,000.00	300.00
Sorsogon	San Jacinto	10,000.00	945.00
Tarlac	Moncada	5,000.00	250.00
Grand total		409,880.00	41,483.00

The above figures do not show the actual capital now on hand. Shares are being constantly sold in every association, and in no association has capital been withdrawn. Complete statistics are not on hand. Most of the 82 associations have had less than six months existence and only eight have had a full year since organizing. In the case of Sibalom the above table shows a capital of ₱270, while in fact they have a share capital of ₱2,324 paid in; Balanga appears in the above as having ₱250 while their paid in capital is ₱898; Samal appears as ₱250 while their paid in capital is ₱1,378. All associations have not had as marked an increase as the above, *but all have advanced,* and San Miguel, Malasiqui, San Carlos, and Mexico have passed the ₱3,000 mark. The paid in capital to-day is nearer the ₱100,000 mark than the ₱41,483 tabulated above.

It was no light matter to introduce an entirely new plan and to instill a sense of individual responsibility in the members by obligating them to assume all the work and responsibility to make these rural credit associations really self managing and self propagating. It would often have been easier to have stepped in and managed their affairs than to have patiently taught the much needed lesson of self-dependence and self-reliance. The degree of success attained is partly due to the merciless exactions of the usurers which have driven the public patience almost to exasperation so that any suggested relief looked good, while the endorsement of public spirited men in all walks of life satisfied all that the proposed village bank was worthy of confidence. There is no need to argue or convince people of the utility or necessity of these associations. This is being effectively done by friends of the cause in each community, who explain the details and remove the fears of the timid. A word of recommendation of rural credit by a man in whom the masses believe, is more effective than a convincing speech by an outsider. It is also proper to state that these friendly advocates received their information and inspiration largely from the press, whose columns are unstintingly open to the Bureau to give wider publicity to rural credit items and happenings in various towns, thus educating and enthusing persons in remote barrios. So really, as a consequence of these preparatory agencies, the ground had been plowed, the seed had been sown and usually it was the agreeable task of the agents to be invited to come and make out the incorporation papers, advise in preparing by-laws, and to instruct the boards of directors in their duties to the members and to the associations and start them off right.

Personal supervision and advice has been fragmentary and irregular owing to the limited number of agents and the numerous calls for matters not of greater importance, but which appeared more pressing. Correspondence at best is a mere makeshift for converying thought or securing action. Letters are easily laid aside while the human monitor insists on something being done and is able to answer objections and suggest lines of action and can also be sure that the person addressed really understands the matter at issue.

Working of associations.—It has been a constant surprise to note the facility with which the associations have carried on their work when once the details of the plan were understood by the members. The Corporation Law requires that the incorporators, who can not exceed 15 in number, must select 5 as directors, these to serve until at a regular meeting of the share holders, to be held at a time fixed in their by-laws, when a new board is elected. The familiarity with municipal procedure makes conducting the affairs of an association an easy task, as is also the keeping of the minutes and other details.

The law (2508) appoints the municipal treasurers as ex-officio treasurers of the associations and the Insular Auditor as auditor of the accounts. These two wise provisions have silenced all doubts as to whether money can be safely entrusted to the associations by prospective share holders. Nothing has contributed more to place these associations in the highest place in the confidence of the public, a place we will always strive to maintain. The boards of directors receive applications for loans. These are either approved or disapproved. If approved a voucher or cheque is drawn on the treasurer, who pays the money to the borrower.

There are cases where the boards of directors were selected on account of the social standing and prominence of the men rather than on the grounds of a desire to advance the economic interests of agriculture and supply necessary loans to the needy farmers. It has required rare tact and diplomacy to induce such to resign without giving offense and creating opposition. We have tolerated inaction in some cases rather than to create dissention.

Rural credit agents.—It is a pleasure to put on record the hearty appreciation of the loyal, efficient service which these agents have cheerfully rendered at all times. Each one is anxious to learn all that can be known about rural credit, and without exception each has gladly served his countrymen and sought to explain the possibilities of rural credit in its bearing on the individual, the town, the province, and the whole country. That they have succeeded in a marked degree is shown by the results already achieved. These agents have been invited by governors, senators, representatives, municipal officers, and public spirited individuals to come and assist in campaigns. They have been sent and in every case have they shown ability, keen interest, and gentlemanly qualities of the highest order. More agents are absolutely necessary to successfully supervise and develop this rapidly growing work. These new associations need advice. They need some experienced person to encourage and guide the members and officers at the start. They meet many perplexities in Law 2508 and its application which can be explained. They start with a small capital and small experience. Some one must cheer them during the formation period when they often look at the height of the financial hill they have to climb and the small start they have made. A few words of encouragement and counsel works wonders. It is a serious omission not to follow up each association by frequent visits during which the wide awake agent can tactfully help them in a hundred ways.

Results.—As previously stated, every one of the 82 associations has advanced in the matter of increasing its capital and membership. Partial reports on "Amount loaned and the number of borrowers," show that in only a few instances have the associations remained inactive and these have begun with the new year. Complete returns are not at hand.

It is impossible in this limited report to mention each one of the 82 associations. It is true there are a few associations under very low pressure, hence advancing very slowly; with a larger force of agents these will be speeded up. Most of the associations are new and hence inexperienced, but they are cheerfully doing the best they know how, and willingly learning from the circulars and letters sent out frequently and any visits paid by agents. The agents are also learning by experience and next year will render better service. It is hoped that they will continue to receive the cordial esteem and respect that is now extended. During the year under review not one questionable or suspicious act occurred in any association. Nor has any accusation been made against any agent, or any officer, or any member of any association.

COÖPERATIVE ORGANIZATION AND COÖPERATIVE MARKETING SECTION.

Status of the section at the beginning of the year.—There were 29 provincial agricultural societies as follows: Albay, Bataan, Batangas, Bohol, Bulacan, Camarines, Capiz, Cavite, Cebu, Ilocos Norte, Ilocos Sur, Iloilo, Laguna, La Union, Leyte, Mindoro, Occidental Negros, Oriental Negros, Nueva Ecija, Palawan, Pampanga, Pangasinan, Rizal, Samar, Sorsogon, Surigao, Tarlac, Tayabas, and Zambales. Ten of these societies have held elections of new officers for the year 1918. Besides these societies there were 280 municipal agricultural societies, scattered in the above-named provinces. Twenty-three municipal agricultural societies have held new election of officers for the year 1918.

Plan of work.—The work of this section consisted of:

(*a*) The continuation of the issuing of a weekly market report of Manila prices of staple farm products.

(*b*) The mailing of the Philippine Farmer free to all members of all agricultural societies, to some employees of the Bureau, to division superintendents of schools, to some supervising teachers and principals, to members of the Philippine Legislature and some foreign agricultural institutions and libraries.

(*c*) The receipt of a weekly cable of prices on the New York sugar market, the same being repeated promptly by wire to the following sugar producing provinces: Occidental Negros, Oriental Negros, Iloilo, Pampanga, and Batangas.

(*d*) To extend information concerning the benefits of coöperation and to encourage and assist the forming of coöperative enterprises among the members of the agricultural societies.

(*e*) Through the organization to bring the farmers and the Bureau of Agriculture in closer touch, thus helping the farmer and increasing the effectiveness of the Bureau.

(*f*) To establish a communication through this office among the societies with the end of furnishing them a market for the disposal of their surplus products and facilitate a cheaper and easier way of buying merchandise needed for their local consumption.

During the month of April the acting chief visited several municipal agricultural societies at Iloilo and Negros. The societies visited were found to be doing good for the benefit of the farmers. He also visited the Provinces of Bulacan, Cavite, Nueva Ecija, Tayabas, Laguna, and Batangas, to study the conditions of the provincial as well as municipal societies. Most of these associations visited were doing good work, and those which we were indifferent were aroused to an active life by giving them hints and suggestions as to the proper way of undertaking business.

To this office falls the duty of computing the Manila weekly market report issued by this Bureau. In order to obtain data for this report it is necessary to visit several important commercial houses to confer with the managers in regard to prices of the most important crops of the Islands. This report contains market prices on abaca, maguey or sisal, pacol, sugar, corn, rice, tobacco, and livestock. This is sent to presidents, vice-presidents, and secretary-treasurers of provincial agricultural societies; to Bureau field men, to banks and commercial houses, press in Manila, and several leading fiber concern in foreign countries. The New York price on 96° centrifugal sugar is received by cable from the Bureau of Insular Affairs by the Philippine Government and this is promptly repeated by telegraph to the five leading sugar producing provinces, and to other provinces from time to time by wire when requested. This market report is one of the most important works of the Bureau which has a direct and beneficial results with the farmers of these Islands.

The following will give a brief statement of some of the activities accomplished by the agricultural societies during the year:

The very active president of the agricultural society of Ambos Camarines, Mr. Andres Garchitorena, has undertaken in another way to improve the agricultural conditions of his province. He bought several modern plows and sent them to the different towns for sale at original price. He even suggested to raffle them for ₱0.50 or ₱1 among the small farmers, those who wanted to own a plow but were too poor to buy one. His idea was to let the people become acquainted with the use of a modern plow.

The societies of Mindoro have emphasized the planting of bananas. Lectures in which the importance of the banana as a food was explained were successfully conducted and as result the land to this crop has increased a great deal.

The municipal agricultural society of San Miguel, Bulacan, had made combinations with the teachers and established its activities among the barrios. Lectures had been conducted in the barrio school buildings. Contents of the Philippine Farmer were translated into Tagalog and read in these conferences every month.

The organized associations have been an important factor in the success acquired by the food production campaign. Almost all the societies have taken a keen interest and responded to the call. As a result a big quantity of seed has been distributed thoughout these societies. In many cases every individual member of a society started a home garden to supply himself and family.

The provincial agricultural society of Surigao has been active during the year in putting all the uncleared space in the municipality under cultivation. For this reason, a petition was submitted to the Director of Forestry to the effect that certain provisions of the regulations of the Bureau of Forestry be amended.

The phase of work undertaken by a great number of societies, among them can be cited the municipal agricultural society of Dalaguete, Cebu, was the improvement of both quantity and quality of their crops. Prizes have been offered to encourage the members to extend their cultivation and to use improved methods.

During the year eleven new municipalities were organized. It shows that coöperation is still growing.

INSURANCE SECTION.

History of the insurance section.—Early on the year 1916, Act No. 2573 was passed by the Philippine Legislature providing for the establishment of the Work Animals Insurance under the control and supervision of the Animal Insurance Board, composed of the Director of Agriculture, as chairman, and the Insular Treasurer and one agriculturist, as members, and creating a new section in the central office of the Bureau of Agriculture known as "Insurance section."

This section was not formally inaugurated until the beginning of 1917, subsequent to the amendment of Act No. 2573 by Act No. 2682, providing among other things for the reduction of the number of heads of animals necessary to start with the operation of the insurance, and for the changes in the members of the Insurance Board, to be composed of the Director of Agriculture, as chairman, and two private citizens, one of them acquainted with and interested in agriculture and the other in cattle breeding, as members.

Work of the insurance section.—The work of the former Insurance Board was reduced simply to the holding of a meeting on March 16, 1916, adopting three resolutions on the preliminary steps towards bringing about the enforcement of animal insurance. These resolutions consisted of a request to the Director of Agriculture for the printing of all papers, circulars, blank forms, booklets, etc., and of the fixing of the schedule of values for insuring animals.

As soon as the new board was duly constituted, its first meeting was held May 16, 1917. A resolution was passed adopting and approving the former board's resolutions save the schedule of values which was made entirely ineffective.

The Insurance Board held various meetings during the last year, which meetings dealt mainly with the preparatory steps with a view to enforcing the insurance law by approving the required papers relative to the management of the insurance society such as the by-laws and regulations governing animal insurance.

On June 25, 1917, the board adopted a resolution providing for the securing of necessary data concerning the local market value of work animals in the leading provinces of the Islands, and the listing of the animal owners desiring to insure their animals when the law is made operative. Accordingly, the two agents were immediately sent out to the provinces to collect data relative to the local market prices of work animals, to confer with the owners thereof as to the advisability of the operation of the Insurance Law, and to list those who might be willing to have their animals insured. These agents visited the provinces of Batangas, Bulacan, Pampanga and Iloilo, the result of their work being the acquisition of sufficient data on the local prices of animals in those provinces, which data were reported to, and presented for, the consideration of the Insurance Board. In the province of Iloilo there has been listed a considerable number of proprietors who are ready to take advantage of the insurance as soon as it is in force.

Judging from the reports of these agents, hardships had to be encountered by them in listing the animal owners, because of the rate of the premiums which the people deem to be so high that they would prefer not to insure their animals rather than to bear an onerous yearly burden constituting a demandable obligation on their part. So they suggested that the rate of the premium be reduced accordingly so as to make it bearable even by the poorest land or animal owners. This suggestion has been made known to the Insurance Board. On the other hand, the sway of the rinderpest prevailing for the entire year in the majority of the provinces was another reason which hindered the enforcement of the insurance society, and unless this calamity is checked there is doubt as to the securing of the minimum number of heads provided for in the law as a necessary condition for its operation.

PLANT INDUSTRY DIVISION.

Progress of work.—With the steady decrease during the year of the technical personnel due to resignations and leave of absences, it has been increasingly difficult to adequately carry on the work of this division and to maintain the former standard of efficiency.

The demands made upon this division are so many and varied that it has been impossible with the limited personnel and funds available to give the various problems connected with the work, the close supervision and careful study they deserve.

With the establishment of the Philippine Food Commission and the inauguration of an extensive campaign for increased food production, the work of the plant industry division was increased many fold. Through the publicity work of the Food Commission and the work of other agencies the people throughout the Archipelago have been encouraged to establish home gardens and also to increase the planting of all food crops, with the immediate result that the plant industry division has been practically swamped with requests for seed and other plant material. The filling of these requests and the supplying of planting instructions has been no small undertaking and has occupied the attention during the latter part of the year of the limited personnel. It is only by additional competent personnel and by a liberal increase in the funds allotted that this division can efficiently discharge its present manifold duties and enter into broader fields of endeavor. Notwithstanding the handicaps cited above under which the division has labored during the past year the results accomplished have been satisfactory.

A record of the work by projects carried on during the year 1917 follows:

CORN.

All the experimental corn work of the division during the year was carried on at the La Carlota station under the following heads: seed propagation, ear-to-the-row test, variety test, and desert maize.

Two plantings of Moro corn, totaling about 1.6 hectares in area, were made during the year. The first crop was planted during the months of March and was harvested in June, and yielded at the rate of about 1,118 kilos per hectare. The second crop was planted during the latter part of October and was on December 15 showing a vigorous growth. An additional planting of Moro corn was made during the forepart of December.

The ear-to-the-row test consists of a given number of rows each planted with a selected ear of some particular variety. The corn plants are thinned while still young so as to give the remaining choice plants the full benefit of the space necessary for their proper development. In order that cross fertilization may be assured one half of each row, alternating halves, is detasseled, care being used that the detasseling is done before the pollen is ripe. At maturity the corn is harvested and the best individual ears selected for further work along the same lines.

Two consecutive tests were conducted during the year of each of four varieties namely, Cagayan yellow, Cagayan mixed, Loboo yellow and Calamba yellow. One test was made early in the year while the other plantings were made during the months of August and September.

The Loboo yellow variety apparently is resistant to wet weather as was shown by its normal growth and yield during the rainy season. The yields of the other varieties especially the Cagayan mixed variety, however, during the rainy season were much lower than those obtained during the dry season.

Due to the extreme variations in the Cagayan mixed variety very little progress has been made in establishing a pure strain of this variety. As a long series of tests will be necessary before a stable variety can establish from the Cagayan mixed stock, this variety will be eliminated in future tests and the work concentrated on the remaining three varieties which are more promising and which do not present so many difficulties to overcome. Observations in detail have been taken on all the ear-to-the-row tests and are reported fully on in the La Carlota station monthly reports.

Seven strains of desert corn were propagated for forage purposes. Due to force of circumstances the plantings were of necessity made during the rainy season and as the desert maize, as its name would indicate is a dry weather crop, very poor results were obtained. The testing of this maize under more favorable conditions will be conducted next year.

RICE.

Progress of work.—The rice work is carried on under the following headings: General variety test, head-to-the-row test, seed propagation, age of seedling test, good vs. poor field preparation, miscellaneous observations and seed distribution. These phases of the work will be taken up successively and the work accomplished under each heading during the year briefly summarized.

General variety test.—This test is designed to determine the behavior, characteristics and yielding power of the different varieties, with the end in view of selecting the best variety for improvement and propagation. The lowland test made at Alabang, Rizal, includes 165 varieties, 132 of which have been found by previous tests as distinct varieties, while 33 are new ones. Of the total number of varieties 90 are non-bearded, 3 non-bearded and glutinous, 69 bearded, and 3 bearded and glutinous.

Varieties tested last year which behaved differently under irrigation and showed that they could not be improved, were discarded from this year's test. Samples of these varieties were sent to La Carlota for upland test. Thirteen duplicate varieties have also been discarded from the lowland test at Alabang.

Four Japanese varieties were received from the Bureau of Agriculture of Japan through the courtesy of Mr. Jose Zamora. These seeds were planted at once, but variety Shinriki did not germinate and only a few plants of the other three varieties have grown. They do not seem to be acclimatized to Philippine conditions but some seeds were saved for further trial next year.

The test for upland varieties was done at the La Carlota experiment station where 71 varieties were planted in duplicate plots.

Head-to-the-row test.—This experiment is designed to improve certain varieties of rice selected from the variety test by means of plant selection through the "head-to-the-row" culture. This test consisted of 17 varieties, representing bearded and non-bearded, early, medium and late maturing plants, so as to establish improved varieties to meet all local conditions and requirements.

Seed propagation work.—This is the propagation of improved varieties produced by the head-to-the-row test, for producing selected seeds for sale as well as for coöperative demonstration work. For this purpose all land at the Alabang stock farm assigned to rice work, not occupied by other experiments, was made use of.

In addition to the 193 cavans of lowland seed palay produced at Alabang, for distribution purposes about 150 cavans of lowland seed were also produced this year at the La Carlota station.

The propagation work of upland varieties was done at the La Carlota experiment station. Only one variety, the Inantipolo II, was planted this year as it has given good results under varying conditions of soil and climate. For this work, about 46.59 hectares of land were planted during the year by the tenants on the "share basis" the Bureau furnishing the seed. This system was found to be economical, the seed costing the Bureau practically nothing. The Bureau's share of the Inantipolo seed harvested amounted to about 235 cavans.

Age of seedling test.—This experiment is intended to verify the results obtained in last years' experiment, that—

(1) The earlier the seedling is transplanted, the earlier and greater will be the yield.

(2) The earlier a variety matures, within prescribed limits the earlier it should be transplanted.

(3) The transplanting period varies between 20 and 60 days from sowing, depending upon the variety planted.

In this experiment, 16 varieties representing the earliest and latest varieties and their intermediates were selected. These varieties were arranged in pairs with reference to their maturing periods.

Miscellaneous observations.—An experiment similar to one carried out last year to determine how many men are required to plow a hectare of land in 1 day, was also done this year. From last year's result 7 to 8 men were required to plow a hectare in one day. For this test four men with a carabao and native plow each were engaged this year. The field was in fairly good working condition. Noting carefully the area plowed by each man and computing the area on an 8 hour-day, it was found that each man plowed on an average $\frac{1}{6}$ of a hectare in one day which meant that it would require six men to plow a hectare in 1 day of 8 hours. The variation of results was due to the condition of the soil at the time of plowing.

Due to lack of laborers this year, women were employed for transplanting the rice seedlings. By so doing it was noted that about 40 per cent of the usual expense in connection with transplanting was saved. It was also found that it required about 12 professional women transplanters to plant a hectare in one day.

Seed disribution.—Due to unfavorable weather during the year 1916, a large portion of upland seed rice produced at La Carlota gave a very low germination test and therefore was not used for seed. Most of it was sold as commercial rice and the remainder was turned over to the Animal Husbandry division for use as feed.

The following table gives the total amount of seed distributed during the year:

Sold:		
Upland	cavans	204.5
Lowland	do	363.5
Free, mostly to coöperators thru field men:		
Upland	do	17
Lowland	do	65
Sold as commercial rice (low germination)	do	225
Turned in to animal husbandry division	do	113
Total	do	988

SUGAR.

Progress of work.—The work of the sugar project for the past year has been done along lines of special investigations, research and experimental, and the results thereby obtained have been used in conducting demonstration work among the plantations in both field and factory. This resulted in improving the yield as well as the quality of the sugar. This work has also resulted in the securing of valuable data on the various soils and in factories which is available to promoters desiring to introduce modern equipment to handle the cane. The cane crop this year in the majority of sugar districts has been slightly below normal, due largely to excessive rains during the early part of the growing season. The area under cultivation is possibly a little larger than that of the last year. The hope of better prices for sugar during the next few years has induced some planters to extend the area whenever milling plants were available to handle the extra cane. This is particularly true in the regions of the large factories. A large production of the better classes of sugar was experienced this year in both centrifugal and muscovado than ever before. This was due largely to the fact that the modern factories were operated at full capacity during a longer period than ever before. In the muscovado factories approved methods of tempering or clarifying the juices by the aid of litmus paper as an indicator and the employing of settling apparatus as recommended by the Bureau of Agriculture, have given better juices for concentration with resulting higher grades of sugar than has been produced heretofore.

La Carlota experiment station.—Four hectares of cane were grown at this station for experimental and distribution purposes. Weekly analyses were made of each variety and these data showing the relative value of the cane, are available to planters and sugar manufacturers.

In addition to the laboratory work on cane grown at the station, numerous specimens of cane and samples of sugar house products were received from the various plantations and these analytical results were furnished the planters gratis.

During the first three months, numerous orders were filled for cane points of the Hawaiian and Louisiana striped varieties for the nearby plantations, and in November ten thousand points were sent to San Carlos for use in starting a demonstration station in coöperation with the San Carlos milling company and planters at that place.

Alabang.—Approximately two hectares of plant and ratoon cane were grown at this station for distribution purposes only. During the first three months of the year, the harvesting of the previous crop was finished and the land was prepared for the ratoon crop. The planting of new cane was finished during the forepart of January. The distribution of the new crop was started during the latter part of October. By starting this work early in the year while the cane was yet immature, a greater number of points were obtained than would have been possible after the cane had ripened. The work of distributing cane was interrupted during December due to the fact that no laborers were available to cut the cane and also to the fact that there was no money available for the purchase of sacks for use in shipping the cane. More than eighty thousand points were shipped from this station to the various provinces during the year.

Singalong.—A small plot of land was planted at this station to the first Philippine seedling varieties produced here. Also a row of each of the promising foreign varieties was planted here. This cane was all used for experimental and observation purposes and the points of the foreign varieties were used for distribution to the various planters as it was cut for the analytical experiments.

Lamao.—Points from Philippine seedling varieties were planted on the small plot near the propagation shed at this station and the cane which develops from this second planting will be used for experimental and observation purposes. All of the Philippine seedling varieties produced during the past year were planted in this same plot as may be observed from the drawing on file in the Lamao office.

Demonstration stations.—The various demonstrations stations conducted during the previous year were continued during the present year and in addition a number of new stations were started.

The one at Pansol, Barrio of Calamba, is being conducted in coöperation with the Philippine Sugar Development Company while the one at San Carlos, Occidental Negros, is being conducted in coöperation with the San Carlos Milling Company.

The technologist made numerous visits to the various plantations and sugar factories where instruction and assistance was given the sugar planter in his plantation and factory work. It is certain that the improvement in the grade of sugar manu-

(*a*) Maize fertilizer plots, Alabang, Rizal.

(*b*) Cane produced from seed from Louisiana striped cane gathered at Alabang, Rizal.

facture during the past three years is the result of this practical instruction. The same may be said also of the increased yield of cane and sugar.

FORAGE AND COVER CROPS.

Sorghums.—The Amber Cane and Broom Corn plots which were planted at La Carlota the latter part of last year were harvested and 8.6 kilos and 11.1 kilos of seed respectively were obtained from the two sorghum varieties. New plantings of these sorghums were made during the month of September.

Sweet potatoes.—A small plot of sweet potatoes planted during the early part of the year was pastured to hogs as soon as the roots were ready for harvesting. In order to serve as a cover crop for abaca about $\frac{3}{8}$ of a hectare in abaca field No. 2 was planted to sweet potatoes. Three varieties of sweet potatoes, namely American Large White, Large New Jersey Red, and Momungan were planted in the nursery on a small scale and will later be propagated in large numbers for distribution purposes.

Cowpeas.—About 600 kilos of seed were harvested from plots planted in December of last year. During the months of July and August of this year two plots 1.16 hectares in area were planted for seed propagation. The harvesting of these plots is yet incomplete but about 50 kilos of seed have already been obtained. An additional plot $\frac{1}{3}$ of a hectare in area was planted to cowpeas in September as a cover crop and have made a satisfactory growth.

Patani (*Red seeded variety*).—This variety of patani was planted in May and has given a good account of itself as a cover crop, effectually smothering out weeds. However, due to heavy rains which damaged the young seed pods the yield of good seed will be small.

Peanuts.—In January a field $1\frac{1}{4}$ hectares in area was planted to the Pondichery variety which yielded 600 kilos of seed. On November 28 another field of 8,536 square meters in area was planted to this variety. A small plot of Chinese peanuts was planted in March but only a small amount of seed was harvested due to the depredations of rats which destroyed the nuts before and after they were matured.

Tahore beans.—The bean was grown on a small scale in the nursery and showed a very prolific and vigorous growth. In order to further determine its possible value as a cover crop a plot 950 square meters in area was planted during November. The worth of this bean cannot be definitely determined until the present crop has progressed further in its growth.

Guar.—About 12 kilos of seed were harvested from a 0.16-hectare plot planted on January 16. The comparatively low yield was due largely to the damage done to the plants by the excessive rains. An additional plot was planted in October and as the pods will ripen during the dry season, larger yields of seed are anticipated.

Grasses.—The 0.2-hectare plot of Sudan grass planted January 8 was harvested in June and produced 16.4 kilos of seed. A second crop of 13.14 kilos of seed was harvested in September. A second cutting of the plants was made in October. The fields of Guinea and Para grass were cut regularly during the year for animal feed. The paspalm grass grown for seed production made a very poor growth and no seed was produced. The Japanese forage cane made excellent growth during the year and was cut regularly to supplement the other grasses fed to the work animals.

TOBACCO.

At Dammao, Isabela Province it was originally planned to grow 120,000 plants for the 1917 tobacco crop but, owing to irregularities on the part of three families who were subsequently dismissed from the station during the cultivation months of February and March, only 70,000 plants grew to harvest time. The appearance of fungus and land snails on the seed beds and irregular weather conditions when the seedlings were still on the flats and in the beds also effected the station seedling supply.

The foreign varieties tested for acclimatization were Vuelta Abajo (Cuban) Texas Cuban, Connecticut Havana and Tirona Hybrid a cross between Cagayan and Connecticut Havana. The seed of all these were furnished by the College of Agriculture thru the courtesy of Prof. Chas. F. Baker, head of the department of agronomy, University of the Philippines. These varieties were grown in separate plots. The following were the results obtained in the first year of acclimatization of these varieties: Vuelta Abajo although exhibiting the genuine charac-

Tobacco, Viscaya type, grown near Ilagan, Isabela.

teristics of a good wrapper tobacco did not grow to its normal size. Texas Cuban did not show fine veins. Connecticut Havana had too uneven and gummy leaf surface for wrapper. Tirona Hybrid was likewise too gummy for wrapper. The experiment was not at all promising, but until the seed becomes fully acclimatized to the locality it is hard to tell how the resulting plants turn out.

Selection of the foreign varieties was not so difficult as they exhibited more or less uniform characteristics, Tirona hybrid, however, was very irregular so that only the individual plants which showed wrapper qualities were saved and the rest discarded.

Permanent improvements.—During the year the following permanent improvements were accomplished:

Tobacco Warehouse, built of strong material, nipa roof, 10 meters wide by 18 meter long by 3½ meters high to the eaves, built for the purpose of curing the station tobacco crop and has a capacity of storing at least 500 three quintal bales of tobacco.

Superintendent's house, built of strong material. The house is 9 meters wide by 14 meters long by 3 meters to the eaves, three rooms with surrounding porch on three sides, can be arranged to accomodate 12 visitors. A kitchen with iron roof attached also built of strong material.

Five drying sheds as per specification of the Bureau of Agriculture, 12 meters long by 6 meters wide by 3 meters to the eaves, built of Tarao hariguez, bamboo sides and cogon roof.

Seven family dwelling houses, Government furnished material such as bamboo, bejuco, and part of the posts.

In addition to the above improvements ₱815.29 was paid to laborers during the year. They were engaged in clearing land for building sites, building culverts, roads and a river landing place at Dammao.

Seed beds for 1918 crop.—The work on seed beds for the 1918 crop was commenced during September 1917. Aside from the sowing of the selected foreign varieties, there were also five main local types including (1) Broad leaf (2) Espada (3) Medium A Repollo (4) Medium B resembling type 3, and (5) Romero (naked petiole). The excessive rains during November and December played havoc with our seed beds destroying more than half of the seedlings.

SEED DISTRIBUTION.

List of seeds distributed from January 1, 1917, to December 31, 1917.

Name of seed.	Amount distributed		Approximate cost.	Retail Value.	Amount on hand Januay 2, 1918.
	Kilos.	Packages.			
Ampalaya	.7	100	.40	10.00	None.
Bean, Boston M					77 kilos.
Bean, C. W	1,208	173,950	797.28	17,395.00	None.
Bean, Cadyos	10	1,440	5.00	144.00	Do.
Bean, Ky. W	2,457	353,808	1,621.62	35,380.80	1,271 kilos.
Bean, Lima	599	86,112	556.00	8,611.20	None.
Bean, Lyon	83	2,988	16.00	298.80	1 kilo.
Bean, M.W.W	2,566.5	369,576	2,429.83	36,957.60	969 kilos.
Beet	327	94,176	1,041.20	9,417.70	266 kilos.
Cabbage	204.5	117,793	2,584.44	11,779.20	6.5 kilos.
Carrot	138.5	79,776	527.22	7,977.60	148 kilos.
Condol	.2	28	2.00	2.60	0.5 kilo.
Cucumber	184.5	53,136	505.53	5,313.60	45 kilos.
Eggplant	15.8	9,184	286.80	918.40	None.
Endive	84	48,578	285.60	4,857.80	3 kilos.
Kale	16.5	9,504	48.94	950.40	None.
Kinchay	52	30,952	208.00	3,095.20	8 kilos.
Kohlrabi	3	768	9.00	76.80	None.
Lettuce	156	88,352	530.40	8,835.20	58 kilos.
Melon	5	2,880	12.50	288.00	None.
Muskmelon	47.75	14,040	119.50	1,404.00	47 kilos.
Mustard	499	286,824	1,846.30	28,682.40	45 kilos.
Okra	134.5	37,080	250.17	3,708.00	0.4 kilos.
Onion	86.3	49,696	483.28	4,969.60	50 kilos.
Onion sets A.B					47 kilos.
Papaya	17	4,684	169.00	468.40	0.8 kilos.
Parsley	.5	288	1.04	28.80	None.
Peas Chinese	203	7,740	400.00	774.00	Do.
Peas Yorkshire	274.5	10,356	151.03	1,035.60	Do.
Pechay	518	298,368	1,813.00	29,636.80	34 kilos.
Pepper	150	86,688	1,155.84	8,668.80	0.5 kilo.
Pumpkin	239	34,416	525.96	3,441.60	42 kilos.
Radish Chinese	597.5	172,080	418.25	17,208.00	27.5 kilos.
Radish F. Break	4.5	1,296	63.90	129.60	None,
Roselle	33.5	16,704	33.50	1,570.40	1 kilo.
Rutabaga	123.75	71,280	616.87	7,128.00	10.5 kilos.
Seguidillas	15.5	2,232	13.50	223.20	11 kilos.
Spinach	.5	288	1.15	28.80	None.
Soy bean					86 kilos.
Squash	358	51,552	667.88	5,155.20	22 kilos.
Tomato	154.5	88,992	1,029.10	8,899.20	71.5 kilos.
Turnip	179.5	103,492	603.04	10,349.20	37 kilos.
Uansoy	46.5	13,392	1,339.20	1,339.20	6 kilos.
Watermelon	373.5	57,806	694.71	5,730.60	187.4 kilos.
Bean, castor oil	18,492	Sent in bulk	3,970.80	3,970.80	5,600 kilos.
Bean, Patani	673	do	134.60	134.60	171 kilos.
Coffee, Abeocuta	17	do	102.00	102.00	None.
Coffee, Canephora	11.5	do	69.00	69.00	Do.
Coffee, Bukobensis	1	do	6.00	6,00	Do.
Coffee, Excelsa	29.5	do	177.00	177.00	Do.
Coffee, Liberia	3.5	do	21.00	21.00	Do.
Coffee, Quillou	19.	do	114.00	114.00	Do.
Coffee, Robusta	85.5	do	513.00	513.00	Do.
Coffee, Uganda	17.5	do	105.00	105.00	Do.
Corn, Moro	4,001	do	355.84	355,84	15 kilos.
Corn, Nat. yellow	5,476	do	472.54	472.54	171 kilos.
Corn, Mex. June	216	do	19.44	12.10	12 kilos.
Cowpeas, Black	250	do	60.00	60.00	None.
Cowpeas, N. Era	2,274.	do	508.00	580.00	3.5 kilos.
Indigo	5	do	5.00	5.00	None.
Ipil-ipil	58	do	5.80	5.80	Do.
Lumbang Bato	120	do	17.00	17.00	Do.
Lumbang Banucalao	522	do	40.00	40.00	100 kilos.
Mongo, Nat. yellow	908	do	128.00	128.00	None.
Onion sets	300	do	120.00	120.00	Do.
Palay, lowland	18,463	do	1,502.81	1,502.81	Do.
Palay, upland	9,530	do	775.67	775.67	Do.
Peanuts	2,093	do	438.00	438.00	92 kilos.
Potatoes	1,710	do	266.00	266.00	None.
Sorghum	8	do	2.00	2.00	Do.
Tobacco	76.0	do	152.00	152.00	29 kilos.
Total	77,527.5	2,931,894	34,044.48	303,262.46	9,775.60 kilos.

LA CARLOTA EXPERIMENT STATION.

Permanent improvements.—The following buildings were erected during the year: One hog house 8.2 meters long by 4.2 meters wide and 3.5 meters high, with cement floor and iron roof, one poultry house consisting of four pens, each measuring 18 feet square, and one cattle shed 12 meters long, 9.5 meters wide, and 5.9 meters high. Aside from the above construction work considerable repair work was done on various station buildings. The foreman's house is in such a dilapidated condition that it is impracticable and it is, therefore, recommended that a new structure of light materials costing about ₱200 be built to replace the old house. During the past year the Bureau of Public Works extended the main road about 2 kilometers in the direction of the barrio of Huguinit. The various roads within the station have been repaired from time to time as needed. One-half kilometer of wire fencing with concrete ports was constructed during the year. The telephone line between the station and the town of La Carlota was repaired as occasion demanded.

Weather conditions.—The rainfall throughout the entire year was exceptionally heavy and considerable damage was done to growing crops owing to the adverse weather conditions. The rice and corn crops suffered especially from the heavy rains.

Progress of work.—The work of the plant industry division at the La Carlota station is carried on under the rice, corn, sugar cane and forage and cover crop projects and is reported on under these projects.

SINGALONG STATION.

Equipment.—The equipment of the station has remained practically the same throughout the year. The present condition, however, of most of the small implements, hoes, rakes, shovels, etc., and of the field implements, is very poor and the replacing of most of this equipment will be necessary during the ensuing year.

Bananas.—Due to the continual digging of suckers in order to supply numerous requests therefor the banana plantation has suffered somewhat. Five varieties of bananas were under test namely, Bungulan, Gloria or Tarnate, Lacatan, Latundan and Saba.

Cotton.—The two rows of Caravonica cotton planted last year were fertilized with acid phosphate, potassium sulphate and sodium nitrate. The plants responded noticeably to this treatment and have made a very satisfactory growth. The sea island cotton made an unsatisfactory growth and was cut down.

Forage crops.—The guinea grass field was harvested four times during the year and the grass used as a feed for the station animals. A considerable number of stools of this grass was also distributed in compliance with various requests received during the year.

Root crops.—The old sweet potato field containing nine varieties of sweet potatoes was maintained during the year and furnished about 14,000 cuttings for distribution purposes.

Nursery.—An important phase of the station work was conducted under this project and consisted mainly in making of seed boxes, planting seed, transplanting seedlings in bamboo tubes and in the outside nursery and in packing seeds and plants for distribution. During the year, 688,709 various kinds of economic plants, cuttings, bulbils, and suckers, and 9,236 ornamental plants and cuttings, etc., were distributed from the station.

LAMAO EXPERIMENT STATION.

Buildings.—The buildings are the following: Residence, office, propagation-shed, barn, compostpit, enginehouse, launchhouse and the beehouse. The residence of the superintendent and the office were both constructed with light materials and nipa roofings. They cover an area of 149.5 and 176.6 square meters respectively. The propagation-shed covering 485.44 square meters in area built with frame structure of hardwood is used as propagation-shed, packing shed, seed bodega, tool bodega, and part of which is used to keep the fertilizers and for the drying of seeds where the canvas frames were placed. The barn and compostpit covering an area of 63.84 and 87.04 square meters respectively were built with hardwood structure, iron roofings and cement floors. Two small houses, one covers an area of 36 square meters and the other 12.6 square meters were built with frame structure and iron roofings. These houses are served to shelter the launch and the engine. The buildings enumerated above including the beehouse are all in good conditions except the adjoining bodega of the office and part of the nipa roofing and walls of the residence. The bodega needs an entire repair as soon as funds are available.

Improvements and repairs.—The improvements made during the year consisted in clearing two pieces of land, measuring about 1.5 and 1.7 hectares respectively. The former was opened the latter part of last year (1916), and it is planted now with three varieties of coffee, namely Abeocuta, Excelsa and Liberian. Two more tropical fruit orchards, one Annona orchard, and the extension of Citrus grove on field "N" were established during the year.

The bamboo-shed constructed last year which covers 1917.3 square meters of ground was entirely rebuilt during the year.

The floor of the office was repaired from time to time. The roof of the propagation-shed was painted with coal tar outside and with Chinese chalk inside. The posts of the office and part of the front wooden fence were also painted with carbolineum. The purpose of the carbolineum and coal tar beside to protect the attack of the white ants was to incrase the durability of the parts painted. The Chinese chalk is to give more light to the young seedlings in the propagating-shed.

The bearing of the launch was broken last September, and it was sent to Manila for repair. Now it is in good working order again. New ties and fishplates were put out on the truck of the launch.

The soil and the cement dams were once repaired during the early part of the year. After the repairs were made the supply of water was sufficient throughout the dry season.

Progress of work.—The work at the Lamao experiment station is carried on under the following projects: Tropical fruits, citrus fruits, pineapples, avocados, papayas, mangos, coffee nursery, and plant distribution, root crops, vegetables, seed growing maintenance and extension. These phases of the work will be taken up successively and the work accomplished under each project during the year briefly summarized.

Tropical fruits.—The object of this project is to assemble and establish in permanent orchards all tropical fruits found in the Philippines, to introduce a large number of foreign tropical fruits, to select and breed those species that have already been established, and finally to vegetatively propagate the different species especially by shield budding.

During the year 254 of various tropical trees have been planted in permanent orchards in fields H and I, besides the 180 Annonaceous plants that were also planted in the test rows of the above-mentioned fields, and in field J. There are now three orchards of tropical fruits and two of annona. The tropical orchards are fields F, H and I, and the annona fields are J and M.

Citrus fruits.—Three hundred thirty-three budded citrus trees were added to in orchards A, B, C, and N during the year.

Twenty seedlings of 5 lots were also planted in fields N and O. The 333 budded trees that were set out include 217 citrus hybrids obtained from the U. S. Department of Agriculture, Washington, D. C., and 116 are both native and introduced varieties. There are new 154 budded citrus trees in orchard "A," 134 in "B," 134 in "C," and 208 citrus hybrids and 128 unbudded trees in orchard "N" and 320 unbudded trees in "O."

Pineapples.—There are now 1,633 Queen, 2,656 Cayenne, and 1,255 Spanish planted among the avocado orchard, 195 Hybrids in Citrus orchard "B" and 104 Sugarloaf in Citrus orchard "C." The work on this project was confined largely to cultivation and irrigation of the old pineapples plantation set out late in 1915. The pineapple plants have set but few fruits this year. We hope to distribute pineapple suckers this coming year as far as they are available but not to destroy the plantation as was done during the previous years.

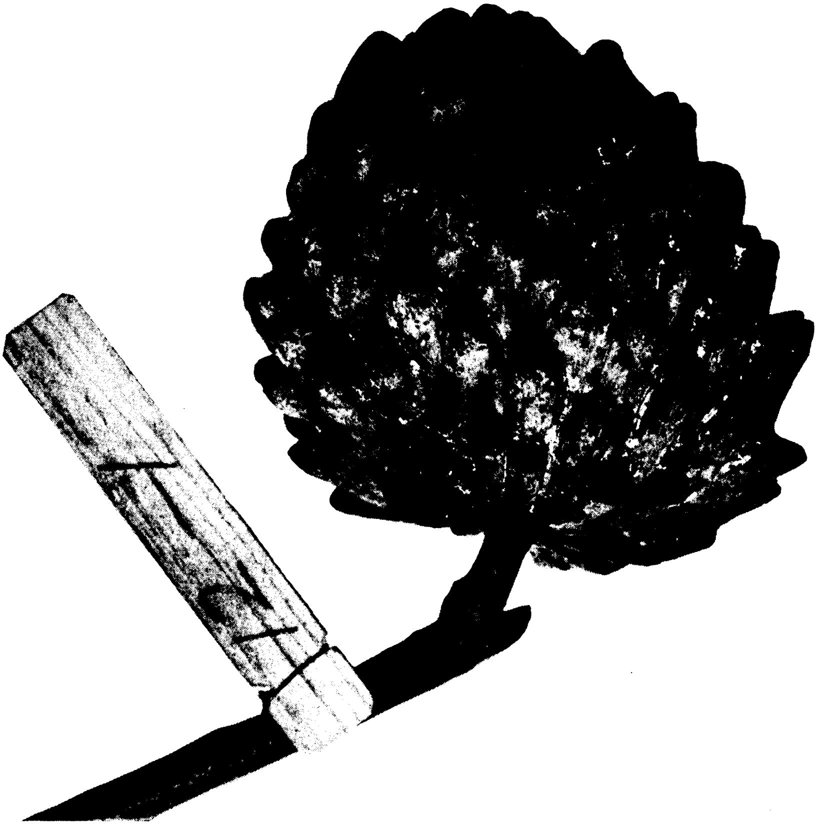
Avocados.—The old avocado trees have fruited earlier this year than the former years. Several fruits have been harvested and seeds of which were planted for stocks. Two varieties of the budded avocados in the orchard were observed in bloom but produced no fruits.

Budsticks of 23 varieties of avocados have been received from the Bureau of Plant Industry, Washington, D. C. Sixteen out of these were received in good conditions, and budded successfully. Due to the fungus which usually caused the die-back of the avocados especially young growing plants, three out of sixteen died.

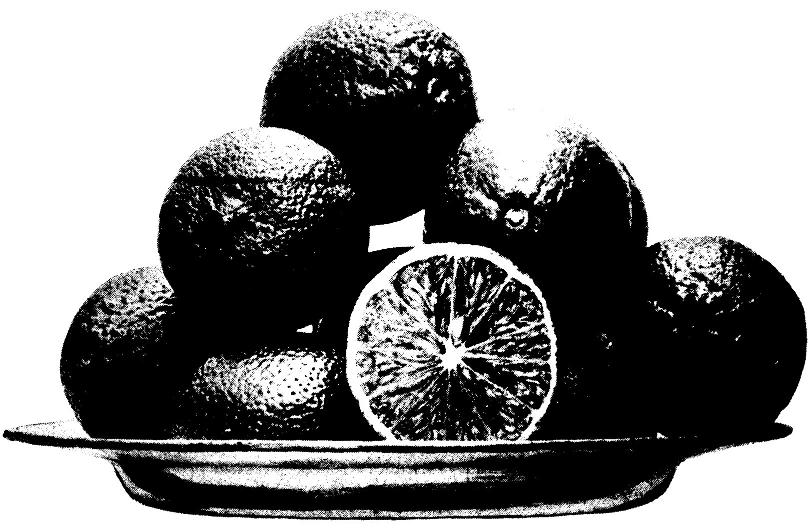
The avocados in the nursery both budded and seedlings were very badly attacked by the die-back fungus during the rainy days. By spraying with Bordeaux mixture, (0.8–.8–100) and given them plenty of light they are now recovering and setting new leaves.

Papayas.—Three orchards of papaya have been maintained at Lamao for seed production. These are interplanted with the citrus orchards A, B, and C. In all there are new 188 papaya trees and out of these plants 102 were newly planted in orchard C. The papaya trees in orchard B are getting too old and small fruits are obtained so sooner or later these papayas will be chopped down.

Mangos.—The mango collection now at Lamao included the following varieties: Surkha, Chickna, Stalkari, Kachamitha, Kakaria, Nijibabadi Amin, Sufaida, Malda, Krishna Bhog, Tamancha, Salibunda, Bombay yellow, Gopalbhog, Gelee, Cam-



(*a*) Philippine Islands No. 12 Atemoya, (annona glabra X A squamosa).



(*b*) Ripe Lemon, supposed to be Libson variety, Lamao Experiment Station, Lamao, Bataan.

bodiana, Geding, Bombay green, Paho, Skrikhas, Biscea mukha, Juani, Davy's favorite, Naspati, Kutna, Langra, Alfonso, Sandurea, Singia, *Mangifera indica* var. M. mekoginensis and 4827.

Previous to the month of May, 1917, no separate expenses have been charged from this project due to the fact that the mangos were all either in the nursery or interplanted among the temporary rows of the tropical arborentum. But last May a separate orchard devoted exclusively to mangos has been established in the old guava field. Thirty inarched mangos have been transplanted which includes Surkha, Sharbati black, Chickna, Stalkari, Kachamitha, Kakaria, Najibabadi Amin, Sufaida, Malda, Drishma Bhog, Tamancha, Salibunda, Bombay yellow, Gopalbhog, Gelee, Cambodiana, Geding, M. mekeginensis, and No. 4827. All are alive and making progress except Sharbati black. The remaining mangos in the temporary rows of the tropical arborentum will also be transplanted in the mango orchard as soon as time permits.

Coffee.—The object of planting coffee at Lamao is to demonstrate modern methods of growing coffee, to provide future seeds for distribution, and finally to provide data as to the actual cost of maintaining a piece of coffee land.

The 150 Excelsa plants set out last year are making good progress and the 70 Liberian were nearly all dead, which is probably due to small size when planted and to the lack of shade in advance before planting the seedling. All dead Liberian were also replaced during this year. Few plants of the Excelsa are now beginning to set flower buds.

The new coffee lands in field "P" have been planted to 87 Abeocuta, 79 Liberian and 66 Excelsa coffee last July. All of them are making a good start.

Nursery.—This project is so far the most important project carried out in this station. The work consists mainly of seed and plant propagation, the packing of plants for distribution, the cutting or sawing of bamboos for tubes, the making of shipping boxes, the hauling of soil and gravel and the composting of soil.

Plant and seed distribution.—Six thousand six hundred and seventy-six tropical fruit trees of various species, 41,005 coffee seedlings representing 10 varieties, 350 pineapple slips, 1959 ornamental plants of various kinds, 108,447 various plants and cuttings and 1762.89 kilos of seed including, corn, various legumes, coffee, etc., were distributed from the Station during the year.

Vegetables.—No definite work has been done on this project except the growing of Lima beans, Seguidillas, Curuba and the two varieties of Libato for seeds production. These crops with the exception of the Libato were cultivated mostly as cover crops.

Root crops.—The work on this project was confined to the growing of various varieties of yams, 3 varieties of sweet potato (Red New Jersey, Momungan and American large white) and 3 varieties of cassava obtained from Java by Mr. P. J. Wester. Six hunderd cuttings of each of the sweet potatoes named above were planted, and 252 square meters of ground to cassava in field "N" among the Citrus hybrids.

PEST CONTROL SECTION.

The locust campaign.—It is with pleasure that it can be announced that the Islands are now free from the grip of locusts. It may be safely said that during the present year, there has been no damage to agricultural crops by this pest. On July 28, 1917, the Archipelago was declared free of locusts, and, except for three straggling bands that have been destroyed upon their appearance, the Islands have been free ever since. Since September 22, 1917, no known locust swarms existed in the Archipelago, a statement that could be made for the first time since the earliest settlement of the Islands.

With the eradication of the locust pest, the work of the office in locust control has by no means ceased. The time of locust inspectors has been devoted to organizing the work in the municipalities in order that possible future swarms may be summarily dealt with immediately upon their appearance.

As a part of this organization, all locust fighting equipment is being gone over and being put into shape for immediate use in case of emergency. Another phase of the organization work consists in the Bureau furnishing a report of the locust conditions throughout the Archipelago to every provincial governor. By this means each governor can see at a glance just what the locust situation is in each province and any possible invasion may be readily anticipated.

During the fiscal year of 1916 funds in the amount of ₱14,850 were allotted to provinces for assistance in controlling locusts. During the present year it has been necessary to allot only ₱11,200, much of which has been made as a measure of precaution and remains unspent. The major portion of the amount expended has been used in the control of the pest in the uninhabited public domain and used for the feeding of laborers. The diminution of the amounts utilized this year as compared

Liberian coffee grown at Lamao Experiment Station, Lamao, Bataan.

with those of preceding years is due to two reasons: (1) Organization of the work and (2) scarcity of the pest. Despite the small amounts allotted every province shows a healthy balance of locust funds which aggregate over ₱40,000.

Work of the provinces.—While most of the provinces have rendered excellent service and handled their compaigns with little or no assistance or supervision, the diminution of the size and number of locust swarms has produced a tendency on the part of some provinces to slack up on the discipline which, if allowed, will undo all of the good work that has been accomplished by that particular province. In fact it may be said that the final clearing of central Luzon was made possible solely to the stand taken by Insular officials, the Constabulary and the Bureau of Agriculture, with the aid and pressure exerted upon local officials by the Executive Bureau. Of all provinces invaded by locuts, Bukidnon probably suffers more than any other. This is due largely to the scarcity of population and the vast areas of uninhabited land. These lands are practically all overgrown with high grass which makes ideal breeding grounds for locusts. Despite the fact that everything is against them, the Bukidnons are the most persistant locust fighters in the Archipelago. During locust invasion they work seven days in the week cheerfully and without a murmur. Their splendid organization is due to the confidence which they have in the governor, the Honorable M. Fortich.

With the locust at present under control, the country is in a better position to remain free from its depredations than ever. However, it has been definitely proven that freedom from locusts can be purchased only at the price of eternal vigilance. One swarm allowed to develop and become distributed will largely undo results accomplished by the entire campaign. This fact should be firmly inculcated in the minds of all officials connected with locust eradication. Furthermore, it should be made a sufficient cause for strong disciplinary action for any local official to allow locusts to develop wings within the jurisdiction of his municipality.

Work in the investigation of pests and diseases of the coconut palm.—During the latter part of the present year, the work of the inspection of coconut groves has been by far the most important of the various activities under the entomologist. With the passing of the locusts, the work of extending and organizing coconut grove inspection work was taken up. The funds available for locust control were diverted to assist the different provinces in this work. While at first budrot eradication was the only object of this inspection, it has been found advantageous to extend the work to include those two primary pests of coconut palms, the *Rhinoceros beetle* and the *Palm weevil.*

With the funds available for assisting the provinces, it has been possible to extend the work in question so that in addition to the Insular forces available for this work there are also large forces of provincial workers in Laguna, Tayabas and the Department of Mindanao and Sulu. Funds have been allotted to each province as set forth in the previous tabulation relating to finances.

In order to make for the greatest efficiency, the provincial inspectors are placed under Insular supervision. The results obtained have been most gratifying during the year, it having been possible to inspect 8,661,380 trees. As the work has progressed, new innovations have been constant and have resulted in the establishment of a most excellent system of control.

Taken as a whole, the work of coconut inspection has yielded most positive results which are very far-reaching and which conclusively show the deplorable condition which the coconut industry is in. Among the features which this inspection has brought out are: (1) That the statistics furnished by the local officials are not only erroneous but misleading as the number of trees reported is much less than that which actually exists, generally being 10 to 50 per cent underestimated; and (2) the statistics also show that the actual production of the groves is considerably less than that reported by the local officials. It is estimated that due to the rhinoceros beetle alone the annual loss from trees killed is over ₱6,000,000, while the damage wrought by the two palm weevils, *Rhynchophorus pascha* and *R. pascha* amounts to ₱4,000,000. In addition to the loss incident to these pests may be added the toll taken by rats, crows, wild hogs, budrot and a host of other lesser pests.

The budrot survey work has been continued as set forth in the Annual Report for 1916 and for the year 1917 an inspection of trees aggregating 8,661,318 individuals has been added. The results of these inspections tend to confirm the belief that the disease is more or less confined to certain local areas of infection, where the climate conditions are favorable to the propagation of the disease, and that these local areas are mostly in sheltered valleys where there is a high relative humidity. While this branch of investigation is by no means complete, it is believed from what is known that the infected areas occur largely in such locations. A careful study of the precipitation throughout the various localities seems to point to the fact that the amount of rainfall has little or no effect upon the prevalence of the disease as it has been ascertained that areas in which the same rainfall prevails month for month throughout the year show some cases a high percentage of diseased trees while other areas with the same precipitation will be almost without a diseased tree.

Comprehensive investigations of plantings at different altitudes in which units of holdings aggregated over 2,000,000 trees planted under all altitudinal conditions, from sea level to 2,200 feet, the altitudinal limit of coconut cultivation, points also to the fact that the disease may be expected with equal frequency in all districts throughout the altitudinal range of cultivation.

Research relative to the pathogenic organism.—In conjunction with Mr. Otto Reinking, plant pathologist of the College of Agriculture, investigations have been continued. In this connection, the work of the office has largely been of collaboration, this office furnishing the material and doing the field work while Mr. Reinking has done the actual laboratory work. While the results have not yet been published, it has been definitely ascertained that the agent responsible for the disease is *Bacillus coli.* This is interesting as there has been a long standing difference of opinion between the pathologists of the new world and those of the old world, as to the exact agent responsible for the disease. In this connection, those of the new world who had worked with the disease maintained that *B. coli* was the cause of the disease. These statements were met by those of the old world that regardless of the results obtained in Cuba and other parts of the new world tropics, the disease known as budrot which occurred in the old world tropics was caused by the fungus *Pythaim palmivorum* and that there must be more than one kind of budrot of coconut palms caused by different organism but of analogous symptoms. Thus, the work of the Bureau has in a large measure helped to bring out the fact that the disease in both places is the same and subject to the same control methods.

The role of insects in the distribution of budrot.—Investigations mentioned in the report of 1916 relative to the role insects play in the distribution of the disease has progressed, the amount of data collected being added to each week. Just what conclusion will ultimately be arrived at, it is now impossible to state though present knowledge seems to indicate that the adult palm weevils, *R. pascha* and *R. ferrugineus* are persistant feeders on the diseased trees and may be responsible for the local distribution but is not however a determining factor in its prevalence.

A synopsis of the different pests attacking the coconut palms.—Of the different pests attacking the coconut palm the *Rhinoceros* *beetle, Oryctes rhinoceros* still continue to outrank all others as the most destructive. During the year the research work in regard to the life history and investigations as to the extent of the damage caused by its uncontrolled activities have been completed and the whole prepared in a manuscript which is now in the press. In brief, they have brought out the fact that the losses in trees killed outright or fatally injured by its attacks amount to over ₱7,000,000 annually, placing the value of each tree at the very conservative figure of ₱5, a loss which while truly appalling does not begin to represent the total losses to the coconut industry from insect pests.

Scarcely less important than the foregoing pests are the palm weevils, *R. pascha* and *R. ferrugineus*. Inspections for the year show that trees are annually killed and injured by the depredations of these pests and cause a loss of ₱7,000,000 annually. While probably no more numerous this year than in previous years, the damage caused by their presence seems to be much larger due to the previous misconception of potentiality. Reports of damages by other pests of coconuts have been few and the invasion of the groves by *Aleyrodicus destructor* seems to have passed, the present year bringing no report of loss from this species. The "pagui-pagui," *Thosca cinereamarginata* has been present in the groves at Zamboanga and while causing some loss by defoliating the palms it has been present in substantially fewer number than during preceding years.

The work on coconuts has proven of inestimable value not only as an object lesson to the planters but to the Government itself. Aside from the actual pecuniary benefits obtained in preventing the spread of pests and diseases and in curtailing the damage wrought by them, other benefits are being realized. First, among these that may be mentioned is the appreciation which is slowly being developed in the planters mind of the Government's attempt to help them and which is being reflected in the more active coöperation which they extend to the Bureau's inspectors and by the large number of requests from municipalities and provinces to have their coconut lands inspected. While there is no financial gain to the Government, this work has shown the deplorable condition of the coconut industry and the great need of legislative measures to correct the many shortcomings of the present system of culture and of marketing the crop. It is a fact that few will believe but which will be substantiated by investigation that the exports of coconut products of the Philippines could be doubled by the adoption of a few simple changes in the methods of cultivation and of marketing the crop.

One typical case of budrot. Note the central frond.

(*a*) A group of Budrot Inspectors.

(*b*) Showing the way how budrot case is prepared for distribution. The pieces are then burned by either dry leaves and sticks or by a fundry torch.

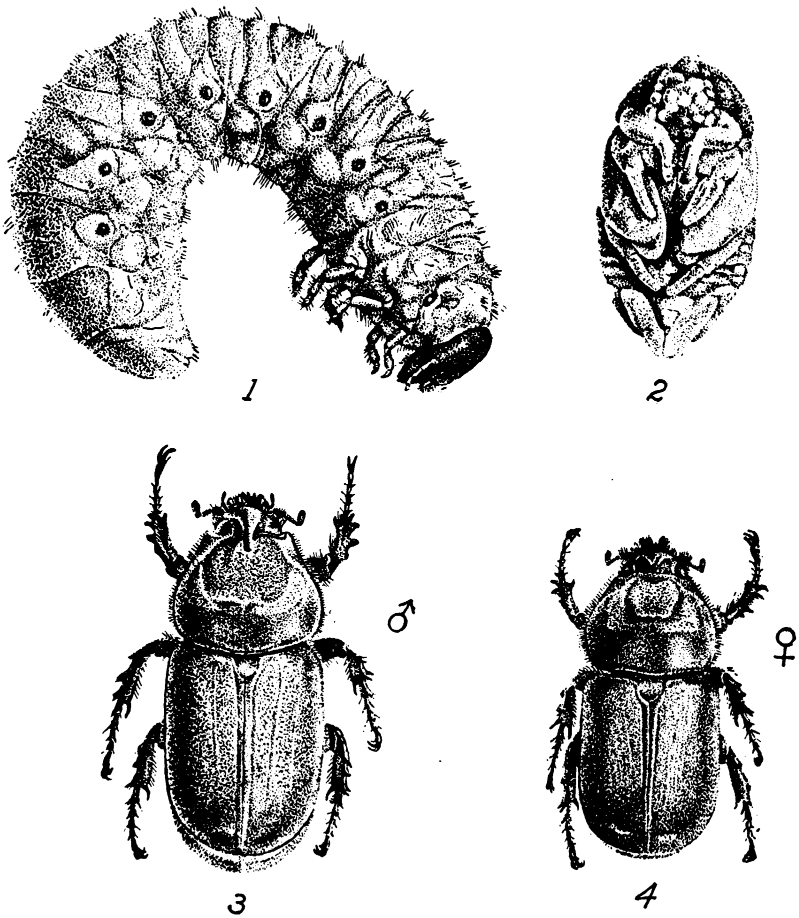


FIG. 1. Larva.
2. Pupa.

FIG. 3. Adult male.
4. Adult female.

(*a*) "Oryctes Rhinoceros" L.

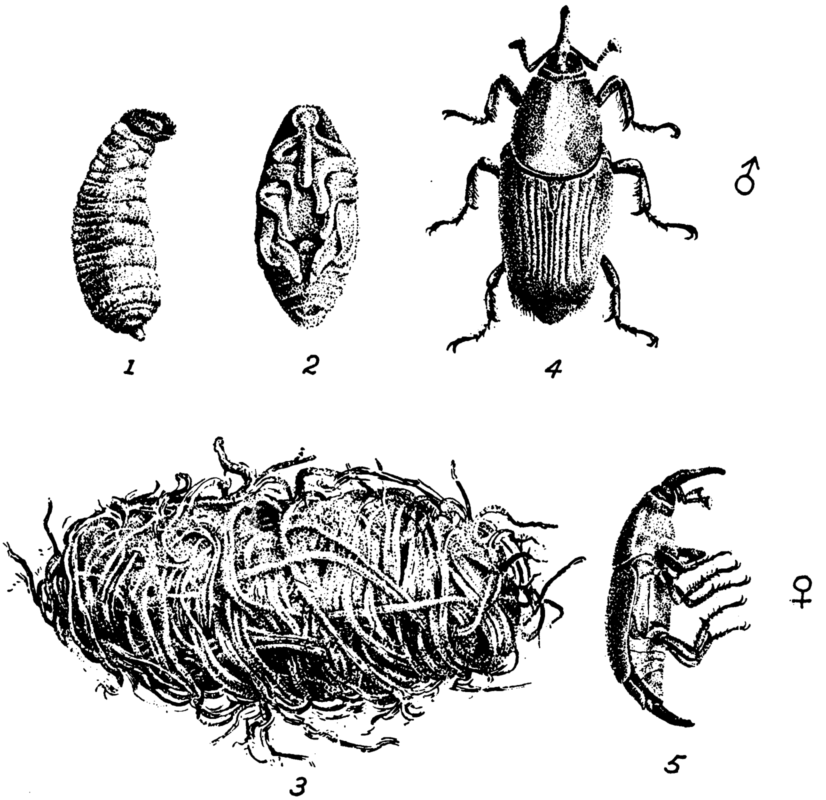


FIG. 1. Larva.
2. Pupa.
3. Cocoon.

FIG. 4. Adult male.
5. Adult female, showing ovipositor.

(*b*) "Rhynchophorus Ferrugineus" Oliv.

It is estimated that the losses from preventable causes in this industry for the current year approximately ₱43,000,000, distributed as follows:

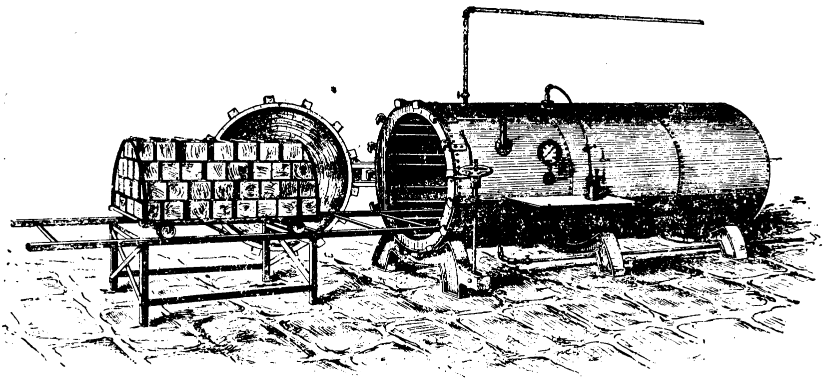
Insects and diseases	₱15,000,000
Close planting	8,000,000
Use of unripe nuts	20,000,000
Total	₱43,000,000

The first of these evils is being corrected in so far as possible by the work of the present forces and although at present the work is only in its preliminary stages the way is being paved for that which will follow later, which is the most important and virtually the key to the situation, viz: The compulsory cleaning up of groves.

Work in the control of pests affecting tobacco.—The work of the year in connection with pests affecting tobacco has been confined to the cigarette beetle, *Lasioderma serricorne* and the tobacco mould, *Aspergillus candida* and has largely been a continuation of last year's work. In connection with the control of the beetle it may be said that the number of cigars treated will equal to 33⅓ per cent of the entire number exported and total approximately 56,000,000. This amount exceeds by over 100 per cent the number treated in any previous year.

The results of our work in this connection have been assembled and published in the Agricultural Review under the heading of "Some Causes of the Failure of the Manila Cigar on the United States Market and a Remedy," which includes also the means of controlling moulds.

With the possibilities such as are offered by the above method for the control of these two pests of tobacco there can be no further complaint as to their control and the Bureau of Agriculture has in every way vindicated, the position it took several years ago in regard to this matter. With matters as they now stand, two alternatives now present themselves. They are (1) for the Government to make compulsory the treatment of all export cigars; (2) to let things go as they are. The former has everything to commend itself and promises a speedy release from the present troubles which beset the path of the Philippine cigars in the United States. A continuance of the present methods means that the product of those factories who fail to keep their goods free of beetle and mould will continue to reflect upon the Manila product in general and militate against the trade. To this may be added the expense of settling claims for damaged cigars and other troubles incident thereto. Taken as a whole the Bureau of Agriculture's work in this connection with this problem is ended. The way has been shown and the methods utilized to obtain the desired results have been found to be in every way practicable and applicable to the conditions that prevail in the Philippines.



Vacuum Fumigating Tank for the control of cigarette bettle (Lasioderma serricorne) on Philippine cigars. Cigars before being exported should be subjected to fumigation in one of these tanks to guaranty being free of bettles.

Insects and diseases affecting abaca.—With the release of inspectors by virtue of the completion of the work of locust control, another of the problems which this office has been able to take up is insects and diseases affecting abaca. Mention of a disease affecting abaca was made in the report of this office for 1916 which stated that the disease had appeared in Cavite Province. The first report of trouble with abaca was received at the Bureau of Agriculture in October, 1916, from the Municipality of Mendez-Nuñez.

During the present year the malady has extended itself until at the time of writing, it has appeared in the towns of Indang, Silang and Amadeo, in addition to Mendez-Nuñez, from which it was first reported. In accordance with the provisions of Act 2515, a quarantine has been declared in the Province of Cavite prohibiting the transportation of any plants or parts thereof of *Musa textilis* for the purpose of propagation to any other province in the Philippines. In accordance with the same authority, regulation prescribing the duties of owners of abaca plants found to be infected with the disease and the relation of such owners to the representative of the Bureau of Agriculture has been prescribed. These regulations which are listed as Quarantine No. 1 and General Order No. 52 are very specific and leave the determination of the means to be employed in the actual work of control entirely in the hands of the Insular authorities which it is believed will overcome any trouble which may be anticipated from apathy on the part of those immediately concerned.

There has appeared in the Province of Cavite a disease which threatens to seriously affect the abaca industry in that province and while referred to casually in the report of the year of 1916 no particular mention was made of it and it was not described. The malady in question affects the central developing leaf from causing it to turn yellow and die, and disease extending down the petiole into the heart of the tender stem causing a soft heart rot that is fatal to the plant and renders it useless for fiber. On this work, the Bureau has been able to utilize the services of Mr. Otto Reinking, of the College of Agriculture who kindly consented to coöperate with this Bureau. The pathological investigations have been carried out by him. In this connection he reports that the trouble in question is of bacterial origin. It is interesting to note that the organism in question is new to science, having been identified by Dr. Reinking as *Bacterium spp.* As the disease records a fatality of 100 per cent the Bureau's efforts are being directed to preventing its further distribution. As a preliminary measure to the actual control work a survey has been made and all the abaca lands of Cavite are being plotted for this purpose.

The Bureau's work in the control of rat plagues.—As in most other lines of activity, the Bureau's work in the control of rat plagues has also been extended. During the year one hundred requests for assistance in controlling the pest have been attended to. In all 260 kilos of white arsenic and fifty liters of carbon bisulphide have been distributed gratis in this connection.

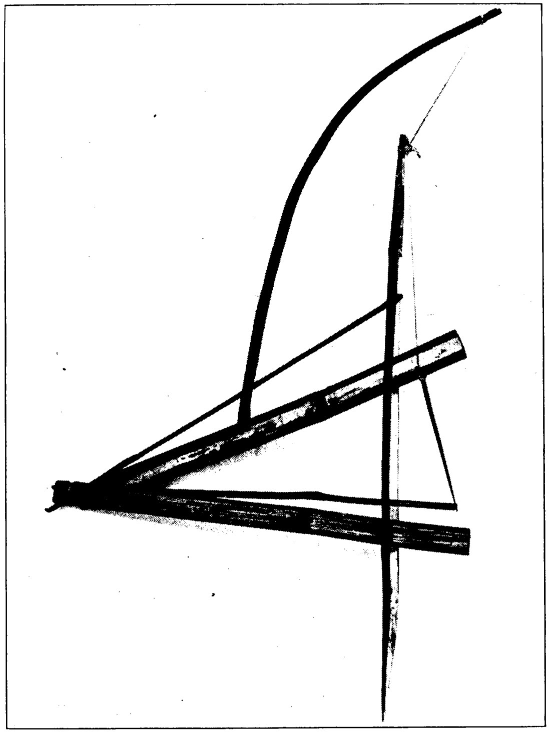
Investigations of this pest show that during the past ten years, there have been 129 reports of extensive destruction by rats, more than half of these attacks being confined to rice, the rest being divided between maize, sugar cane and coconuts. In addition to poisons and fumigants distributed gratis to planters, organized campaigns under the Bureau of Agriculture field men have been undertaken in the Province of Rizal. The results in this initial venture are gratifying and in some cases the catch of rodents ran as high as 5,238 rats a day. Campaigns of this nature have thus far received the necessary coöperation of the planters and have reduced the numbers of the rats till their attacks are no longer noticeable. In addition to this, the chief entomologist has prepared for publication a manuscript setting forth in detail the habits and bionomics of each species, their status as agricultural pests and the different methods available in their control.

Insects affecting rice.—There has been few outbreaks of insect pests in this crop though there have been several indefinite reports of damage which have been apparently caused by fungus. Work conducted by Mr. Bonifacio Arce in the control of the rice bug, *Lepticoriza varicornis* promises to furnish a successful solution to this problem which has so long baffled this office. In fact this discovery offers possibilities in the control of that group of the Hemiptera which have so long been immune to the ordinary methods of dealing with insect pests viz: Poisoning, by reason of their mouth parts being suctorial which enables them to obtain their foods without being exposed to the poison. This discovery demonstrates that both the adults and the immature bugs are attracted to the smell of putrid meat and recognize it from a considerable distance and immediately investigate the source. Not only do the bugs come in large numbers to the poisoned baits but feed with avidity on the juices of the meat.

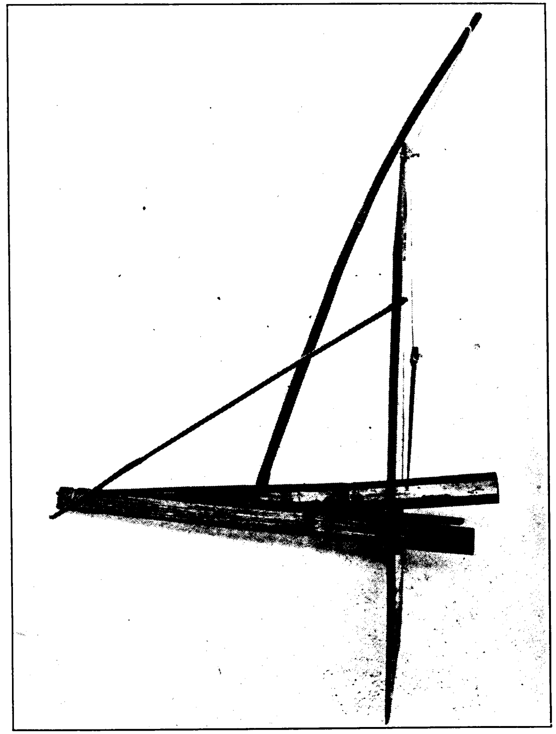
Field demonstrations have shown that the meat tied up in small bags and suspended from poles well located in open land will rapidly be covered with feeding bugs. While our investigations are not yet completed it has been found that a three per cent solution of arsenate of soda mixed with the meat will kill any bug that partakes of it. Until further experiment demonstrates that trapping or some other method in conjunction with this kind of bait, the poison method will be utilized. The next step will be to ascertain the best time to conduct the campaign. Present observations seem to point to the fact that the period just before the rice heads out will be productive of the best results. However, this will readily be found out by experiment.

Fungus diseases.—Of the fungus diseases present on rice a very pronounced case comes from the district of Cabanatuan, Nueva Ecija. Examination of diseased plants show the cause of the trouble to be the fungus *Ustilago virens.* This is a fungus which affects the heads of the rice causing their grains to become swollen and covered with a deep orange colored powder which is the fruiting bodies of the organism. As this class of disease can largely be controlled through treatment of the seed with copper sulphate, it is believed that the control of this outbreak will be affected at the coming planting season.

From the Lamao station a report of a disease of rice that is new and hitherto unreported was received. This disease has



(a) Open.



(b) Closed.

Effective bamboo guillotine rat trap used by the people of Taytay. Traps are placed on rat trails or on ricepaddies.

all the appearance of being of possible economic importance. It has been identified by the mycologist of the Bureau of Science as *Phyllosticta miurai Mivake.* Another report of which investigation was possible was received from the Sual district of Pangasinan. To judge from the correspondence, as no specimens were forwarded, this latter disease was caused by one of the rusts.

Investigations relative to pests and diseases of sugar cane.—There has been little done under this heading. Complaints from this source for the year have been practically nil. From San Jose, Mindoro, however, comes a report of a disease which from present indications point to a possible futural trouble. From the appearance of infected plants, it would seem that the disease in question is what is commonly called the Fiji disease. This is one of the most dangerous of all the known diseases of cane and is most rigidly quarantined against by all cane growing countries. It is characterized by the formation of gall like swellings of the midrib of the leaves and a failure of the plant to grow beyond the formation of a tussock similar to a stool of marsh grass.

The pathogenic agent is a member of the lowest group of organism, *Plasmodiphora.* The great danger to be anticipated from this disease is the fact that the organism propagates with equal facility in the soil, so that once the disease appears in a district its eradication becomes almost an imposibility.

Pests and diseases of citrus.—Work along these lines has been limited to the collection of insect pests noted feeding upon the various members of this group. While these investigations are of no great importance they have added considerably to our available knowledge of the season broods. One case in particular is that of a hitherto unreported *Aleyrodid* closely resembling *Aleyrodes citri,* and which will probably be found to be closely related to that species, if not identical. The only other work with this group has been of a coöperative nature with Mr. H. A. Lee, of the United States Department of Agriculture, who is investigating the possibility of the control of citrus canker.

Plant inspection service.—This branch of the service shows a healthy growth. In pursuance with recommendations made in the report of 1916 it has been possible to secure authority for the appointment of three new Filipino inspectors to this branch of the service. Perhaps the most important innovation is the opening of a plant inspection office at Zamboanga and making a permanent detail to that port.

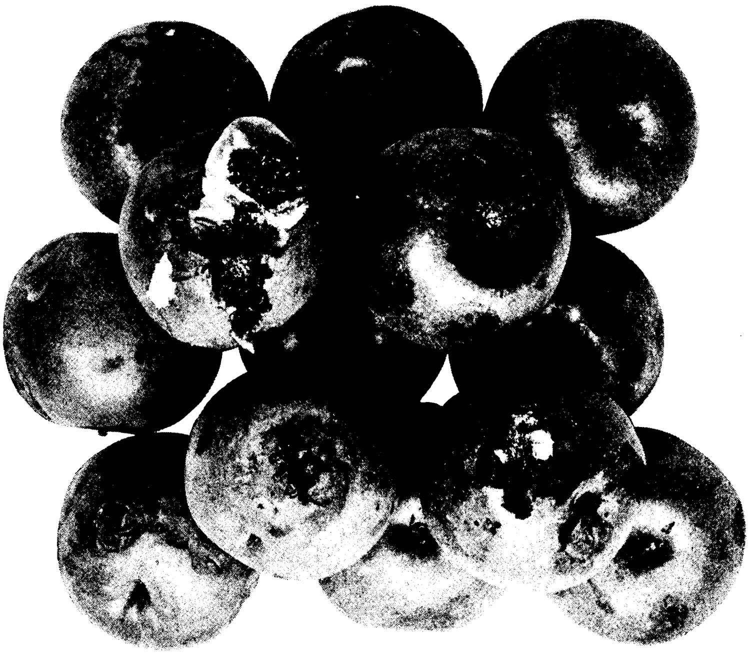
The insectary at Singalong experiment station has been remodelled and enlarged for the purpose of making it into a research and quarantine laboratory. The present change will double the size of the building which now houses the fumigating equipment of this branch of the service. This arrangement allows for the examination, fumigation and destruction of all material and is also of signal assistance to other divisions.

In accordance with Act 2515, new regulations covering the inspection of imported plant material have been promulgated as General Order No. 1, restricting the shipment of abaca for propagation purposes has been put into force. The records of the office show that during the year under consideration certificates covering the inspection of 3,948 packages of seed and plant material were issued. During the year 21 species of insect pests have been intercepted on incoming shipments. There has been considerable falling off in the number of export shipments inspected due to a decrease in the number of orchids exported, this decrease being due entirely to the war.

Educational propaganda.—The office's activities in this line have been continued and have been productive of excellent results. During the year, educational work has been taken up in connection with budrot of coconuts, abaca rot, rat control in rice, coconuts and sugar cane and the control of the rice bug. Propaganda in connection with budrot was conducted in La Laguna, Tayabas, Department of Mindanao and Sulu and in Pangasinan; that relative to rats in Rizal, Pampanga, and Tarlac; that in connection with our work on the rice bug was made in Bulacan and Cavite Provinces.

Work in Apiculture.—Experiments with honey bees have been of necessity slighted. The colonies of *Apis indica* are in a thriving condition and have shown no desire to abscond. The same holds true of those of *A. mellifica.* Work with *A. dorsata* has been confined to securing good series of photos of this species as there has been no time to give this subject the individual attention which it needs.

Coöperative work.—During the year, representatives of the United States Department of Agriculture and the State of California have made extended visits to the Islands in connection with pest control work. Mr. Lee of the Federal Department of Agriculture as previously stated is engaged in investigations relative to the possible control of citrus canker. For this purpose the entire citrus collection at the Lamao experiment station has been put at his disposal. Mr. C. P. Clausen visited the



Pear fruits attacked by moth borer.

Leptocoriza varicornis Fab., sucking the juice of putrified meat.

Islands for several months for the purpose of securing possible parasites of insects destructive to citrus fruit in the State of California. To judge from the hearty letter of thanks received from the State Commissioner of Horticulture in California, the assistance extended was duly appreciated. It becomes more apparent year by year that by aiding other countries in this way a courteous and helpful service to others is performed and reciprocal service of a similar kind is willingly and courteously rendered.

Acknowledgments.—A report of this nature would not be completed without making due acknowledgments of assistance received from outside sources. The Bureau is particularly in debt to the officers and men of the Philippine Constabulary. Their work in patrolling the uninhabited domain has been of inestimable value in connection with locust control and has more than any other thing been responsible for the successful termination of this campaign.

To the Bureau of Entomology and other Bureaus of the United States Department of Agriculture particularly to the former the thanks of the Bureau are due for the identification of specimens.

FIBER DIVISION.

PERSONNEL.

The personnel of the fiber division during the fiscal year ending December 31, 1917, consisted of a chief, thirteen inspectors, three acting inspectors, twenty-two assistant inspectors, four assistant agricultural inspectors, nine clerks, and several laborers.

As in previous years, the force of fiber inspectors attended to the inspection of the grading of fiber in the different fiber-grading establishments and to the issuance of the proper certificates of inspection on all fiber graded and baled in accordance with Act 2380 of the Philippine Legislature. The assistant inspectors performed their duties in helping the inspectors in the supervision of the grading of fiber at the press or presses to which they were assigned, as well as to check and stamp all bales submitted for inspection. A number of assistant inspectors were detailed during the year to carry on an educational campaign among the producers in the more important fiber-producing provinces, with the end in view of bettering the quality of fiber, as well as to advise them from time to time of the current market prices of fiber.

During the year the fiber division lost through resignation the services of four of its American inspectors of whom Mr. M. M. Saleeby, its first chief, was one. On the other hand, a Filipino was promoted to the position of second assistant chief of the division, together with a number of others who were promoted to the position of inspectors as a result of qualification by passing the fiber inspector examination as required by the Bureau of Civil Service. Three of the assistant inspectors, because of very efficient service rendered by them since the beginning of the fiber inspection work, were given assignment as acting fiber inspector in charge of station.

SCOPE OF WORK.

The most important work performed by the fiber division during the year covered by this report was the enforcement of the fiber grading and inspection law (Act 2380), and also investigation and experiment on abaca (Manila hemp), Agave and allied fibers, kapok, cotton, and miscellaneous tropical fibers of commercial possibilities. The distribution of fiber plants and seed was performed by the seed and plant distribution office of the Bureau, in coöperation with the fiber division.

FIBER GRADING AND INSPECTION.

The system of grading and inspection during the year just past was, on the whole, conducted in a most satisfactory manner. The grading establishments having profited by their experience of the previous years by becoming thoroughly acquainted with the official standard of grading and the prescribed regulations governing the baling of fiber, contributed materially in minimizing the frictions between them and the inspectors, as was the case during the first years of the enforcement of the fiber grading law.

Hardly any difficulty worth mentioning was encountered in this year's work of the division, save perhaps the towy and strippy fibers which came mostly from Sorsogon and the northwestern part of Samar, the various colored fiber from Jolo, and the coarse and strippy but high colored fiber from northern Mindanao. The towy condition of Sorsogon and Samar fiber was due mainly to the fact that the hanks once in the godowns and the coarse strips are separated, the resulting effects are the tow which are invariably found in the high-grade fibers coming from these districts. In the case of Jolo and north Mindanao fibers, the trouble here was that ever since the enforce-

PLATE XXVII.

A groun of Government fiber inspectors with same government laborers and bodega men.

Government Fiber Inspectors making the inspection of bales.

ment of the fiber-grading and inspection law, no educational inspector has ever been assigned to these provinces through lack of a proper personnel who can handle the situation. However, this division expects soon to be able to relieve this want by the employment and training of a Moro from the Department of Mindanao and Sulu.

Grading station and establishments.—During the year just past, there were designated thirty-four grading stations and 101 grading establishments, an increase of four stations and four grading establishments over the previous year.

Of the one hundred and one establishments operating under the fiber grading law, there are only twenty-four establishments that still use special house marks for each grade of the Government standard. They were classified as follows: First-class, 8; second-class, 12; third-class, 5; fourth-class, 29; fifth-class, 20; and sixth-class, 27. The class of establishments is determined by the number of bales graded and baled per year. First-class establishments handle 40,000 bales or more; second-class, 20,000 to 40,000; third-class, 16,000 to 20,000; fourth-class, 8,000 to 16,000; fifth-class, 4,000 to 8,000; and sixth-class, under 4,000 bales.

Inspection stations.—Seventeen inspectors, three of whom were acting, were assigned to inspect fiber during the year, a gain of two inspectors over the previous year. These inspectors were assigned to the following stations: Manila, 2, besides the chief; Cebú, 2; Legaspi (including Ligao) 1; Tabaco, 1; Lagonoy, 1; Sorsogon, (including Gubat), 1; Casiguran, 1; Calbayog, 1; Tacloban, 1; and Surigao, 1; and the rest are either on leave of absence or resigned.

Quantity of fiber graded and inspected.—Accurate reports on the quantity of fiber graded, baled, inspected and certified to every month, by grades and provinces, were regularly prepared during the year as in the past. These monthly reports were distributed to both local and foreign buyers and manufacturers, and our list of subscribers has been continually growing, which emphasizes the value of these reports to the trade in general.

The Government fiber inspectors, during the year 1917, inspected, stamped and approved 1,291,851 bales of abaca (Manila hemp), and 113,579 bales of maguey and sisal, and also 1,553 bales of pacol and canton. During the past year, 21,228 bales of abaca and maguey were rejected as not being up to the proper standard.

There were produced a total of all fibers during the year 1917, 1,406,983 bales, an increase over the total of the previous year of 101,831 bales.

Receipts and expenditures.—The total allotment to the fiber division for the year 1917 was ₱123,395, a considerable amount of which was not expended by this division. The following collections were made by the fiber division for the year 1917:

License fees for grading permits	₱20,350.00
Inspection fees on abaca fiber	129,185.00
Inspection fees on the rejected abaca and maguey	2,122.80
Inspection fees on maguey, sisal and pacol	11,513.20
Total	163,171.00

The above total collected for the fiber division does not include small amounts collected during the year for the sale of standard samples, nor does it include the items for the sale of abaca and maguey suckers. The fiber division is not only self-supporting but is the source of considerable revenue to the Government.

General remarks.—The year 1917 has been a very favorable year for the fiber industries, in so far as weather conditions are concerned. No typhoons nor floods of any serious character have visited the fiber provinces during the year, and the abaca plantations in the southern Luzon provinces are reported to have fully recovered from the effects of the typhoons of 1915. This condition, it is believed, is conducive to still further material increase in the production of abaca and maguey throughout the Archipelago.

The most notable change in the abaca production during 1917 was the great increase of the good and excellently cleaned grades and a corresponding decrease in the production of the coarse and Daet grades. This improvement was the direct results of the work of our educational inspectors throughout the abaca producing districts in their effort to educate the producers to improve the method of stripping in order to procure the very satisfactory prices being paid for the excellent and well-cleaned grades.

The price obtainable on the local market for abaca and maguey fiber throughout the year 1917 was most satisfactory. In fact, during a great period of the year 1917 the market price of abaca fiber reached a maximum never before obtainable in the Philippines.

During the latter part of the year 1917, the Bureau of Agriculture received the Prieto maguey extracting machines, which were ordered in the early part of the year, and immediately had them installed at Singalong experiment station and began experimenting with the view of adjusting these machines to the adaptability of stripping Philippine maguey. The results obtained were very satisfactory and it is believed by the undersigned that these machines will give perfect satisfaction and greatly increase the maguey industry throughout the Philippine Islands, and put it on a more staple basis.

Coöperation of the United States Department of Agriculture in fiber investigations.—During the previous fiscal year tentative arrangements were made by the chief of the fiber division, in conference with officials of the United States Department of Agriculture, for coöperative work in promoting the interests of the binder-twine-fiber industry in the Philippine Islands. Appropriations covering the cost of this work were subsequently obtained, and in June, 1917, a specialist in fiber-plant production was detailed by the United States Department of Agriculture for duty in the Philippine Islands.

The development of our maguey and sisal industries, both by increasing the production and by improving the quality of these fibers, is a matter of vital interest to the farmers in the maguey-producing provinces. As a result of the increased demand on the part of American farmers for binder twine, due in part to war conditions, together with the existing high prices and the possibility of a world's shortage of binder-twine fiber in these Islands has attracted considerable attention in the United States.

The purpose of this coöperative work is to facilitate, by reason of increased funds and personnel, the continuance of work already organized by the Bureau of Agriculture, and the extension of this work along such lines as may seem desirable.

The coöperative work that has been carried on during the latter part of the current year has included investigational and publicity work in the maguey provinces, and the testing of fiber-cleaning machines at the Singalong station in the city of Manila.

EXPERIMENTAL WORK.

The experimental and extension work is carried on by the fiber investigation section of this division. The experimental work is being conducted, mainly, at La Carlota experiment station, La Carlota, Occidental Negros. Several experiments are in progress; they are grouped as follows:

I. Abaca.
II. Agave.
III. Kapok.
IV. Cotton.
V. Miscellaneous fiber plants.

This work is all continuous, and has now been in progress for several years, but it seems desirable that it should be continued for some time longer before publishing results. The extension work is carried on firstly by distributing plant materials to the old and prospective growers, secondly by a sort of an extensive campaign all over the Islands. This comprises practical talks and lectures to farmers throughout the year. Coöperative experiments are conducted, the work being done by the grower under our direction. These coöperative experiments, we believe, are one of the most effective types of extension work. And thirdly by correspondence, which is increasing yearly. Prompt attention is given to the letters of inquiry received by this office during the year. It is the policy of the fiber investigation section to have such correspondence attended to promptly, giving desired information so far as it is known. Several letters of this nature were written during the year. Additions to the force of the fiber investigation section will make it possible to prosecute this work with greater vigor during the coming year, and this will add some new lines of investigation, and sufficient men to run the campaign.

Abaca (Manila hemp) investigations.—There are planted in adjoining experimental plots at La Carlota experiment station the most common varieties of the abaca plant which are cultivated in south Mindanao (Davao), east Leyte, south Luzon (Lagonoy, Camarines) and Occidental Negros. In addition to the three fields that have been planted in the previous years, a fourth field was started this year. The nature and purpose of planting these four fields and the interesting results obtained therefrom may be briefly but fully stated in the following manner:

Variety tests.—In order to study the distinguishing characteristics of the degree of hardiness, rapidity of growth, the proportion of fiber contents to the raw material, the quality and tensile strength of the fiber and the facility of fiber extraction in each of the varieties cultivated in the regions mentioned above, field No. 1, was started in 1912. Last year, experiments along these lines were almost completed in all the varieties grown, with the exception of those varieties from south Luzon, which were determined this year.

It is intended that a work of this kind be continued for some time longer before publishing results. As has been stated, addition to the force of this section will make it possible to prosecute this work with greater vigor during the coming year, and thus will add some new lines of investigation to what have already been accomplished.

Repeated variety tests.—Owing to the fact that the extent of growth and development at La Carlota of most of the south Mindanao and east Leyte varieties has been inferior to what the same varieties exhibit when grown in their respective native localities, it was deemed necessary to repeat the whole series of variety tests by planting a new field designated as field No. 2, in which all the varieties of all the districts are propagated from rootstocks obtained from the first field. It is believed that the second generation of plants will give better results than the first generation, due to the fact that the former will be better adapted and acclimated to local soil and climatic conditions. This field was started on June 20, 1916, and the varieties grown, have not, with the exception of the Ilayas and Kala-ao, which flowered in July and October, respectively been sufficiently developed to enable us to make a full study of their characteristics as compared with the varieties grown in field No. 1.

Propagating abaca for distribution.—It has been found that the demand for abaca suckers is growing larger and larger from time to time and for this reason, we have decided to start two more new fields of abaca. The purpose of which is to propagate the most desirable varieties and distribute same to the various abaca growers of the Islands. These fields are designated as field No. 3 and field No. 4. They were planted on September, 1916, and May, 1917, respectively. Field No. 3 was planted with suckers while field No. 4 was planted with rootstocks.

Propagating abaca from seed.—Repeated experiments were conducted at La Carlota experiment station in order to determine the merits of this method of propagating the abaca plant, and it has been found that the conclusion drawn from these experiments in the previous years, holds good in conformity with the results obtained this year. Experiments at La Carlota have demonstrated that this method of propagating from seed is undesirable.

AGAVE INVESTIGATIONS.

Experimental work.—In August, 1912, the following Agave species were planted in experimental plots at La Carlota experiment station:

Maguey (Agave cantala).
Sisal (Agave sisalana).
Henequen (Agave fourcroydes).
Zapupe (Agave zapupe).

In addition to the above, a few plants of Mauritius hemp (Furcroya foetida) were set out at the same time in an adjoining plot.

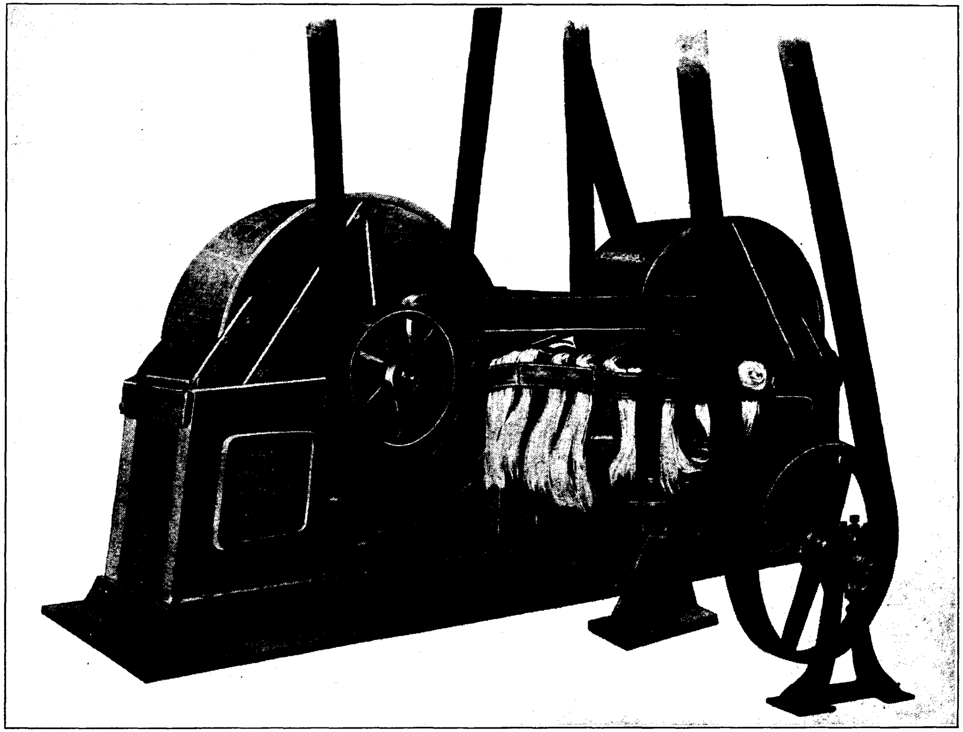
Maguey (Agave cantala).—There are at present four different plots of maguey. Plot No. 1 consists of 2 rows of plants, one grown from suckers and the other from bulbils. There are 22 hills in a row. Five exceptionally good plants from each row are selected for determining the percentage of fiber. While these selected plants have not yet reached maturity, an experiment to determine the percentage of fiber obtaind by the processes of knife stripping and water retting was performed.

Investigations show that the maguey plant is on the whole well adapted to soil and climatic conditions in the Philippines. It can also be observed that of all these species maguey produces the highest percentage of fiber. Maguey exhibits longer but narrower leaves than sisal. Owing to its low percentage of fiber content, the Mauritius hemp is considered inferior to the remaining species. For the same reason, the Zapupe species is not considered as desirable for cultivation in the Philippines as either the maguey or the sisal.

Status of industry.—Statistics show that the production of maguey fiber for export from the Philippine Islands commenced in the year 1904, when the quantity of fiber exported was only 690 metric tons, valued at ₱156,242. Between the years 1905 and 1915, inclusive, the quantity exported varied between 2,000 and 7,000 metrict tons, and the value between ₱326,546 and ₱1,181,902, the highest figures being for those of the year 1913. Last year, 15,686 metric tons were exported, valued at ₱3,493,142. This phenomenal increase of production during 1916, is due to the material improvement in the preparation and grading of the fibers, as a result of the application of the fiber inspection and grading law; and by the considerable rise in price of all cordage fibers, on account of the European war.

Again, this increase in the quantity and value of maguey production has aroused considerabe interest in this fiber throughout the Philippine Islands. A large number of requests for maguey and sisal plants has been received by this division during the year, both from old and prospective producers. All these requests have been complied with, by furnishing suckers and bulbils from the plants we have at La Carlota.

Practically the entire quantity of maguey is still being produced by the retting method, and this office fully realizes that during normal years such a product can not compete on favorable terms with the Henequen or the sisal of German East Africa, Mexico and Java, all of which are cleaned by machinery.



Prieto stripping machine for maguey and sisal.

On this account, an effort has been made by this division to obtain funds from the Philippine Legislature, in order to purchase stripping machines, and operate same for demonstration purposes. This year an appropriation was made available and two Prieto stripping machines were bought from Prieto Machine Company, New York. They are at present temporarily installed at Singalong experiment station, under the supervision of our mechanic and superintendent of repair shops of this Bureau.

These two machines are operated from time to time for the purpose of demonstration. After a series of demonstrations, one will be sent to Ilocos district and the other to Cebu, where extensive cultivation of maguey and sisal is carried on.

KAPOK INVESTIGATIONS.

Experimental work.—There are twelve rows of kapok trees planted at La Carlota. Eight rows are propagated from seed, the seed having been planted in the nursery in August, 1912, and transplanted to the permanent field in September, 1913, Four rows are propagated from cuttings, which were set out in August, 1912. In addition to these four rows, four more were added in the latter part of the same year.

This year, the kapok trees were at their flowering stage from January to March, and four harvests were made. The harvesting of the pods was started in April and ended in July. The trees were beginning to set out new flowers at about the middle of December. In order to determine the yield of pods of average trees grown from seed and from cuttings, six plants were selected from each of the eight rows in each case.

The figures obtained show that the trees grown from seed produced more pods of kapok than those grown from cuttings. Aside from this quality of producing a larger number of pods, trees grown from seed exhibited a more uniform growth, the trunks and branches being smoother and more regular than the trees grown from cuttings, although the latter are larger in size and height. Furthermore, the pods produced from the former trees were of a much more uniform size than those from the latter trees.

Status of industry.—No new developments have taken place in this industry during the year. There is at present at the Singalong repair shop of this Bureau, a machine for cleaning kapok. In 1916, a machine was built by the office of construction and repairs of the United States Naval station at Cavite, and said machine has given very satisfactory results in separating the kapok fiber from the seed. The fiber division coöperated with the above office by furnishing plans and data of similar machines used successfully in Java. Now that the question of adequate cleaning machine for kapok is solved, it is hoped that the commercial development of this product will be enhanced at a much more rapid rate than heretofore. This division is fully equipped with information on all phases of the industry which all prospective producers and exporters may require for its proper development and extension.

COTTON INVESTIGATIONS.

Experimental work.—The experiments made last year with the growing of American upland type of cotton as well as native types, gave discouraging results, but to find out the defects of such results, further experiments with these plants were again conducted this year. Although present indications point to better results than those of last year, it is believed that repeated tests are necessary before a final decision can be rendered as to whether it is advisible to grow them on a large scale for commercial purposes or to grow them simply for home use. During the year another consignment of seed of Sea Island cotton was received from the United States Department of Agriculture, and same has been planted in experimental plots at La Carlota. The good results obtained from last year's planting indicates that continuous propagation of same is advisable for the purpose of distributing the seed to various cotton growers of the Islands. A large quantity of seed of this variety obtained from our trees planted last year, was distributed and it is hoped that this species will give good results. Our experiment shows that our soil and climatic conditions are favorable for the growing of Sea Island cotton and that same will thrive well. As has been stated in the previous report, the value and use of the Sea Island cotton have recently considerably increased on account of its suitability for use in the manufacture of rubber tire fabric for automobiles and other similar motor vehicles.

The newly planted varieties this year, in addition to those abovementioned, are the Balawan Light Brown and Balawan Brown, from La Union; "Soot" Light Brown and "Soot" Brown, from Batangas; and Toquillo and Burac, from Antique.

MISCELLANEOUS FIVER INVESTIGATIONS.

Panama-hat plant.—In our station at La Carlota, an area of 2,722 square meters was planted to 24 rows of 22 hills in a row of this plant.

The first planting of this plant was started in 1913, and the suckers were obtained from the old plants secured from Lamao experiment station.

The object of planting this plant is simply to be able to meet any demand for plants in case the Bureau of Education succeeds in developing a good weave of Panama-hats. The plants are exhibiting luxuriant growth, which indicates that this plant is adapted to our local soil and climatic conditions. The plants are now producing numerous suckers.

Roselle (*Hibiscus sabdariffa*).—There are at present growing at the station four plots of white roselle and two plots of red roselle. Of these plots three of the white roselle plots and one of the red roselle plots are for propagation and distribution purposes. The other two are for the purpose of conducting an experiment on the "plant-to-the row-test" culture.

Ramie or China grass (*Boehmeria nivea*).—In March 28, of this year, the plants were cut down to encourage the growth of the young shoots. The shoots grew rapidly and one month later the stems vary from 100 centimeters to 126 centimeters high. Two months after the first cutting, the second one was made for the same purpose. In less than a month later, the average height of the plants was 135 centimeters an increase of 10 centimeters. Since then, the plants were allowed to grow until their fruits reached maturity, and until enough stems were ready to be harvested for fiber extraction. Considerable success was obtained from repeated growing of this plant, and it can safely be stated that its cultivation can successfully be carried out in the Philippines. The fiber possesses superior qualities, and it is well known in all the fiber markets of the world. We are continually propagating this plant so as to be able to meet any demand for it.

CONCLUSION.

As in the report of the previous year, many of the statistical tables such as sale of animals, livestock purchases, breeding records, inspections, publications, fiber statistics, sugar and other plant propagation records, laboratory tests, etc., were not incorporated in this report on account of economizing both time and space in its preparation. However, these statistical tables are available in every instance where more detailed information may be desired.

Respectfully submitted.

ADN. HERNANDEZ,
Director of Agriculture.

To the Honorable,
the SECRETARY OF AGRICULTURE AND
NATURAL RESOURCES,
Manila, P. I.

THE PHILIPPINE

Agricultural Review

VOL. XII THIRD QUARTER, 1919 No. 3

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STUDIES OF PHILIPPINE BANANAS [1]

By Eduardo Quisumbing y Argüelles

INTRODUCTION

There are few of the many valuable fruits in the realm of horticulture that can rival the banana in range of utility and response to culture. Every part of the plant has its use. The fruits and flowers supply an excellent variety of foods. The leaves are used for wrappings and for temporary roofing. The farmer makes use of the stems and tubers to feed hogs. The plant does fairly well, even under the poorest kind of culture. Generally, the Philippine bananas do not receive any kind of cultivation, being planted usually in a poorly prepared hole. If given the right scientific treatment and culture, the future of the banana as a commercial fruit yielder can hardly be overestimated.

The banana has a great number of varieties supplying many different uses. Because of its availability through the whole year and its abundance, it has come to be the poor man's food in the tropics. With the development of commercial facilities in transportation and in preservation, it is now increasing in popularity in the temperate zone and there bids fair to become also every man's food. Because of its food value and the ease with which the fresh fruit can be shipped, and also the many ways in which the fruits can be preserved, the banana deserves scientific study in a far greater measure than it has thus far received.

We lack adequate knowledge of what varieties of bananas may be best adapted for special purposes. Among the Philippine varieties and those introduced we do not know yet which possess the best qualities for eating raw, cooking, baking, drying, for fig purposes, and for flour. It is, first of all, necessary to be able to distinguish all varieties of bananas, clearly and certainly. Teodoro's thesis, published two years ago, was a beginning toward this end.

[1] Sprouts of any of the varieties described in this paper may be obtained by application to either Bureau of Agriculture or College of Agriculture.

Very little systematic study of cultivated banana varieties has yet been made, although about 77 species have been described. A former report of O. W. Barrett * of the Bureau of Agriculture in the Philippine Agricultural Review states that the collection of the Bureau totals 276 Philippine varieties. As many synonyms appear in the list cited, it is doubtful whether there was so large a number.

The present work is a continuation of the work begun by Nicanor G. Teodoro, a 1915 graduate of the College of Agriculture, University of the Philippines. The descriptive work is based upon: floral characters; stooling, size and habit; fruit characters; distribution; etc. There are some floral characters which readily differentiate one variety from another, but there are only a few single characters which can be used for safe varietal separation in *Musa,* since most of the characters are subject to more or less variation. The minor fruit characters are not constant, for they may be affected by cultivation and other environmental factors. Besides these influences, mutation, seedling reproduction and hybridization may cause variation. Such variations have been responsible for the great differences in texture and flavor of bananas. Some varieties are acidulous, others are subacid, sweet, sour or bitter. There are varieties of peculiar texture which adapt them only to certain special uses.

STERILE AND FERTILE FLOWERS

The floral characters of bananas form the best basis for the systematic distinction of varieties. Though fruits and other plant characters are also considered, more critical attention should be given to the flowers. There have been several publications on hybridization and pollination experiments on bananas but little attention has been given to the study of the structural differences and behavior of the sterile and the fertile flowers. The flowers are fairly constant in their characters. Fruits furnish especially valuable characters in the case of the plantains or Tundoks and in the separation of sections.

In fertile and sterile flowers there are marked differences in the gross structure and physiology. It is commonly believed, that the most highly improved form of bananas are devoid of seeds. The Tundok and the Tiparot are typical examples. The physiological development that these varieties show points out which varieties were the primitive ones. The Tundok never produces sterile flowers and a "heart." The Tiparot, on the

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* Barrett, O. W. *Phil. Agri. Rev.* VI: 439 (1913).

other hand, sometimes produces sterile flowers and "heart" but occurs very often without.

The basal portion (ovary) of the fertile flowers is much larger than the undeveloped ovary of the sterile flowers. The size of the ovaries changes or decreases, proportionally to age and position of the flowers on the stalk. The number of flowers in the fascicle is a decidedly variable character. The fascicles near the base contain more flowers than those nearer the tip.

Varieties may be termed fertile varieties when they are able to produce seeds and reproduce by them, and sterile when they are seedless and the only means of perpetuating the race is by suckers. Bananas are said to be self-pollinated. Whether the pollen of the sterile flowers is fertile or whether it affects fertilization is not yet clearly demonstrated, though occasionally one may find fertile pollen grains in the sterile flowers. The production of fertile pollen grains in sterile flowers is regular in some varieties, as in the case of *Musa basjoo* and *Musa ornata* Chitt.

The perigonium (calyx) is short, broad, and more or less uniform in the fertile flowers but narrow and long, irregularly inflated in the sterile flowers. The scales of the fertile flowers are generally larger than those of the sterile, and show less irregularities in form and in the form of the apices. The pistil of the fertile flower is also very much larger, often with very broad stigma which is quite uniform in shape in most cases. On the other hand, the stigma of the sterile flower shows very great variation in shape. The stamens of the two flowers are very different. In the sterile flowers, the stamens are more or less regular in number, and in arrangement. In position the stamens are generally campanulate, uniform in their spread, usually five in number though in some cases a rudimentary one (sterile) may be found. The stamens of the fertile flowers show great variation. In number they range from five to seven but generally are five to six. In form they vary from club-shaped to lanceolate as in the case of *Musa sapientum.* The anthers in some varieties are very much reduced while in others, they are elongated and pointed.

THE GROUPING OF BANANAS

Commercially, bananas are known as *plantains* and *bananas* proper. These terms are used with several different meanings. In some places the name plantain is applied to an almost edible *Musa* while in other places the word banana has an equally wide meaning. In common use, the distinction between the two terms is, that bananas are seedless and eaten raw while plantains have to be cooked before being eaten. Even this distinction is of somewhat doubtful value as some varieties which are usually cooked are also eaten raw.

The synopsis below is more or less provisional, for while the characters used in the separation apparently were constant for the varieties studied during the progress of this work, it can not be said definitely that these characters will prove of permanent and general application.

SYNOPSIS OF THE GROUPS

I. Sterile flowers in a fascicle, always present. BANANAS.
  - 1.[1] Fruits usually cylindric or oblong; angles disappearing as they reach maturity; eaten raw; with or without seeds; fleshy, filamentous, and mostly juicy; height, medium to small. BANANAS.
  - 1.[2] Fruits prominently angled; sides flattened; tip narrowed; very often with few seeds; rather fibrous; core well defined; usually tall, resistant to wind. SABAS.

II. Sterile flowers absent, or occasionally absent. PLANTAINS.
  - 1.[1] Sterile flowers absent (rudimentary); fruit is long and large; cylindric; core prominent; 4–5 angled to round cross sections; not eaten raw; style persistent; poor stoolers. TUNDOKS (TINDOK).
  - 1.[2] Sterile flowers sometimes absent; fruits flattened; prominently angled; tip narrow; juicy; fibrous; not eaten raw; style and calyx deciduous; good stoolers. TIPAROTS (KLIN PHAYA SAWER).

The best distinction between bananas and Philippine plantains is that bananas produce sterile flowers, and have a more or less persistent "heart," while Philippine plantains usually produce no sterile flowers and have a quickly deciduous if any "heart." In most cases rudiments of the sterile flowers are present in the plantains. The rudimentary structure is finger-like with a few warts on it, and is covered by bracts which fall off immediately after the falling of the bracts enclosing the fertile flowers. This finger-like rudimentary structure is broadened at the base and gradually tapers to a round apex. To the above distinctions there are exceptions, in that some varieties show intermediate characters, that is, sometimes they produce sterile flowers but usually are without any. The varieties Tiparot and Klin Phaya Sawer are examples of these exceptions. These varieties differ also from the Tundok by being good stoolers and by producing leaves similar to that Saba. The leaves of the Tundok resemble some of those of the readily edible bananas, (banana proper). Though there are these variations in the fruits, the distinctions between plantains and bananas are very marked. These distinctions will be fully discussed in the description of varieties.

SPECIES AND VARIETIES OF MUSA

A number of exotic varieties are in cultivation in the College of Agriculture. Not many of these exotic varieties were taken up in connection with this work, because few were in proper condition at this time. In several instances Philippine bananas were found to be closely related to the bananas from neighboring or even distant countries.

There are hundreds of varieties of bananas and plantains in cultivation all over the tropics. The College of Agriculture alone, as shown by records, has under culture more than 600 varieties, about one third of which are identified. Several of the varietal names in the original list are most certainly synonymous. Many of these bananas and plaintains came from the Bureau of Agriculture four years ago. Besides the large numbers of cultivated varieties, there are also several wild forms. On Mount Maquiling alone, there are two or three different forms of wild bananas. Whether these are distinct species remains to be ascertained. Wild forms, here, are known generally under one name, Saguing maching. For the sake of avoiding farther confusion most of our cultivated bananas and plantains are grouped under *sapientum* and *paradisiaca*.

Key to species of Musa in the Philippines.[1]

1.[1] Stem not stoloniferous, more or less swollen at the base.
  2.[1] Leaves oblong or lanceolate, bright green with red midrib; 6 meters or more in length; one or less than a meter in width. Bracts ovate, dark claret—brown, seed 2 cm. in diameter; whole plant 960 to 1280 cm. .... *Musa ensete* Gmel.
  2.[2] Leaves, light green, oblong-lanceolate, acute; about 2 meters long and 30 cm. wide; midrib green. Bracts of female flowers are green and ovate, sometimes broadly ovate; male flowers same but oblong-ovate and persistent; whole plant 320 to 384 cm. high. *Musa glauca* Roxb.
1.[2] Stem stoloniferous, not swollen at the base.
  2.[1] Flowers few in a fascicle, bright red to light purple or lilac tipped with yellow; spadix small and erect.
    3.[1] Spathes broad lanceolate; bracts light purple or lilac tipped with light orange yellow........ *Musa ornata* Roxb.
    3.[2] Spathes linear-oblong; bracts bright red, tipped with deep orange. *Musa glauca* Roxb.
  2.[2] Flowers numerous in fascicle, bracts not bright red, or lilac; spadix large and pendant.
    3.[1] Plant two or more meters high.
      4.[1] Fruits inedible, with numerous seeds; trunk usually slender; pistil in terminal flowers distinctly shorter than the stamens.

[1] In the description of the flowers, sterile flowers were used in all cases, except in Tundok.

5.[1] Scale more than $\frac{3}{4}$ as long as perigonium, tip acute and short; without apical shoulders; bracts dragon's blood red to dark Yvette violet tipped lettuce green, shiny and not glaucous.
Musa textilis Nee.

5.[2] Scale nearly $\frac{2}{3}$ as long as perigonium or less, tip usually acute, with distinct apical shoulders.

6.[1] Fruits sub-cylindric, smooth or slightly angular; bracts deciduous, greenish red-yellow.
Musa errans (Blanco) Teodoro.

6.[2] Fruits sub-ovate, very angular, 4–5 angled; bracts partially persistent, glaucous.

7.[1] Apex of scale tricuspidatė; stigma 3 or 4 lobed.
Musa errans var. *botoan* Teodoro.

7.[2] Apex of scale tetracuspidate; stigma rounder.
Musa errans (Blanco) Teodoro var. *basilisae* var. nov.

4.[2] Fruits edible, seedless or sometimes with few seeds; trunk usually sub-cylindrical.

5.[1] Free margins of perigonium (calyx) broadly inflated and largely covering the scale (petal); scale with a very broad scarious margin; fruit small, obovoid and long pedicelled.
Musa humilis Perr.

5.[2] Free margins of perigonium straight or receding, never inflated; scale with narrow scarious margin if any, never obovoid in form; plant normal in size; petioles long, narrowly if at all margined; the leaf blades never crowded at the summit of the trunk.

6.[1] Flesh sweet and edible uncooked; usually of medium and small size and yellow or red when ripe..*Musa sapientum* L.

6.[2] Flesh not sweet, usually sub-acid and not usually edible uncooked; fruits usually very large and often few in a bunch; commonly green at maturity; evanescently yellow, quickly becoming black; without terminal flowers (heart).
Musa paradisiaca L.

3.[2] Plant more or less dwarfed; petioles short and strongly margined, the leaf blades crowded at the summit of the trunk.
Musa cavendishii Lamb.

Musa ensete Gmel. Abyssinian Banana.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**: 387. 1915.

The Abyssinian banana is a remarkably tall species of Musa. Its only use so far reported is for ornamental purposes. The fruit is never edible. It is non-stoloniferous and perishes after fruiting. The only means of propagation is thus by seeds. It has been reported to thrive well in Southern California, Florida, Algeria, and the Canary Islands.

Musa glauca Roxb. Virgen, Tag. Merrill, E. D. *Philippine Agricultural Review* 9: **6**: (1913).

This banana is not abundant in the Philippines, though found scattered through Luzon. It was called Virgen by the people, because of the bracts hanging like the apron of the *Virgin*. Its life time from seedling to death of the plant is from one year and a half to two years. The roots of the plant are fibrous and perish with the columnar stem. The spadix is drooping, the spathes ovate-lanceolate, imbricated. It has remarkably large seeds. The bracts, which are very large, are persistent. The sap, unlike that of the other bananas, is colored.

Musa ornata Roxb. (C. A. No. 5077).

(Plate VIII, Figs. 79, 80, 85, 86, 90, 91, 94, 95.)

Producing 10 or more flowering stems in a stool, reaching a height of from 150 to 210 cm. each having a diameter of from 8 to 10 cm. The trunk is rather slender, cylindrical, of almost upright growth; of deep green color, blotched with black.

The leaves are narrow, linear, very thin, lanceolate, with tip acute, both sides smooth and below shiny. The mature blade measures from 110 to 125 cm. in length and 30 to 33 cm. in width, and is green in color. Petioles long and slender, very glaucous, green in color, shallowly grooved, widely channeled, margin garnet brown. The midrib is pale whitish green and of same color as petiole and is shaded with rose pink.

The heart is lanceolate, with an acute tip, erect on the plant, spadix and spathes erect; of very fine pink color on the outside, white inside with light pink lines; apices of bracts are of light orange yellow color.

The inflorescence is short, sterile flowers not far from the fertile flower. In color the male and the female flowers are alike. The flowers (Plate VIII. Figs. 79, 80, 85, 86, 90, 91, 94, 95) are small and of cadmium orange color gradually becoming whitish as they approach the base, loosely arranged; 4–5 in a fascicle. The length is from 4.8 to 4.9 cm. and the width from 6 to 6.5 mm. 7 to 7.5 mm. deep, dorso-ventrally. The scale is 4 mm. shorter than the stamens and perigonium, long and white with an acute tip, much compressed and normally only tip visible; devoid of grooves. The perigonium is 4.8 to 4.9 cm. long and with short limbs, and regularly of cadmium orange color, which gradually lightens as it approaches the base; the perigonium is wide and overlaps on the venter. Sterile ovary short, light green, 4 to 5 mm. long. The pistil is hidden, very short, measuring 19 to 20 mm. in length; stigma of martius yellow color. The stamens are five in number, no sterile ones present; as long as the calyx; compact and with only tip exposed; anthers purple and base of filaments light viridine green. The fertile flowers are much larger than the sterile flowers; perigonium shorter, 3.2 to 3.3 cm. longer than that of the sterile flower and of same color; limbs of perigonium less divided, irregular in size; the scale is shorter but deeper, with grooves; apicula acuminate to cuspidate, pinard yellow; the pistil of fertile flower is larger than that of sterile, about 5 mm. shorter than the perigonium, with a large stigma of maize yellow color; the stamens are five in number, only half of the length of the pistil, white in color, denticulate and contorted.

The bunch of fruits is very small. The fruits vary in size from very small to 7.3 to 7.8 cm. long and 2.2 to 2.4 cm. wide. They vary in form, from finger-like to inflated at the middle, often with sharp angles. It produces from 5 to 6 hands to the bunch of 26 fruits, with an average number of 4 to the hand. The fruits are upright with short pedicels; the skin is light turtle green when matured and changes to lighter green approaching yellowish green when ripe; rather soft, the non-edible, tasteless, and odorless; seeds six in a longitudinal series.

This banana came from the Bureau of Agriculture with number 3179, original locality unknown. It is used for ornamental purposes only. The stools grow so fast that it requires only 6 to 7 months to flower.

Musa coccinea Andr. Red-flowered banana.
Roxburg, Flora Indica. 2: 457–488, 1824.

This species of *Musa* is an ornamental banana commonly cultivated in the Philippines. It is rather easy to grow and very often planted in tubs for decoration in corners of buildings, etc. The bright red bracts of the flowers are the attractive part of the plant.

Musa textilis Nee.
Teodoro, N. G. *Philippine Journal of Science, Section C* 10: 388–389. 1915.

Musa errans (Blanco) Teodoro, Saguing Maching, Saguing na ligao (Tag.)
Teodoro, N. G. *Philippine Journal of Science, Section C* 10: 390–391. 1915.

Musa errans (Blanco) Teodoro var. *botoan* Teodoro. Butuhan, Butuan (Tag.) Lisohan (Vis.)
Teodoro, N. G. *Philippine Journal of Science, Section C* 10: 391–392. 1915.

Musa errans (Blanco) Teodoro var. *basilisae* var. nov.
(Plate VIII, Figs. 83, 84, 92; XII, 206–207; XXIX, 1).

This particular Musa came from Vilmorin, Paris, through the Bureau of Agriculture, No. 1397. In stooling, habit of growth, and the character of the leaves it is very much like *Musa errans* (Blanco) Teodoro var. *botoan,* but it differs a great deal in the floral parts. It is not much used for food owing to the number of seeds, but is rather delicate in taste.

Producing from 15 to 21 flowering stems in a stool. The mature plant reaches a height of from 335 to 345 cm. and the base has a diameter of from 22 to 25 cm. The trunk is cylindric, usually smooth and deep green in color. The plant as a whole is very much like Botoan in stooling as well in other stem characters. The leaves are similar to Botoan in many respects, except that the base instead of being subtruncate as in the case of Botoan is somewhat round. The mature blade is from 184 to 218 cm. long and 52 to 57 cm. wide. The petiole is quite deeply grooved, measuring from 55 to 64 cm. in length. Midrib nearly like that of Botoan.

The spathe is pendant, drooping quite abruptly. The heart is cordate, of pink color with yellow stripes on the outside and deep pink inside with martius yellow margin. Bracts persistent, the apices pointed.

The flowers are arranged in 2-rowed fascicles. They vary from 5.6 to 6 cm. long; 6.5 to 8 mm. wide and 7 to 8 mm. deep. The scale is carneo pink with white apex; apex apiculate; tetra-cuspidate; 2.2 to 2.3 cm. long and 5 to 6 mm. wide, quite folded at the upper portion, slightly lanceolate in form with the base serrated. The perigonium is 4.9 to 5.2 cm. long, not inflated, a little lighter in color than the scale, limbs short and quite folded instead of curled, baryata yellow in color and rather elongated-oblong. The pistil is from 3.4 to 3.6 cm. long, slightly curved towards the outside; stigma rounded, slightly acerose, light brown in color. The stamens are much longer than calyx, five in number, no sterile ones, rather irregular in arrangement; anthers of straw color.

The fruits are oblong in shape with apex rather short; rhachis curved and medium in length; calyx persistent; style deciduous; usually 5-angled and marked; seeds rough and plentiful, toothed and with grooves, dark brown in color. The skin is bice green to light chalcedony yellow when ripe; the flesh is white, not juicy, rather delicate in taste, but spongy and dry. For food they are not good but can be used for vinegar manufacture because of their sweetness. It produces an average of 13 hands to the bunch, numbering from 240 to 246 fruits, averaging 16 to 18 fruits to the hand. The weight of the fruits, excluding the rachia, is from 12.2 to 12.62 kg. It takes practically one year to mature from the time of planting.

Musa humilis Perr. Pitogo, Tag.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**: 392–393. 1915.

Musa sapientum L.

Producing from 4 to 14 flowering stems in a stool. Trunk cylindrical, slender, slightly enlarged at the base, usually green or yellowish, often spotted with reddish brown to black patches, reaching a height of from 200 to 500 cm. with a diameter of from 12 to 25 cm.; erect or declining; weak or strong.

The leaves are elongate-elliptic, oblong lanceolate, oblong, or linear oblong, often smooth and shiny on the upper surface, waxy in some varieties, apex rounded or obtuse, base rounded, subtruncate, acute, etc., often with margin red, scarlet to garret brown or straw color. The length of the mature blade varies from 200 to 270 cm. and the width is from 50 to 80 cm., very light green especially in the young plants. Petiole measuring from 35 to 78 cm. scalloped above in cross section, deep or shallowly channelled; margins from red to scarlet; shaded with light pink in some varieties.

The inflorescence is pendant, with fertile flowers toward the base and the sterile flowers toward the apex. Bracts are reed yellow, dark lavender, brownish vinaceous and varying from pale pink to somewhat brownish pink, ovate, elongate-lanceolate or oblong-lanceolate, the inside is either reed yellow or red. The time of blooming varies, some requiring six months while others require nearly two years.

The male flowers are arranged in dense 2 rowed fascicles, in 3-ranked spirals. Size varies from 5 to 9 cm. long and from 1 to 2 cm. wide. Perigonium (calyx) is long, tubular, boat-shaped, open, spreading, apex 5-toothed, 2 inside usually shorter, limbs curved and coiled. Scale thin, often scarious margined, ovate, lanceolate, oblong, or subovate, etc., white in some varities, pink or purple in others; apex often acute, cuspidate, coiled outward or inward; shoulders entire; usually deciduous, some persistent, bases rounded. Stamens usually five, the sixth rudimentary or undeveloped and short; usually longer than the pistil, campanulate, filaments usually longer than anthers. Pistil usually shorter than the stamens and perigonium, erect and recurved, salient or not salient; stigma rounded or lobed, apiculate, brain-shaped, heart-shaped, or oblong, etc.

We often distinguish one variety from another by the fruit characters. They exhibit different sizes, from 10 to 30 cm. long; in form they vary, cylindrical, oval, elongated, elliptical, subtruncate, etc.; cross section angular or rounded; from 25 to 300 or more fruits to the bunch; they are either compact or loose in the bunch from an angle of 45° to the vertical, to almost erect; some are curved while others are straight; pedicel short, curved, straight or sessile. The skin is thick to very thin, soft, rough or firm; color varies a great deal, some ripening while green, others changing from light bordeaux to antimony yellow, usually from green to yellow, orange, or purple; the flesh is white to yellow, or deep orange, seeds usually absent, if present, not many; flavor sweet or sour, dry or juicy. Varieties mostly used for food. Sometimes the stem may be utilized for fiber purposes, but it is inferior to *Musa textilis* in quality.

Some of the plants are good stoolers while others are poor. The species is not known in a wild state. Linneaus includes in his *Musa sapientum* L. all edible and seedless bananas.

SYNOPSIS OF PHILIPPINE VARIETIES OF MUSA SAPIENTUM L.

I. Fruit usually sub-cylindric, cylindric oblong, obovate, lanceolate, compressed, lanceo-ovate, ovate, etc.; angles disappearing at maturity; without seeds; flesh mealy, creamy, juicy or spicy; non-fibrous; usually devoid of core, plants of medium size or small.

- $1.^1$ Scale sub-oblong; apicula of scale introrse, base blunt and involute.
  - $2.^1$ Apicula of scale reclinate; stamens much longer than the perigonium.
    - $3.^1$ Pistil salient, as long as the stamens; stigma irregularly grooved. Fruit gladiate, short pedicelled; apex acute, narrowed; style and calyx deciduous.................... Var. *gladiata* var. nov. Kileng.
    - $3.^2$ Pistil enclosed by stamens, not salient, length 3.4 to 3.6. Fruit oblong, compressed with more or less pointed apex, pedicel quite long; style and perigonium deciduous. Var. *oanga* var. nov. Oanga.
  - $2.^2$ Apicula of scale salient; smooth and not serrated; shoulder of scale quite rugate near apical portion tumescent; pistil slender, 4.8 to 4.9 cm. long; stigma triheaded, stamens longer than perigonium and pistil, fruit cylindrical, 5-angled and quite prominent, apex quite short, skin scabrous, style and calyx deciduous. Var. *klum* var. nov. Klum.
  - $2.^3$ Apicula of scale bent horizontally, very acute and rugose, somewhat compressed and slightly inflated near the middle; pistil 3 to 3.1 cm. long; reclined, much shorter than stamens and perigonium; stigma 3-lobed and elongated; fruit cylindrical, pedicel narrowed, apex abruptly acute, cross section nearly rounded, angles not marked; style persistent, calyx deciduous. Var. *tombak* (Blanco) Tinumbaga.
- $1.^2$ Scale oblanceolate depressed; apicula of scale hooked ventrad, three-lobed.
  - $2.^1$ Fruits cylindrical, base large and tapering; tip short and not acute, and pedicel long, length 10.5 to 11 cm. calyx and style deciduous, fruit approaching the shape of that of Inarnibal, angles five, not very marked; cross section 3-celled; sour in taste; maize yellow flesh; good stooler, 14 to 24. Var. *misi*, var. nov. Misi Luki.
  - $2.^2$ Fruits slightly curved; oblong, subcylindric; 12 to 16 cm. long; base nearly as long as the tip; not tapering, nearly uniform; apex quite blunt and pedicel short, 5-angled, marked but not very sharp edges; flesh from light yellow to orange yellow; spicy odor; sweet in taste.... Var. *lacatan* (Blanco) Teodoro. Lacatan.

1.[3] Scale oblong.

2.[1] Apicula of scale long and pointed, slightly serrated on one side or on both, straight.

3.[1] Scale depressed; pistil shorter than the stamens; stamens campanulate.

4.[1] Scale with four sinuses. Fruit oblong, cylindric, cross section nearly round, long and filled up to the apex, nearly rounded, 18.2 to 18.7 cm. long; pedicel quite long; style deciduous; skin thin; flesh pulpy,[1] marguerite yellow, almost white; mild subacid in taste; odorless................ Var. *dool.* var. nov. Dool.

4.[2] Scale with two sinuses. Fruit lanceolate, not cylindric, cross section, irregular, 4–5 angled; 9.5 to 9.8 cm. long; pedicel short and apex quite long; style and calyx persistent; flesh juicy, not fibrous pleasant odor similar to *Nanka,* naples yellow.. Var *sision* var. nov. Sisi-on

3.[2] Scale not depressed, slightly inflated, somewhat acerose; sinuses not very marked, one or two if present. Pistil shorter than the stamens, stamens quite uniform and nearly as long as the perigonium; bracts primrose yellow.

4.[1] Heart ovate. Fruit linear oblong, subcylindric and slightly curved; 3-angled; and almost disappearing at maturity, 6.2 to 7.6 cm. long; stigma five-headed and nearly funnel-shaped; apex of fruit quite long and pedicel as long as apex; flesh light cream; sweet and slightly subacid; slightly coarse in core; skin thin; style persistent; calyx deciduous; cross section 3-celled................................ Var. *putian* var. nov. Puttean.

4.[2] Heart lanceolate. Fruit elongate-oblong, apex and pedicel very short and former blunt, base larger than the apex, angles very marked and sharp, usually five; 7.2 to 7.4 cm. long; stigma 2-headed and recurved a little; flesh white, smooth and fine texture; mid-subacid in taste. Var. *eda.* var. nov. Eda an.

2.[2] Apicula of scale shorter.

3.[1] Surface of scale deeply depressed; pistil shorter than the stamens.

4.[1] Scale tricuspidate; fruit somewhat curved; markedly angular; 5-angled; pedicel short.

5.[1] Apex of fruit marked; style persistent; three-lobed.
Var. *saloor* var. nov. Saloor.

5.[2] Apex of fruit blunt and subacute; style deciduous.
Var. *canara* Teodoro. Canara.

4.[2] Scale decacuspidate; fruits very compact in the bunch, base short and pointed, apex markedly inflated, slightly subcylindric; style deciduous, calyx persistent; heart cordate; bracts primrose...................... Var. *sarocsoc* var. nov. Sarocsoc.

3.[2] Surface of scale shallowly depressed; scale with many apices, deformed; stamens shorter than the calyx; pistil shorter than stamens.

4.[1] Pistil curved and hooked near stigma; stigma funnel-shaped; fruit resembling *latundan;* style persistent; calyx deciduous.
Var. *galatayan* var. nov. Galatayan.

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[1] Ridway, Robert. Color Standards and Color Nomenclature with Plates, Washington, D. C. 1912.

4.[2] Pistil erect, large; stigma rounded; fruits angular, not compressed; usually 4–5 angled; apex blunt and both style and calyx deciduous........ Var. *chuntara* var. nov. Hum Chuntara.

1.[4] Scale obovate.

2.[1] Pistil longer than stamens and perigonium; fruit slightly curved, pedicel long, apex marked usually 5-angled, calyx and style deciduous; stamens irregular, loose, shorter than the perigonium.

3.[1] Apicula of scale acuminate, with three conspicuous sinuses; surface of scale deeply depressed; sides not serrated; stigma 3-lobed and nearly rounded. Trunk is pale yellow with dark brown or black patches; fruits readily edible, white colored flesh, slightly subacid, skin smooth and light yellowish green.
Var. *cinerea* (Blanco) Teodoro. Latundan.

3.[2] Apicula of scale acute, broad at the base; sides somewhat serrated; 2-shouldered; surface of the scale very much inflated; scrobiculate and rugose at middle portion. Trunk dark green; usually fruit not readily edible; skin rough and spinach green, flesh capucine buff with some pale orange, rather tasteless.. Var. *pelipia* var. nov. Pelipia.

2.[2] Pistil as long as stamens and perigonium or nearly so; fruit cream colored; stem with purplish or reddish patches.

3.[1] Fruit usually sessile, reddish and purplish; scale with long apicula, with terminal rugae, greatly depressed, conspicuously sinuate and deformed.
Var. *violacea* (Blanco) Teodoro. Morado.

3.[2] Fruit short pedicelled nearly filled up, tapering, larger than *Morado;* scale not depressed, surface smooth, rugate near the base of apex........ Var. *glaberrima* (Blanco) Teodoro. Durugo.

2.[3] Pistil slightly shorter than the stamens but longer than the perigonium. Scale with two sinuses, not rugose, inflated, without depressions; apicula of scale acute; fruit short pedicelled, reddish in color skin; calyx and style persistent.
Var. *americana* Teodoro. Cuban Red.

2.[4] Pistil far shorter than the stamens and perigonium.

3.[1] Perigonium lanceolate, limbs rather short.

4.[1] Fruit oblong-ovate, tip either sessile or partly marked.

5.[1] Apicula of scale cuspidate; scale inflated and punctate near apicula, with two sinuses; fruit yellow orange when ripe, with brown dots and slightly rough, sweet; style and calyx persistent...................... Var. *inarnibal* Teodoro. Inarnibal.

5.[2] Apicula of scale acute, sides serrated, scale three-shouldered, swollen at the middle, surface not inflated; fruit light yellow, sour in taste, juicy, smooth skin and thin as former, with prominent apex and pedicel, style deciduous; calyx persistent.
Var. *glauca* (Blanco) Teodoro. Veintecohol.

4.[2] Fruit oblong, apex and pedicel short; style and calyx persistent, ripens while green; bracts of heart read yellow.
Var. *pop* var. nov. Pop.

4.[3] Fruit nearly kidney-shape, apex nearly tapering and angular, skin light cadmium when ripe, short-pedicelled; scale with

two discal depressions, with conspicious sinuses, tricuspidate.
Var. nov. *canaya* var. nov. Canaya.

3.[2] Perigonium ovate; limbs fairly long; fruit oblong, elongate, nearly linear subcylindric, 5-angled, long pedicelled and with rounded tip to somewhat tapering; style and calyx deciduous; scale depressed; apicula acute and slightly bent dorsal rugae deformed; with two sinuses.

4.[1] Color of the skin of the fruit apple green to mustard yellow when ripe; 11.7 to 14.1 cm. long; 1 to 2 mm. thick; smooth; flesh pale orange yellow; stigma 2-lobed.
Var. *sicsec* var. nov. Sicsec.

4.[2] Color of the skin of the fruit lettuce green to light orange yellow when ripe; 3 mm. thick; tough; flesh naples yellow; stigma 6-lobed.................................. Var. *maori* var. nov. Maori.

1.[5] Scale ovate to obovate.

2.[1] Pistil exceeding stamens and twice their length; stamens slightly longer than scale; tricuspidate, surface smooth, depressed near apicula; stigma bilobed; limbs of perigonium irregularly toothed; fruit small, 4 to 10 cm., sessile; style persistent; calyx deciduous.
Var. *cubensis* Teodoro. Apple banana.

2.[2] Pistil nearly as long as perigonium and stamens; fruit with deciduous flower parts, apex conspicuous, pedicel short, 14 to 16 cm. long, green, flesh cream-colored; scale with strong terminal rugae
Var. *suaveolens* (Blanco) Teodoro. Bungulan.

2.[3] Pistil distinctly shorter than stamens and perigonium.

3.[1] Pistil more than twice the length of the scale; scale simple, apicula not prominent, margin smooth and unbroken; inflated fruit nearly sessile, angular, long and compressed tip, skin thick, flesh light cream and slightly sour; style and calyx deciduous.
Var. *tudlong* Teodoro. Tudlong dato.

3.[2] Pistil less than twice the length of scale; scale always with well marked apicula and rugae or depressions.

4.[1] Scale without deep terminal rugae, apex curved ventrad, with broad scarious margin, suddenly broadened below; fruit slightly curved, skin thick, flesh light yellow orange and sweet, pedicel long and sharp, prominent apex, very angular, usually 4-5 and style persistent.
Var. *ternatensis* (Blanco) Teodoro. Ternate, Gloria.

4.[2] Scale with deep terminal rugae, quite inflated; apex abruptly acuminate, without scarious margins; fruits subcylindric, elongated-oblong, somewhat curved, flesh deep orange yellow, calyx and style persistent. Var. *daryao* Teodoro. Daryo.

1.[6] Scale oblong; with terminal rugae, surface depressed and much inflated; apicula serrated, acute; pistil slightly shorter than the perigonium; stamens longer than the perigonium; fruit subcylindric, elongate-oblong like *Maori* in shape, apex rounded, pedicel short; style and calyx deciduous; smaller bunch than in *Maori*, and plant not as tall.. Var. *laguma* var. nov. Láguma.

1.[7] Scale lanceolate.

2.[1] Stamens longer than the pistil and perigonium.

3.[1] Apicula of scale mucronate.

4.[1] Scale greatly depressed at center and with wavy margins; rugae not conspicuous; perigonium tubular, margins wavy and rugose; fruit 5-angled; calyx and style persistent.
Var. *tuldoc* Teodoro. Tuldoc.

4.[2] Scale not depressed, much inflated at middle; rugae quite marked, stigma brain-shaped; perigonium not tubular; fruit recurved slightly, apex and pedicelled quite prominent, conspicuously 5-angled, skin thick; calyx and style deciduous.
Var. *radja* var. nov. Pisang radja.

3.[2] Apicula of scale tricuspidate; perigonium nearly tubular.

4.[1] Limbs of perigonium long and evenly divided; stigma tetralobed.

5.[1] Fruit linear lanceolate, 11.3 to 13.3 cm. long, 2.8 to 2.9 cm. wide, subcylindric, pedicel and apex of same length, apex more or less compressed, angles disappearing at maturity, skin chartreuse yellow to amber yellow when ripe, flesh baryata yellow................ Var. *pamotion* var. nov. Pamotion.

5.[2] Fruit oblong, 13.3 to 13.7 cm. by 4.3 to 4.4 cm., apex and base tapering, pedicel short, apex truncate, similar to *Morado* in form except color of skin and stem characters; skin deep chrysolite green to mustard yellow, flesh napes yellow.................................. Var. *principe* var. nov. Principe.

4.[2] Limbs of perigonium short and unequally divided; stamens more or less compact and uniform; stigma trilobed; scale depressed at middle, with rugae; fruit 5-angled.

5.[1] Fruit subcylindric, elongate-oblong, not very angular, apex obtuse, pedicel short and almost absent, 10 to 10.3 by 2.7 to 2.9 cm., skin from kildare green to mustard yellow, flesh cream color, calyx and style persistent.
Var. *baca* var. nov. Sungay Baca.

5.[2] Fruit oblong-lanceolate, angular, apex compact and conspicuous, pedicel quite long, 13.5 to 15. by 4.0 to 4.5 cm.; skin thick, deep turtle green to colonial buff when ripe, flesh rather dry and white, calyx and style deciduous.
Var. *nam* var. nov. Nam Chang Rai.

5.[3] Fruit subcylindric, somewhat kidney-shape, apex tapering to nearly round and blunt, pedicel long, 13.2 to 14.3 cm. by 3 to 3.2 cm., skin medium thick, absinthe green to reed yellow when ripe, flesh white and succulent.
Var. *yanaikonban* var. nov. Yanaikonban.

3.[3] Apicula of scale polycuspidate, short and acute, rugate; limbs of perigonium short and curled.

4.[1] Scale not depressed, inflated evenly; fruit subcylindric, oblong-lanceolate, apex as long as pedicel and marked, with very long rachis, 13.5 to 14 by 3.5 to 3.6 cm., slightly subacid and rather dry... Var. rachidis var. nov.

4.[2] Scale depressed near the base of apicula; heart cordate; fruit oblong-ovate, similar to Inarnibal in form and color characters, sweet and succulent, apex more or less rounded.
Var. *dinalaga* var. nov. Dinalaga.

2.[2] Stamens far shorter than the perigonium and pistil or somewhat shorter.

3.[1] Apicula of scale, tricuspidate or nearly so.

4.[1] Scale greatly depressed near apicula, rugose with two to three sinuses.

5.[1] Perigonium broad, margins wavy and rugose; stigma swollen and slightly curved, tetra-lobed; fruit 13.1 to 13.3 by 4 to 4.2 cm., lanceolate-oblong, blunt apex, pedicel very short and angles quite conspicuous, 5-angled cross section 3-celled, skin rather thick, lettuce green to apricot yellow when ripe, flesh deep cream color, juicy and odorless, slightly sweet; style persistent and calyx deciduous.
Var. *raines* var. nov. Raines na puti.

5.[2] Perigonium tubular, margins entire and without rugae, limbs not as long and evenly divided; stigma funnel-shaped; fruit finger-like, slightly sub-cylindric, angles disappearing at maturity, with distinct tip, pedicel quite long, 9.5 to 11.2 by 2.3 to 2.8 cm., the skin is medium thick, viridine yellow when ripe, flesh with peculiar spicy taste and odor, maize yellow in color; style persistent and calyx deciduous.
Var. *cochinchinensis* var. nov. Chuoi Ticu Huong.

4.[2] Scale inflated, without depressions, with one sinus, deformed; stigma bilobed; style slightly curved; margins of perigonium rugose, limbs long; fruits sub-cylindric, lance-ovate, tips compressed, marked, as long as pedicel; 11 to 11.3 cm. by 2.5 to 3.2, flesh with peculiar mint taste, white in color, skin thin, biscay green to naples yellow when ripe, calyx and style persistent. Var. *kinamay* var. nov. Kinamay dalaga.

3.[2] Apicula of scale tetra to hexacuspidate; scale without repressions, inflated, with one sinus.

4.[1] Apicula of scale hooked ventrad; stigma erect, slender; fruit angular as in Ternate, pedicel long, apex rather tapering and blunt, no distinct apical shoulder, 13.5 to 13.8 by 4 to 4.2 cm., skin is rather thick, light green to primuline yellow when ripe, flesh cream color, style persistent, calyx deciduous.
Var. *angao* var. nov. Angao.

4.[2] Apicua of scale turned upward, point slightly curved dorsad; pistil slightly coiled at the apex, stigma almost rounded; fruit with distinct tip and long pedicel, 13.2 to 13.6 by 4 to 4.3, skin quite thick, from kildare green to light buff yellow when ripe, flesh white, seeds quite numerous, grooved and rounded.. Var. *katali* var. nov. Katali.

II. Fruit strongly angled at maturity, sides strongly compressed, oblong-oval, lance-ovate, usually five-angled, pedicel long, apex tapering and narrowed; commonly with a few seeds, flesh spongy and filamentous, with more or less defined core; plant usually dark-green; leaves glaucous; stem strongly wind resistant; plants usually very large. *Saba type.*

1.[1] Pistil longer than the stamens, stigma more or less rounded; cracks on skin few.

2.[1] Scale broadened at the apical two-thirds.

3.[1] Apicula small and simple, with deep depression near base of apicula....................... Var. *compressa* (Blanco) Teodoro. Saba.

3.[2] Apicula quite broad, irregular and deformed, with rugae, shoulders of scale irregular and conspicuous; fruit shorter than *Saba,* apex much shorter, pedicel very long; plant not erect, inclined. Var. *khai* var. nov. Khai Pet.

2.[2] Scale not broadened at the apical two-thirds, with depressions, nearly lanceolate, with rugae, apicula acute; fruit very glaucous giving characteristic silver white colored skin, apex of fruit acute and very tapering.. Var. *krie* var. nov. Krie.

1.[2] Pistil slightly shorter or of the same length as the stamens; scale depressed, almost oblanceolate.

2.[1] Apicula of scale short and acute, with one sinus; fruit longer than Khai Pet but similar in form, skin forest green to wax yellow when ripe; style and calyx deciduous, plant not erect. Var. *yan* var. nov. Yan Vat Ching.

2.[2] Apicula of scale long, pointed, sharp, with three conspicuous sinuses; fruit compressed, wider and longer than *Yan,* apex tapering, skin biscay green to apricot yellow when ripe. Var. *padilat* var. nov. Padilat.

III. Fruit usually lanceolate with more or less pointed apex and tapering abruptly, pedicel curved and long; 5-angled, not compressed as in *Saba* type, commonly without seeds, core distinct; pistil longer than stamens and perigonium; stigma nearly rounded. *Saba Iloco type.*

1.[1] Flowers more or less compressed; scale lance-ovate, not broadened at the apical two-thirds, apicula simple and acute, sinuses 3 and prominent... Var. *garangao* Teodoro.

1.[2] Flowers more or less swollen; scale obovate, swollen at two-thirds of apicula, deeply grooved at or near apicula; tip broadly acute, not sharp, sinus one................ Var. *grandis* Teodoro. Sabang Iloco.

IV. Fruit 5-angled, not compressed, sides evenly divided or cylindric to subcylindric, skin very rough, with cracks and longitudinal slits, dark in color, almost bottle-shaped, with conspicuous head.

1.[1] Scale ovate, with longitudinal depressions at the center; apicula tricuspidate short, sharp, perigonium broadened at the apex; pistil longer than the stamens and perigonium; fruit cylindric, skin rough, dark chocolate in color, with numerous cracks, usually coriaceous, tip tapering and without distinct shoulders, pedicel medium in length; style and calyx deciduous. Var. *subrubea* (Blanco) Teodoro. Hanatuco Morado.

1.[2] Scale oblanceolate.

2.[1] Base of apicula very much inflated; apicula acute, apex not twisted; pistil shorter than the stamens, stigma somewhat rounded and lobed; fruit subcylindric with few cracks, pedicel long and tip though tapering has quite distinct shoulder, angular not conspicuous; style and calyx deciduous. Var. *hazara* var. nov. Hazara.

2.[2] Base of apicula not much inflated or inflated uniformly, apex acute and twisted; fruit almost as long as stamens and perigonium; angles conspicuous; not compressed, bottle-shaped, with distinct neck, pedicel long; style persistent and calyx deciduous. Var. *maduranga* var. nov. Maduranga.

V. Fruits adnate, compressed at the base and swollen at the apex, apex blunt; scale obovate, simple with no apicula, style and calyx deciduous; *Inabaniko type.* Var. *flabellata* var. nov. Inabaniko, Binendito.

Synopsis of Philippine varieties of Musa sapientum L. based on fruit characters alone.

1.[1] Fruits adnate in hand, compressed at the base swollen near the apex, hands fan-like in form; size 10 to 13.8 by 3 to 4 cm.
Var. *flabellata* var. nov. Inabaniko.

1.[2] Fruits not adnate in hands, separate at maturity..

2.[1] Fruits cylindrical or subcylindrical, cross section rounded or nearly so, angles not very marked.

3.[1] Skin light bordeaux when fruits are young; slight violet red when matured; fruit elongate-oblong; tip long and tapering, size 13 to 13.2 by 2.8 to 3 cm............ Var. *tombak* (Blanco). Tinumbaga.

3.[2] Skin light yellowish green to deep green when matured.

4.[1] Skin rough, with cracks and thick, and light greenish brown when young, size 16 to 18 cm. by 5 to 6 cm.
Var. *subrubea* (Blanco) Teodoro. Hanatuco morado.

4.[2] Skin smooth and without cracks.

5.[1] Fruits ripening green in color.

6.[1] Fruit oblong to almost obovate, pedicel short, apex nearly round, size 6.5 to 7.6 by 3.1 to 3.5 cm.
Var. *pop* var. nov. Pop.

6.[2] Fruit at a right angle to the rhachis, straight, flesh pulpy and coarse and milk subacid in taste, skin marguerite yellow to almost white when mature; style persistent, 18.2 to 18.7 cm. in length................ Var. *dool* var. nov. Dool.

6.[3] Fruits not at right angles, curved, style deciduous, flesh juicy, soft, cream color, sweet and melting, 14 to 16 by 3 to 4 cm.... Var. *suaveolens* (Blanco) Teodoro. Bungolan.

5.[2] Fruits yellow to deep orange yellow when ripe.

6.[1] Apices of fruits not distinct, rounded or nearly so, style and calyx deciduous.

7.[1] Fruits 3.7 to 15.6 cm. by 4.4 to 4.7 cm., skin lettuce green to light orange yellow when ripe, flesh naples yellow, lacking flavor and dry, odorless, seeds absent.
Var. *maori* var. nov. Maori.

7.[2] Fruit 11.8 to 12.5 cm. by 4 to 4.1 cm., skin light bice green to mustard yellow when ripe, flesh cream color very delicate, soft, sweet, seeds sometimes present.
Var. *languma* var. nov. Languma

6.[2] Apices of fruits distinct, tapering short, no distinct shoulder and abruptly acute.

7.[1] Color of fruits same as Latundan, style persistent and calyx deciduous, flesh white and slightly subacid, soft, 11 to 11.5 by 3.5 to 3.8 cm.
Var. *galatayan* var. nov. Galatayan.

7.[2] Color of fruits apple green to mustard yellow when ripe, flesh, pale orange yellow, rather coarse; calyx and style deciduous, 11.7 to 14.1 by 3.9 to 4.3 cm.
Var. *sicsec* var. nov. Sicsec.

6.[3] Apices of fruits with distinct shoulder, somewhat tapering and not abruptly acute.

7.[1] Flesh aciduluos.

8.[1] Fruit linear, oblong.

9.[1] Skin very thin, nearly adherent, light yellowish green when ripe, flesh soft and melting; style persistent, size 7 to 10 by 2.5 to 3.5 cm.
Var. *glauca* (Blanco) Teodoro. Veintecohol.

9.[2] Skin medium thick, not adherent, lettuce green to mustard yellow when ripe, flesh rather firm, style and calyx deciduous, size 10.5 to 11 cm.
Var. *misi* var. nov. Misi Luki.

8.[2] Fruit slightly curved, style persistent, skin yellow when ripe, flesh white, size 10 by 4 cm.
Var. *cubensis* Teodoro. Cuban Red.

7.[2] Flesh sweet and slightly sub-acid.

8.[1] Apex bent and quite long, lanceolate, calyx and style persistent, 11 to 11.3 cm. by 2.5 to 3.2 cm. skin, biscay green to naples yellow when ripe, flesh white, peculiar mint flavor, slightly odorous.
Var. *kinamay* var. nov. Kinamay Dalaga.

8.[2] Apex not bent, linear and short; 10 to 12 cm. long and skin medium thick.

9.[1] Fruit elongate oblong, light orange yellow flesh, skin thick and part of the skin adherent, sweet and melting and slightly firm, pale orange yellow in color, size 12 to 16 by 3 to 4 cm.
Var. *lacatan* (Blanco) Teodoro. Lacatan.

9.[2] Fruit elongate oblong; white soft flesh and light yellow skin when ripe, acidulous sometimes when harvested old, size 10 to 12 by 3.5 to 4.5.
Var. *cinerea* (Blanco) Teodoro. Latundan.

8.[3] Apex short and nearly tapering, fruit small, oblong-ovate, skin very thin and adherent, sweet flesh and light cream in color, melting and juicy, size 10.2 to 10.4 by 3 to 3.1 cm.... Var. *dinalaga* var. nov. Dinalaga.

6.[4] Apex long and tapering; fruits loosely arranged, pulp firm.

7.[1] Fruit 13 cm. by 3. cm., pulp reddish yellow when ripe, skin slightly green to pinard yellow when ripe.
Var. *daryao* Teodoro. Daryao.

7.[2] Fruit 11.3 to 13.3 by 2.3 to 2.9 cm. chartreuse yellow to amber yellow when ripe.
Var. *pamotion* var. nov. Pamotion.

2.[2] Fruits with cross section nearly triangular, linear-oblong, slightly curved, apex quite long, not tapering marked shoulder, flesh light cream, sweet and slightly sub-acid, skin thin, lettuce green to mustard yellow when ripe; style persistent; deciduous, size 6.2 to 7.6 cm. long.. Var. *putian* var. nov. Putian.

2.[3] Fruits angular at maturity, sides flattened and sometimes with rounded sides.

3.[1] Fruits flat or nearly so, usually 5-angled.

4.[1] Fruits with silvery white skin, tip rather tapering and no distinct shoulder, size 12.5 to 15.2 by 3.9 to 4.3 cm.
Var. *krie* var. nov. Krie.

4.[2] Fruits more or less square in cross section, large and with distinct apex and shoulder, bottle like in form, size 21 to 23.5 by 4.6 to 4.7 cm.

Vars. *maduranga* and *hazara* vars. nov. Hazara and Maduranga.

$4.^3$ Fruits flat and compressed, tip tapering, no distinct shoulder.

$5.^1$ Pedicel very long; size 8.5 to 12 by 2.5 to 3.8 cm.; 12.6 to 12.8 by 4.4 to 4.5 cm.

Vars. *yan* and *khai* vars. nov. Yan Yat Ching and Khai Pet.

$5.^2$ Pedicel short to medium.

$6.^1$ Fruits 17 to 18 cm. by 5 to 6 cm., skin yellow when ripe, seeds present.... Var. *compressa* (Blanco) Teodoro. Saba.

$6.^2$ Fruits 21 to 22 cm. by 6 to 8 cm., skin deep green to yellow when ripe, flesh reddish white.

Var. *grandis* Teodoro. Sabang Iloco.

$6.^3$ Fruits 18 to 20 cm. by 5 to 7 cm., slightly glaucous pulp cream in color.

Vars. *garangao* and *binutig* Teodoro. Garangao and Binutig.

$6.^4$ Fruits 16 to 18 cm. by 4.3 to 5.6 cm., skin biscay green to apricot yellow when *ripe*. var. *padilat* var. nov. Padilat.

$3.^2$ Fruits not flat obovate, base tapering and near to apex enlarged, very compact in the bunch, 8.5 to 9.7 cm. by 2.7 to 3.1 cm., skin lettuce green to apricot yellow when ripe, flesh light orange yellow, calyx and style persistent, angles very prominent. Var. *sarocsoc* var. nov. Sarocsoc.

$3.^3$ Fruits linear oblong, pedicel abruptly curved and short.

$4.^1$ Calyx and style deciduous; skin spinach green with some javel green towards the side to light orange yellow with red and scarlet when ripe, thick, coarse and stringy; 15.7 to 15.9 by 4.2 to 4.4 cm .... Var. *pelipia* var. nov. Pelipia.

$3.^4$ Fruits much curved ventrad, sharp and blade like; style and calyx deciduous.

$4.^1$ Skin light green to reed yellow when ripe; 15.7 to 18.3 cm. by 4.5 to 4.8 cm. flesh deep cream color, sweet with peculiar odor.. Var. *gladiata* var. nov. Kileng.

$4.^2$ Skin light bice green to cadmium when ripe; flesh light orange yellow, lacking in flavor and rather sub-acid, odorless; 9.8 to 14 cm. by 3.5 to 4.9 cm................ Var. *canaya* var. nov. Canaya.

$3.^5$ Fruits finger-like and linear, but long and pointing upward, pedicel almost sessile, skin light greenish yellow to yellow when ripe, size 15 to 16 by 3 to 4 cm.... Var. tudlong Teodoro. Tudlong dato.

$3.^6$ Fruits finger-like and much curved, distinct apex and pedicel, 9.5 to 11.2 cm. by 2.3 to 2.8 cm., pointing at angle nearly 45°.

Var. *cochinchinensis* var. nov. Chuoi Ticu Huong.

$3.^7$ Fruits short; style and calyx persistent.

$4.^1$ Size 9.5 to 9.8 cm. long; lanceo-ovate in form; cross section of fruit 3-celled, angles of fruits irregular.

Var. *sision* var. nov. Sisi-on.

$4.^2$ Fruits elongate oblong, pulp white.

$5.^1$ Size 7.2 to 7.4 cm. long; angles very irregular.

Var. *cubensis* Teodoro. Apple banana.

$4.^3$ Fruits short as above, usually 4-5 angled and marked but not compressed, apex blunt and with distinct shoulder; style and

calyx persistent; skin thick crysolite green to mustard yellow when ripe; 10.6 to 11 by 3 to 3.2 cm.
Var. *chuntara* var. nov. Hum Chuntara.

3.[8] Fruits linear-oblong.

4.[1] Cross section of fruit nearly round and similar to Klum; style and calyx deciduous; apex as long as pedicel; 13.5 to 14 cm. by 3.5 to 3.6 cm.; skin and flesh similar to Klum.
Var. *rachidis* var. nov.

4.[2] Cross section 5-angled; with outward side marked and sharp; apex obtuse and blunt and pedicel nearly sessile; calyx and style persistent; 10 to 10.3 by 2.7 to 2.9 cm.; skin kildare green to mustard yellow when ripe.... Var. *baca* var. nov. Sungay baca.

4.[3] Cross section practically 4-angled; compressed; apex and shoulder marked; pedicel longer than the tip; style and calyx deciduous; skin chromium deep to wax yellow ripe; 18.5 to 20 cm. by 3.8 to 4.1 cm.. Var. *oanga* var. nov. Oanga.

3.[9] Fruits narrowly oblong, declinate apex tapering and nearly round and blunt, pedicel long, style persistent and calyx deciduous, 13.2 to 14.3 cm. by 3 to 3.2 cm., resembles Bungulan in form but smaller, skin absinthe green to reed yellow when ripe, flesh white succulent........................ Var. *yanaikonban* var. nov. Yanaikonban.

3.[10] Fruits broadly oblong, apex blunt or nearly so, slightly curved, pedicel short.

4.[1] Skin purple to red.
Vars. *glaberrima* and *violacea* (Blanco) Teodoro. Morado and Durugo.

4.[2] Skin green to deep green.

5.[1] Fruits ovate-lanceolate, cross section 5-angled, not very marked, somewhat tapering, without very distinct shoulder, pedicel quite short.

6.[1] Style persistent and calyx deciduous; 11.8 to 12.3 cm. by 4.1 to 4.3 cm.; skin is lumiere green to mustard yellow when ripe; flesh cream color............ Var. *saloor* var. nov. Saloor.

6.[2] Style and calyx persistent.

7.[1] Fruits 10 to 11 by 2 to 2.5 cm., pulp is solft and white when ripe, like Latundal.
Var. *americana* Teodoro. Cuban Red.

7.[2] Fruits smaller than the Cuban Red and slightly larger than the Inarnibal, tip slightly tapering and wider toward the sessile base, pulp is cram color, fine palatable.
Var. *tuldoc* Teodoro. Tuldoc.

5.[2] Fruits very regular, with all sides flat and sharp on one side, with more or less distinct apical shoulder, style and calyx deciduous, 5-angled.

6.[1] Fruits not curved, pedicel short.

7.[1] Fruits oblong-lanceolate, 13.5 to 15 cm. by 4 to 4.5 cm., skin deep turtle green and colonial buff when ripe, seeds absent........................ Var. *nam* var. nov. Nam Chang Rai.

7.[2] Fruits oblong-elongate, 13.3 to 13.6 cm. by 4 to 4.3, skin kildare green to light buff yellow, seeds present grooved and rounded............................ Var. *katali* var. nov. Katali.

7.[3] Fruits lanceolate, apex short, cross section irregular and many celled........................ Var. *canara* Teodoro. Canara.

6.[2] Fruits recurved, pedicel long, skin thick, spinach green to buff yellow when ripe, flesh cream color and center orange.
Var. *radja var. nov.* Pisang Radja.

5.[3] Fruits angular, one or two sides rounded and not sharp, apex tapering and blunt end.

6.[1] Pedicel short.

7.[1] Skin deep chrysolite green to mustard yellow when ripe; 13.3 to 13.7 cm. by 4.3 to 4.4 cm.; naples yellow flesh; style and calyx deciduous.
Var. *principe* var. nov. Principe.

7.[2] Skin lettuce green to apricot yellow when ripe; flesh deep cream color; 13.2 to 13.7 cm. by 4 to 4.2 cm.; style persistent................ Var. *raines* var. nov. Raines na puti.

6.[2] Pedicel long; style persistent and calyx deciduous; skin coose green to primuline yellow when ripe; flesh cream color; 13.5 to 13.8 cm. by 4 to 4.2 cm.
Var. *angao* var. nov. Angao.

DESCRIPTION OF VARIETIES UNDER MUSA SAPIENTUM LINN.

Musa sapientum Linn. var. *gladiata* var. nov. Kileng. (C. A. No. 6678). (Plate IV, Fig. 1; VI, 39; IX, 96; X, 132–133; XIII, 1).

Producing from 9 to 10 stems in a stool. Trunk cylindrical and orange yellow, spotted with dark brown patches; measuring from 285 to 290 cm. in height with a base of from 18 to 22 cm. in diameter; of upright growth; rather slender; a poor cropper.

The leaves are oblong, of medium length, but broad; round apex; both surfaces smooth, thick, neither one glaucous or shiny; the margin is morroco red, entire and not brittle; the mature blade is from 175 to 180 cm. and from 60 to 65 cm. in width, forest green. The petiole is fairly long, measuring from 53 to 55 cm.; pale dull green yellow, with alizarine-pink at the middle.

The apical portion of inflorescence, "heart," is ovate, with tip acute. The bracts are sometimes persistent, purple black on the outside and light kaizer-brown in the inside. The flower is from 5.7 to 5.9 cm. long and 8 to 10 mm. wide; white in color; scale recurved inwards (dorsad); suboblongate; base blunt and in volute; apicula of scale reclinate; perigonium white, limbs long and five in number, of pinard yellow color. The pistil, is as long as the stamens, salient. The stigma is irregularly grooved, pale orange yellow in color. The stamens are five in number; cream in color; with pale brown anthers, shorter than calyx and as long as the pistil.

The fruits are gladiate; quite compact, inclined and bent slightly upward, 3–5 angled, measuring from 15.7 to 18.3 by 4.5 to 4.8; short pedicelled, tip quite narrowed, pistil and calyx deciduous, producing on an average 5 hands to the bunch, numbering 63 fruits, and an average of 14 to the hand, bunch weighing about 10.9 kg.; the skin is coose-green to red-yellow when ripe; rather thick, 3 to 4 mm.; flesh deep cream color, firm, with dry and sponge-like core, sweet with peculiar taste and odor; style and calyx deciduous; seeds entirely absent; a very good eating banana.

Time from planting to harvesting about 17 months and 11 days. Origin not known.

Musa sapientum Linn. var. *oanga* var. nov. Oanga, (C. A. No. 5267), Vangofi, (C. A. No. 5265).
(Plate IV, Fig. 2; VI, 40; IX, 97; X, 134–135; XIII, 2).

Producing from 4 to 5 stems; poor stooler; rather upright in grouwth, like Canaya; stem oil-green and blotched with claret-brown, reaching a height of 280 cm. with a base diameter of 18 to 20 cm.

The leaves are similar to those of Canaya in form but with apex somewhat obtuse and base rounded; mature blade measures from 190 cm. in length and 75 to 80 cm. in width; smooth and shiny on both sides, forest-green with the margin light seal-brown. The petiole is light lumiere-green; 38 to 40 cm. broad; open-channelled; margin light begonia-rose; midrib pale green-yellow and shaded with orient-pink at the middle.

The flower is 5.3 to 5.4 by 1.0 to 1.1 cm. and 0.7 to 0.75 cm. thick. Scale recurved inwards, suboblongate, 2.2 to 2.4 cm. long, 3.5 to 5 mm. wide; more or less compressed; base blunt and involute; apicula of scale reclinate. The perigonium is 5.3 to 5.4 cm. long with quite long limbs, curved inwards; empire-yellow in color; body white and lumiere-green at the base. The pistil is 3.4 to 3.6 cm. long, not salient as in *Kileng*. The stamens are longer than pistil, a little shorter than the perigonium and without sterile stamens.

The fruit is oblong, compressed, 18.5 to 20 cm. long and 3.8 to 4.1 wide, with more or less pointed tip; pedicel quite long; style and calyx deciduous; producing an average of 7 hands, upper fruits almost straight while those at the bottom are curved; the skin is thick, chromium-green to wax-yellow when ripe; flesh sweet, center quite fibrous, maiz-yellow in color, juicy and delicate astringent taste, rather subacid. Bunch weighs about 21.48 kg. Fruit with 3–4 well marked angles, seeds absent. Rather poor for eating raw but good when baked or dried.

Origin, Mamanga, Port Moresby, Papua. Bureau of Agriculture Acc. No. 3946.

Musa sapientum Linn. var. *klum* var. nov. Klum, (C. A. No. 5399). Choi Mak, (C. A. No. 5156), Chuoi La, (C. A. No. 5103).
(Plate IV, Fig. 3; VI, 41; IX, 98; X, 136–137; XIV, 1).

Producing from 14 to 16 stems, stem from 220 to 320 cm. high, with a diameter of 22 to 24 cm. at the base, pale, copiously blotched with garnet-brown, cylindrical.

The leaves are oblong, brittle, apex round and base obtuse; veins deeply channelled, smooth on both surfaces, shiny beneath and glaucous. The mature blade is cedar-green, measuring from 165 to 225 cm. in length, and with a width of from 63 to 76 cm., margin garret brown. The petiole is channelled, curved, and slender, measuring 53 to 55 cm. long, chrysolite-green with lesine-pink margin and pale green-yellow midrib.

The heart is oblong-lanceolate, and usually with 18 flowers to the fascicle; apex not very pointed; bracts brownish vinaceous on outside and uniformly coral red inside; apices of bracts, orange. The flower is from 7.6 to 7.7 cm. long. 1.0 to 1.1 cm. wide and 1.1 to 1.3 cm. deep. The scale is recurved inwards, 2.6 to 2.8 cm. long and 9 to 10 mm. wide, suboblongate; base blunt and volute; apicula of scale salient, smooth and serrated, shoulder quite rugose near apical portion, tumescent; white in color; more or less inflated at the middle; without depressions; light yellow at the base. The perigonium maiz yellow, with limbs curled outward; 7.6 to 7.7 cm. long. The pistil is slender, 4.8 to 4.9 cm. long, with cerebriform stigma (triheaded), and light orange in color. The stamens are five in number with violet pink anthers; shorter than perigonium and longer than the pistil.

The fruits are very loose in the hand, cylindrical, 5-angled, with quite prominent tip and quite short; skin scabrous; style and calyx deciduous. It produces 6 hands to the bunch, numbering from 83 to 162 fruits with an average of 13 to the hand. Fruit linear in form, 13.5 to 13.8 cm. long and 3.5 to 3.7 cm. wide; skin is absinthe-green to mustard-yellow when ripe, about 3 to 4 mm. thick; flesh is deep-cream, with the center lighter, 3-celled and distinct, rather firm, with milk flavor, odorless; a fair cooking banana but lacking in flavor, not a good eating banana when uncooked, as it is too fibrous. The seeds are absent. The bunch weighs from 3.4 kg. to 5.0 kg.

It is a rather late maturing variety and probably will not be worth very much for general culture.

This variety came from the Bureau of Agriculture No. 3464, and, as records show, originated in India.

Musa sapientum Linn. var. *tombak* (Blanco) Teodoro. Tinumbaga (C. A. No. 5405) Tombaga, Goyoran.
(Plate IV, Fig. 4; VI, 42; IX, 99; X, 138–139; XIV, 2).

Producing from 20 to 25 stems; rather a poor cropper; with slightly inclined growth, stem rather slender as in *Kileng* and the color is greenish-yellow blotched with black; height from 274 to 280 cm., with a diameter at the base of from 16 to 18 cm.

The leaves are elongate elliptic, quite upright in growth, rather crowded at the tip; upper and the lower surfaces smooth, and shiny with the lower surface glaucous. The blade is from 160 to 170 cm. long and 65 cm. wide; forest-green, with margins entire and morroco red; rather brittle; with the apex and the base rounded. The petiole is from 6.0 to 6.5 cm. long, rather small, opened-channelled, the margin is colonial-buff; middle portion is thulite-pink with the rest colonial-buff, the whole slightly shaded with pale-pink.

The heart is comparatively small, with the naked rhachis about a foot long. The sterile flower is 5.6 to 5.9 by 6 to 8 mm. by 10 to 11 mm. The scale is recurved inwards; suboblongate, somewhat compressed and slightly inflated near the middle, 2.0 to 22 cm. long and 1.5 to 2.0 cm. wide, base blunt and volute; apicula of scale bent horizontally, very acute and rugose. The perigonium is thin, with quite regular buff-yellow limbs, and more or less compressed, 5.6 to 5.9 cm. long. The pistil is 3.0 to 3.1 cm. long, somewhat protruding, much curved, shorter than stamens and perigonium; stigma three-lobed and elongated light orange yellow in color. The stamens are almost regular in arrangement, 5 in number, without sterile ones, much longer than the pistil but shorter than perigonium.

The fruit is cylindrical, pedicel narrowed, tip abruptly acute, cross section nearly rounded, angles not marked; style persistent and calyx deciduous. Fruits arranged like that of Pamotion, in form it approaches that of Pamotion but has more pointed apices; in size it is 13.0 to 13.2 by 2.8 to 3.0 cm. cross dimensions; the stalk is hairy instead of glaucous; at first when flowers begin to develop the stalk has the same color as the fruits but it gradually becomes lighter as the fruits approach maturity. The stalk is cerro-green and coated with light bordeaux colored hairs. The fruits are light bordeaux at early stages but when mature loose this color and become slightly violet-red with shades of light lumiere-green to antimony-yellow, blotched with yellow-ochre when ripe. The flesh is light orange yellow, firm and dry, quality poor to fair not acid, only fair when cooked; not very juicy. Seeds are absent. It produces from 5 to 7 hands to the bunch, numbering about 55 to 102, and an average of from 11 to 14 fruits to the hand. The bunch weighs from 3.00 kg. to 12.760 kg. It is rather an early maturing variety requiring nearly 11 months from planting; the second harvest however, was made after 13 months.

Plant from the Bureau of Agriculture, No. 2193. It is a native of Naval, Leyte.

Musa sapientum Linn. var. *misi* var. nov. Misi Luki, (C. A. No. 5171). (Plate IV, Fig. 5; VI, 43; IX, 100; X, 140–141).

Producing from 14 to 24 stems. Stem upright and usually dark green, spotted with dark brown and black patches; reaching a height of from 220 to 395 cm. with 20 to 23 cm. diameter at the base.

The leaves are oblong-elongate with tip and base rounded. The mature blade measures from 216 to 236 cm. in length and 68 to 75 cm. width; the margin is dark cress-green; the blade wavy and rather brittle; the upper surface is smooth and shiny and the lower is glaucous; young leaves characterized by pinkish-green and the midrib alizarine-pink. The petiole is from 60 to 68 cm. long and chrysolite-green; the margin Eugenian-red in color; midrib is long with upper side dotted with brown and the base chatenay-pink. The flower measures from 6.4 to 6.5 cm. long, 1.1 to 1.2 cm. wide, marguerite-yellow in color, the scale oblanceolate, depressed near sinus of apicula; apicula short and slightly curved. The perigonium is marguerite-yellow with lines of cameo-pink, limbs short and light orange-yellow. The stamens are five in number, with light brown anthers, longer than the perigonium and a little longer than the pistil.

The fruits are compact in the bunch, very similar to Dinalaga in position from 10.5 to 11 cm. in length, approaching the shape of Inarnibal, very marked; cross section three-celled, flesh maize-yellow, apex short and not acute, pedicel long, nearly oblong, calyx and style deciduous; angles five and not sour in taste, skin is medium thick, lettuce-green to mustard-yellow when ripe. Quality medium; texture velvety; flavor acid, and therefore good for vinegar and sour figs; odor slight if any. It is not even a fair eating banana and does not cook well. It produces from 9 to 10 hands to the bunch, numbering from 145 to 166 fruits, and an average of from 14 to 15 fruits to the hand. The bunch weighs from 5.600 kg. to 8.9000 kg. It takes about 15 months and 14 days to mature from planting.

Origin, Bureau of Agriculture, 3423. From Pago Pago. Tutuila, American Samoa.

Musa sapientum Linn. var. *lacatan* (Blanco) Teodoro. Lacatan.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**: 405–406, (1915).

Musa sapientum Linn. var. *dool* var. nov. Dool, (C. A. No. 4984).
(Plate IV, Fig. 6; VI, 44; IX, 101; X, 142–143; XV, 1).

Producing from 15 to 28 stems; similar to Oanga in stem character; reaching a height of from 175 to 310 cm.; diameter of the base from 20 to 23 cm.

The leaves are oblong-ovate, long and broad, tip and base acute, thin, smooth and shiny above and not glaucous beneath. The mature blade measures from 170 to 205 cm. in length and from 60 to 78 cm. in width, cedar green throughout. The petiole is held at an angle of 30°, shallowly channelled, margin scarlet-red, length from 40 to 48 cm.

The heart ovate with tip pointed, dark purple-drab on the outside and apricot-orange inside, with edges martius-yellow. The bracts are generally persistent and resemble those of the Tudlong dato and Virgen. The flower is from 7.4 to 7.8 cm. long, 1.0 to 1.15 cm. wide and 1.1 to 1.2 cm. deep, white, with base light yellow. The scale is oblong, base nearly as large as shoulder cf apicula; apicula of scale long and pointed, slightly serrated on one side, depressed, and with 4 sinuses. The perigonium is more or less compact, 7.6 to 7.8 cm. long and 1.1 to 1.2 cm. wide, with five divided yellow limbs and curved inwards. The pistil is 4.4 to 4.5 cm. long, shorter than the stamens. Stamens longer than the pistil and calyx.

The fruits are of average size, like the ordinary Bungulan, 18.2 to 18.7 cm. long, oblong cylindric, cross section nearly round, long and filled out at the apex and quite rounded; pedicel quite long, style persistent and calyx deciduous; skin thin; flesh pulpy, marguerite yellow to almost white; mild subacid in taste; and odorless. The fruits are held in the bunch at almost right angles. A fairly good eating banana except that it is a little fibrous, though good in flavor. It produces an average of 5 hands, 66 fruits to the bunch with an average of 13 fruits to the hand. The bunch weighs, approximately 11.525 kg. It is rather a late maturing variety requiring about 18 months from planting.

Origin: Bureau of Agriculture, No. 2005. From Sumilao, Bukidnon. The same variety is known as *Du-ol*, (Bureau of Agriculture, No. 2577). In Tankulan, Bukidnon, Mindanao.

Musa sapientum Linn. var. *sision* var. nov. Sisi-on (C. A. No. 5142).
(Plate IV, Fig. 7; VI, 45; IX, 102; X, 144–145).

Producing from 3 to 4 stems, a poor cropper and stooler, of upright growth, reaching a height of 240 cm. with base a diameter of 16 cm. The stem is pale yellowish-green with blotches of reddish brown and ochre.

The leaves are lanceolate, with tip and base acute. The mature blade measures from 140 to 150 cm. in length, and 57 to 59 cm. in width, lettuce-green in color, smooth above and partly glaucous below. The petiole is 49 to 61 cm. long, clear dull green-yellow with shades of light phlox-pink and with margin broad and reddish-brown in color, deeply channelled. The midrib is clear dull green-yellow, shaded at the middle with alizarine-pink which disappears as it approaches the tip. The flower is more or less compact, 6.5 to 6.9 cm long, 7 to 8 cm. wide, and 8 to 9 mm. deep. The scale is oblong, as a whole depressed, 2.3 to 2.4 cm. long and 7 to 8 mm. wide, white in color; apicula long and pointed, slightly serrated, and with two sinuses. The perigonium is white; limbs diverging and yellow. The pistil is 4.1 to 4.2 cm. long, shorter than the stamens; stigma amber yellow; style dotted with small pinkish-red spots. Stamens five in number, as long as the perigonium and longer than the pistil.

The fruits are lanceolate, not cylindrical, cross section irregullar, 4–5 angled, 9.5 to 9.8 cm. long, 2.6 to 2.8 cm. wide, pedicel short and tip quite long; style and calyx persistent. The plant produces an average of 5 hands to the bunch, numbering 74 fruits to the bunch with an average of 14 fruits to the hand. The skin is very thin and the color is from light lumiere-green to mustard-yellow when ripe; the flesh is juicy and not fibrous, naples yellow, odor pleasant, like that of Nanka, sweet and very good. Seeds absent. The bunch weighs 3.22 kg. It requires 18 months, at least, to bloom from planting and nearly 21 months to mature.

Origin: Bureau of Agriculture, No. 3327. From Looc, Capiz.

Musa sapientum Linn. var. *putian* var. nov. Puttean, Putian. (C. A. No. 5109).

(Plate IV, Fig. 8; VI, 46; IX, 103; X, 146–147; XV, 2).

Producing from 23 to 31 flowering stems, slender like Pamotion. The stem is characterized by having blotches similar to Inarnibal, reaching a height of from 210 to 230 cm. and with a diameter at the base of from 12 to 14 cm.; almost upright in growth.

The leaves are rather short, oblong-lanceolate, base acute and tip somewhat rounded, smooth on both surfaces, thin, margin is dark brown to black. The mature blade measures from 100 to 120 cm. in length and has a width of from 45 to 48 cm., light forest-green in color. The petiole is almost half the length of the blade, 54 to 63 cm. long, shallowly channelled, midrib quite short, of the same color as the petiole, and very shallowly channelled.

The heart is ovate, similar to Eda-an in color, except that the proportion of yellow is greater in the latter, apices of bracts not pointed; the inside color is similar to Eda-an, bracts primrose yellow. The flower is 5.7 to 5.8 cm. long, 7 to 8 mm. wide, and 6 to 8 mm. deep. The scale is oblong, base nearly as large as at shoulder of apicula; not depressed and slightly inflated on the surface; somewhat acerose and white in color; apicula of scale long and pointed, slightly serrated on one side or both. The perigonium is white, with limbs quite long. The pistil is shorter than stamens, 3.11 to 3.4 cm. long; stigma pale orange-yellow. The stamens are five in number, without sterile ones, nearly as long as the perigonium and longer than the pistil.

The fruit is linear-oblong, subcylindric and slightly curved, 3-angled, the angles almost disappearing at maturity, 6.2 to 7.6 cm. long; stigma five-headed and nearly funnel shape, tip quite long; pedicel as long as tip; flesh light cream, sweet and slightly subacid, slightly coarse in core; skin thin, from lettuce green to mustard-yellow in color when ripe; style persistent and calyx deciduous; cross section three-celled. The bunch is very light, comparatively small and with very small fruits. The fruit approaches the shape of Inarnibal but is more elongated and pointed. The plant produces an average of 4 hands to the bunch, numbering 43 fruits with an average of 10 fruits to the hand. The bunch weighs about .750 kg. It requires 20 months approximately to mature from planting, and therefore is a very late maturing variety. Seeds are absent. This is a delicious banana, known as Puttean in the Visayas.

Musa sapientum Linn. var. *eda* var. nov. Eda-an (C. A. No. 5974). .(Plate IV, Fig. 9; VI, 47; IX, 104; X, 148–149; XV, 1).

Producing from 16 to 28 stems almost upright in growth, and with the same color characters as the Inarnibal. It reaches a height of from 145 to 300 cm. and has a diameter at the base of from 13 to 18 cm.

The leaves are not brittle, oblong-elongate, with apex and base rounded base much broader than the apex. The mature blade measures from 175 to 198 cm. long and has a width of from 60 to 69 cm. forest-green in color, thin, shiny and smooth above and glaucous below, veins shallowly grooved. The petiole is 43 to 53 cm. long, viridine-yellow and blotched with dark brown near the base, shallowly channelled, the midrib same color as the petiole.

The heart is lanceolate, apex of bracts very pointed and of various colors; at the edges slate-violet, middle variegated with vinaceous-lilac and marguerite-yellow and the inside primrose-yellow. The flower is similar to that at Sisi-on and Putian; 6.4 to 7 cm. long, 1.0 to 1.1 cm. wide and 9 to 10 mm. deep; the scale is 2.1 to 2.3 cm. long and 6 to 8 mm. wide white in color. The perigonium is 6.4 to 7 cm., with limbs long, deep yellow in color. The pistil is 3.7 to 4 cm. long, stigma pale orange-yellow. The stamens are five in number, none sterile, 2 mm. longer than the pistil, shorter than the perigonium.

The fruit is elongate-oblong, with usually five very marked and sharp angles 7.2 to 7.4 cm. long; apex and pedicel very short, apex blunt, base larger than the apex, stigma 2-headed and recurved a little. The plant produces an average of 5 hands, numbering 81 fruits with an average of 6 to the hand; fruits held loosely, and forming somewhat larger bunch than Putian; the skin biscay-green to mustard-yellow; the flesh is white, smooth and fine in texture, flavor subacid, odor none, quality fair. The styles are conspicuously persistent and the calyx not always. Seeds absent. The bunch weighs about 1.160 kg. It requires nearly a year to mature from planting and is a fair eating banana.

Origin, Bureau of Agriculture, No. 3171. From Gigaquit, Surigao, Mindanao.

Musa sapientum Linn. var. *saloor* var. nov. Saloor. (C. A. No. 5219). Kanaibansi, (C. A. No. 5667). Susu petri, (C. A. No. 5029). (Plate IV, Fig. 10; VI, 48; IX, 105; X, 150–151; XVI, 2).

Producing from 10 to 12 stems a rather tall variety reaching a height of from 210 to 320 cm. with stem diameter at base of from 20 to 24 cm. The color markings of the stem and habit of growth resemble that of Dool.

The leaves are very similar to those of Dool in form and color characters. The mature blade measures from 210 to 240 cm. in length and 77 to 85 cm. in width. The petiole is 50 to 55 cm. long, with the same markings as in Dool but a little lighter in color.

The heart is ovate, the bracts with pointed apices overlapping each other and terminating at the end. Apices of bracts pointed with lighter color than the rest, livid brown on the outside, light coral-red in the inside, apex darker in color and base lighter, one-half of the base being sulphur yellow. The flower is 6.9 to 7.2 cm. long, 1 to 1.1 cm. wide, and 1.1 to 1.2 cm. deep. The scale is oblong, tricuspidate, with the surface depressed; sinus one, apex apiculate. The perigonium is white with yellow limbs. The pistil is 4.5 to 5 cm. long, shorter than stamens. The stamens are five in number, none sterile, longer than the pistil.

The fruit is slightly curved, angular and marked, 5-angled, 11.8 to 12.3 cm. long and 4.1 to 4.3 cm. in cross section diameter; pedicel short apex distinct style persistent, stigma three-lobed, calyx deciduous. The bunch is as large as in Pisang radja but fruits more curved, the skin is lumiere-green to mustard-yellow when ripe, quite thick; the flesh is cream color, taste resembling that of Lacatan; like Kileng in odor though not as strong, slightly sweet and fine in texture. It is a good eating banana and fairly good for cooking, though poor when boiled. The seeds are absent. It is a medium late maturing variety, requiring 19 months from planting, approximately, to mature.

Origin, Bureau of Agriculture, No. 3631. This is one of the plantains, called in India Kanaibansi and in Borneo, Susu petri.

Musa sapientum Linn. var. *canara* Teodoro. Canara.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**: 406. (1915).

Musa sapientum Linn. var. *sarocsoc* var. nov. Sarocsoc, (C. A. No. 5377).
(Plate IV, Fig. 11; VI, 49; IX, 106; X, 152–153; XVII, 1).

Producing from 6 to 8 stems; upright in growth and few stemmed at first; reaching a height from 264 to 270 cm. with a diameter at the base of from 18 to 20 cm. The stem is lumiere-green blotched all over with victoria-lake.

The leaves are brittle, medium in length, the upper surface smooth and the lower glaucous; apex gradually tapering and the base rounded.

The mature blade measures from 120 to 130 cm. in length and from 45 to 58 cm. in width, lettuce-green in color margin light seal-brown. The petiole is short, measuring from 35 to 38 cm. long of pale dull green-yellow, the margin geranium-pink and open-channelled; the midrib is pale dull green in color.

The heart is cordate, persistent, close to bunch, with short stalk; color similar to Eda-an; bracts primrose, apices somewhat rounded persistent even fruits are mature.

The flower is 6.3 to 6.5 cm. long, 9 to 10 mm. wide and 8 to 9 mm. deep. The scale is oblong, 2.5 to 2.8 cm. long and 6 to 7 mm. wide, white, inflated at the center and deeply grooved on the upper part with 2 grooves; apex acute and quite long and serrated on sides, decacuspidate, irregular and not sharp. The perigonium is maize yellow. The pistil is very small; style less than 2 mm. wide, 3.6 to 3.7 cm. long, stigma 2-groved of cream color. Stamens five in number, with none sterile, longer than pistil and shorter than perigonium, and with 2 bent outward.

The fruits are similar to that of *basilisae,* the apices being more or less enlarged, somewhat compressed at the base. The plant produces an average of 6 hands to the bunch numbering 106 fruits, with an average of 16 to the hand. Fruit measures from 8.5 to 9.7 cm. in length and 2.7 to 3.1 cm. in diameter of cross section. The skin is lettuce-green to apricot-yellow when ripe; the flesh is light orange yellow, quite tough and fibrous, the quality is poor and texture soft, delicate, stringy at center, rather starchy, lacking in flavor and odorless. It is a poor eating banana as it is too starchy. The angles are very prominent. The calyx and style are persistent. Fruit is without seeds. The bunch weighs an average of 4.500 kg. It is rather an early maturing variety, requiring one year and one month from the time of planting.

Origin: Bureau of Agriculture, No. 4756. From Goa, Ambos Camarines.

Musa sapientum Linn. var. *galatayan* var. nov. Galatayan, (C. A. No. 5376).

(Plate IV, Fig. 13; VI, 50; IX, 108; X, 154–155; XVIII, 1).

Producing from 7 to 9 stems. The plant is rather upright in growth and in this differs from the Latundan. The plant has a height of from 220 to 300 cm. and a base diameter of from 20 to 23 cm. The stem is cylindrical with dark parches. It differs from Latundan in being a better cropper and the stem being pale viridine-yellow with shades of light pink.

The leaves are oblong-lanceolate, narrowed at the apex and base, large and broad. The mature blade measures from 200 to 225 cm. in length and 60 to 76 cm. in width. The leaves have the same color characters as Latundan, with margin claret-brown. The petiole is long, very deeply channelled, and measuring from 65 to 79 cm. in length. The midrib is same as Latundan.

The flower is from 5.5 to 5.6 cm. long, 5 to 7 mm. wide and 9 to 10 mm. deep. The scale is 2.1 to 2.2 cm. long and 3 to 5 mm. wide, oblong, white, the surface smooth and with depression apex apiculate. The perigonium is white and with yellow-stray limbs, rather short. The pistil is curved and hooked near the stigma, 3.9 to 4.1 long; the stigma is funnel-shaped, three-lobed, pale orange yellow in color and with pink dots. The stamens are five in number, shorter than the perigonium none sterile, longer than the pistil.

The fruits resemble very closely those of Latundan except that they have more or less rounded apices and angles, color same as in Latundan; the style is persistent and the calyx deciduous. They measure from 11 to 11.5 cm. in length, and with cross section diameter of 3.5 to 3.8 cm. The plant produces a fairly large bunch. The number of hands to the bunch varies from 6 to 7, numbering 72 to 93, with an average of 12 to the hand. The bunch weighs from 5.460 kg. to 7.020 kg. It is quite a late maturing variety requiring about 19 months from the time of planting.

Origin: Bureau of Agriculture, No. 4776. From Silang, Cavite.

Musa sapientum Linn. var. *chuntara* var. nov. Hum-Chuntara (C. A. No. 5181).

(Plate IV, Fig. 12; VI, 52; IX, 107; X, 156-157; XVII, 2).

It is very prolific stooler, producing from 12 to 19 stems from the base, rather crowded and nearly upright in growth. The plant reaches a height of from 213 to 282 cm. and has a base diameter of from 15 to 20 cm. The stem is deep orange-green with background mostly reddish-brown and dark-red, and very resistant to wind.

The leaves are not very large drooping slightly and somewhat brittle. The mature blade is from 210 to 220 cm. long and 50 to 65 cm. wide. The color is oil-green, the surface smooth, slightly grooved and not glaucous; the apex is rounded and the base slightly rounded, the margin warm blackish-brown, the petiole is 60 to 65 cm. long, chartreuse-yellow with dark reddish-brown midrib, the midrib is chartreuse-yellow throughout.

The heart is elongate-oblong; the bracts slate-violet on the outside and light eugenia-red inside. The flowers are compact and thin, white, and from 6.2 to 6.9 cm. long to 5 to 6 mm. wide and 7 to 9 mm. deep. The scale is 2.5 to 2.6 cm. long, 6.5 to 7 mm. wide, white, oblong, apex apiculate; surface of scale smooth and with depressions. The perigonium is white with orange limbs. The pistil is erect and large measuring from 4.6 to 4.7 cm. in length, style white with some scarlet dots near the stigma; the stigma rounded and pinard-yellow. The stamens are five in number, shorter than the perigonium, longer than the pistil.

The fruits are angular and not compressed, usually 4–5 angled, tip blunt and both style and calyx deciduous, small, measuring from 10.6 to 11 cm. in length and 3 to 3.2 cm. in diameter of cross section; the skin is chrysolite-green to mustard-yellow when ripe, rather thick and smooth; the flesh is cream-colored and very fibrous with peculiar flavor and slightly sweet; odor similar to that of Kileng. It is a very good eating banana and is very delicious for table use. Seeds are absent. There are 7 to 8 hands, including 103 to 132 fruits to the bunch with an average of 16 fruits to the hand. The bunch weighs from 3.5 to 5.6 kg. It takes about 19 months to mature from the time of planting.

Origin: Bureau of Agriculture, No. 3447. From Bangkok, Siam.

Musa sapientum Linn. var. *cinerea* (Blanco) Teodoro. Latundan.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**: 397. (1915).

Musa sapientum Linn. var. *pelipia* var. nov. Pelipia (C. A. No. 5073). (Plate IV, Fig. 14; VI, 51; IX, 109; X, 158-159; XVIII, 2).

Producing from 10 to 14 stems. The stem is rather inclined in growth, reaching a height of from 303 to 345 cm. with a base diameter of from 26 to 30 cm. The color and the texture of the stem is similar to that of Butuan.

The leaves are broadly elongate-elliptic with rounded apex and base, smooth above and glaucous below, thick, not brittle, margin deep-straw. The mature blade measures from 198 to 210 cm. in length, and 65 to 70 cm. in width, light forest-green in color. The petiole is comparatively short, somewhat curved, not deeply channelled; margin broad biscay-green in color and lined with black from 47 to 50 cm. long. The midrib is pale green-yellow.

The heart is cordate-lanceolate; apex pointed, yellow in color; bracts dark-purple on the outside and nopal-red inside, persistent. The flower is 8 to 8.1 cm. long, 1 to 1.1 cm. wide and 1.3 to 1.6 cm. deep. The scale is obovate 2.3 to 3.2 cm. long and 5 to 7 mm. wide, apex acute light yellow, apically more inflated than at the base, sides rather serrated, with two sinuses, scrobiculate on middle portion and rugose, very light pink in color. The perigonium is deep pink in color with quite long limbs of light orange-yellow in color. The pistil is 5 to 5.2 cm. long, longer than the stamens and perigonium, stigma buff-yellow in color, rather acute. The stamens are five in number, and shorter than the perigonium.

The fruit is slightly curved, pedicel short, apex distinct, usually five angled; calyx and style deciduous. The bunch has 6 to 9 hands, total number of fruits 71 to 107, and an average of from 12 to 13 to the hand. The fruits are irregularly and quite loosely placed. The fruit measures from 15.7 to 17.9 cm. in length, with a cross section diameter of from 4.2 to 4.4 cm. spinach-green with some javel-green towards the sides when young and light orange-yellow with red and scarlet when ripe, thick, coarse, and stringy, the flesh is coarse, tough, with a core, fibrous, and as hard as Tindok, capucine-buff with some pale orange-yellow, taste similar to that of Saba; odorless and not sweet. The quality is not good the flesh being slightly bitter and astringent. It is not a very good cooking banana and very poor for eating raw. The seeds are present and quite numerous. The bunch weighs from 8.060 kg. to 17.500 kg. It is a late maturing variety requiring about 18 months from the time of planting.

Origin: Bureau of Agriculture, No. 7131. From Gigaquit, Surigao, Mindanao.

Musa sapientum Linn. var. *violacea* (Blanco) Teodoro. Morado.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 398–399 (1915).

Musa sapientum Linn. var. *glaberrima* (Blanco) Teodoro. Durugo.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 399. (1915).

Musa sapientum Linn. var. *americana* Teodoro. Cuban Red.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 398. (1915).

Musa sapientum Linn. var. *inarnibal* Teodoro. Inarnibal.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 406. (1915).

Musa sapientum Linn. var. *glauca* (Blanco) Teodoro. Veintecohol.
Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 402–403. (1915).

Musa sapientum Linn. var. *pop* var. nov. Pop. (C. A. No. 5223).
(Plate IV, Fig. 19; VI, 53; IX, 110; X, 160–161; XXI, 1).

Producing from 14 to 19 stems. It is fair cropper and very good stooler. The stem is of upright growth, rather slender; and with the same stem characters as the Yanaikonban. The plant reaches a height from 183 to 230 cm. with a base diameter of from 13 to 15 cm.

The leaves are oblong-elongate, with rounded apex and base; not brittle; both surfaces smooth with the upper surface stripped with light ochre color. The mature blade is parrot-green, and the margin is dull straw color. The petiole is from 40 to 45 cm. long, chrysolite-green, channel open; margin, light spectrum-red; midrib, pale dull green-yellow.

The heart is ovate-lanceolate; rhachis short; the bracts are reed-yellow on the outside and same inside with light pink shades. The flower is 5.4 to 5.5 cm. long, 1 to 1.1 cm. wide and 7 to 8 mm. deep. The scale is obovate, 2.4 to 2.5 cm. long and 8 to 9 mm. wide, one depression at middle, rather triangular in shape, with long and rough curled margins; apicula with three sinuses. The perigonium is lanceolate, with limbs rather short and pinard-yellow in color. The pistil is very much like Sicsec, very much shorter than the stamens and perigonium; the stigma is very much like that of Sicsec. The stamens are five in number, none sterile; anthers dull indian purple in color.

The fruit is oblong with apex and pedicel short; style and calyx persistent with the apex rather rounded. The fruits on the whole are small, measuring only from 6.5 to 7.6 cm. in length with a cross section diameter of from 3.1 to 3.5 cm. loose on the rhachis and held at almost right angles. The skin is thin and adherent, light viridine-yellow when ripe. Young and ripe fruits do not vary in color. The flesh is naples-yellow, not fibrous, sweet and mild and somewhat starchy, with a faint odor. The angles are not prominent and disappear at the approach of maturity and ripening. Seeds entirely absent. It produces an average of 4 hands, numbering 49 to 53 fruits and an average of from 12 to 13 to the hand. The bunch weighs from 2.09 kg. to 4.600 kg. It is one of the early maturing varieties requiring only about 12 months from planting.

It is very much like the common Popoulu variety widely cultivated in Hawaii. It is characterized by short thick fruits set almost at right angles to the bunch. Fruits blunt at the end and of good quality when baked.

Origin: Bureau of Agriculture, No. 3635. From Kudat, Borneo.

Musa sapientum Linn. var. *canaya* var. nov. Canaya. (C. A. No. 7405). (Plate IV, Fig. 18. VI, 54; IX, III; X, 162–163; XX, 2).

Producing from 9 to 10 stems after the first harvest. Usually, it is single stemmed during the first year of planting. It is upright in growth and characterized by the enlargement of the base. The suckers are fast growers during the first two months. The trunk is pale viridine-yellow and blotched all over with black. Average height 280 cm. and base from 25 to 27 cm. in diameter.

The leaves are oblong and similar to the Hawaiian Dwarf in shape but much larger in size, with rounded apex and base. The mature blades measures from 200 to 210 cm. in length and from 75 to 80 cm. in width, with the upper surface smooth and the lower surface smooth and shiny, not brittle, and of deep green color, with an entire margin of morocco-red, rather thick in texture. The petiole is enormously enlarged with the base broad and not blotched and of pale green-yellow, from 38 to 40 cm. in length, rather short. The midrib is long and pale dull green-yellow.

The heart is ovate with more or less rounded apex. The bracts are indian-red on the outside and orange-cinammon inside, much darker at the apex and lighter toward the base. The rhachis is Paris-green. The flower is from 5.6 to 5.8 cm. long, 7 to 8 mm. wide, and 8 to 10 mm. deep. The scale is from 2.3 to 2.5 cm. long, white, obovate, with two discal depressions, tricuspidate. The perigonium is lanceolate; limbs rather short, and yellow. The pistil is very much shorter than the stamens and perigonium, 3.9 to 4.1 cm. in length. The stamens are five in number, none sterile, 5 to 8 mm. longer than the pistil and 5 to 6 mm. shorter than the perigonium.

The fruits are very compact and 108 to 137 to the bunch in 7 to 8 hands and with an average of 18 to 21 fruits to the hand. The fruits vary in length from 9.8 to 14 cm. and 3.5 to 4.9 cm. in diameter cross section. The skin is light bice-green when mature and light cadmium when ripe; the flesh is light orange-yellow. The texture is firm, somewhat stringy and medium coarse, lacking in flavor when eaten raw, though slightly subacid; when cooked very bitter and astringent. The odor is not pronounced. Fruits reclinate, apex somewhat tapering and angular. Style and calyx decidous. Seeds entirely absent. The bunch weighs from 14.6 to 19.11 kg. It is quite late maturing, requiring about 18 months from the time of planting.

Origin: Bureau of Agriculture, No. 3003. From Surigao, Mindanao.

Musa sapientum Linn. var. *maori* var. nov. Maori, (C. A. No. 5243).
(Plate IV, Fig. 16; VI, 55; IX, 113; XI, 166–167; XIX, 2).

This is as poor a stooler as the Canaya, but a rather tall variety, with upright and vigorous growth. The stem is 275 cm. high and with a diameter at the base of 24 cm. It is javel-green blotched with morocco-red.

The leaves are elliptical, with acute apex and rounded base, deep lettuce-green, quite long and broad like that of Tundok. The petiole and midrib are of the same color, pale green-yellow, with the petiole rather glaucous.

The flower is 6.9 to 7 cm. long, 1.4 to 1.5 cm. wide and 1.3 to 1.4 cm. deep. The scale is obovate, depressed, 2.6 to 2.7 cm. long and 1.4 to 1.5 cm. wide; apicula slightly bent, acute, rugose, variable in forms and with two sinuses. The perigonium is light cream color with rather short limbs and thin, broadened at the middle and tapering to the base. The pistil is 4.2 to 4.3 cm. long, very much shorter than the stamens and perigonium; stigma 5-lobed, pale orange-yellow in color with the base dotted with red and brown spots. Stamens five in number; none sterile, as long as the perigonium but longer than the pistil.

The fruits resemble those of Languma in form but with much larger bunch and fruits, elongate oblong, nearly linear, subcylindric, 5-angled, with rounded apex, style and calyx deciduous; held at almost right angles to the stem and measure from 13.7 to 15.6 cm. in length, with cross section diameter of from 4.4 to 4.7 cm. The skin is lettuce-green to light orange-yellow when ripe, quite thick. The flesh is naples-yellow, rather pulpy in texture, lacking flavor and too dry; taste very much like that of Saba. Seeds absent. The bunch holds 8 hands on the average, numbering 93 fruits with an average of 12 fruits to the hand. The bunch weighs 11.48 kg. It is very late maturing variety requiring about 20 months.

This variety is evidently similar to Kauolau variety of Hawaii described by Higgins in the "The Bananas of Hawaii" and said to belong to the Maori group of Hawaii.

Origin: Bureau of Agriculture, No. 3796. From Rarotonga, Cook Is., New Zealand.

Musa sapientum Linn. var. *sicsec* var. nov. Sicsec. (C. A. No. 5326). (Plate IV, Fig. 17; IV, 56; IX, 112; X, 164–165; XX, 1).

Producing from 7 to 12 stems. The stem is 240 to 340 cm. high with a diameter at the base of from 18 to 20 cm., upright in growth, light viridine-yellow and blotched throughout with mahogany red.

The leaves are broad and long; elongate-elliptic with rounded apex and base; both surfaces of the leaf smooth and shining, deep parrot-green and margin entire, not brittle, and the color morocco-red. The mature blade is from 185 to 190 cm. long and 78 to 80 cm. wide. The petiole is from 70 to 75 cm. long, light dull green-yellow; margin light eosine-pink; midrib pale dull green-yellow and shaded with orient-pink at the middle.

The flower is 6.1 to 6.2 cm. long, 1.1 to 1.3 cm. wide, and 1 to 1.1 cm. deep. The scale is quite inflated, obovate, rugose, and with variable form, 2.6 to 2.8 cm. long and 9 to 10 mm. wide; apex acute and slightly bent. The perigonium is white, limbs short, coiled, pinard-yellow in color, broadened at the middle and tapering to the base. The pistil is 3.8 to 4 cm. long; stigma buff-yellow in color and bilobed. The stamens are five in number, as long as the perigonium and longer than the pistil.

The fruits are held at right angles to the rhachis, elongate oblong, nearly linear, subcylindric, 5-angled, pedicelled, apex well filled, somewhat tapering. There are 7 to 8 hands to the bunch, numbering 83 to 104 fruits in all with an average of from 11 to 14 fruits to the hand. They measure from 11.7 to 14.1 cm. in length, and 3.9 to 4.3 cm. in cross section diameter.

The skin is apple-green to mustard-yellow when ripe, medium thick. The flesh is pale-orange-yellow in color, rather tough and coarse, slightly subacid, odorless. The calyx and style deciduous. Seeds absent. It is a fairly good eating banana when raw, but not so good as when cooked or baked. It requires about a year to mature from time of planting.

Origin: Bureau of Agriculture, No. 4036. From Port Morsbey, Papua.

Musa sapientum Linn. var. *cubensis* Teodoro. Apple Banana.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 397–398. (1915).

Musa sapientum Linn. var. *suaveolens* (Blanco) Teodoro. Bungulan.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 400. (1915).

Musa sapientum Linn. var. *tudlong* Teodoro. Tudlong dato.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 402. (1915).

Musa sapientum Linn. var. *ternatensis* (Blanco) Teodoro. Ternate, Gloria.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 404–405 (1915).

Musa sapientum Linn. var. *daryao* Teodoro. Daryao.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 403–404. (1915).

Musa sapientum Linn. var. *languma* var. nov. Languma (C. A. No. 5266). (Plate IV, Fig. 15; VII, 57; IX, 114; XI., 168–169; XIX, 1).

Producing from 5 to 9 stems. It is rather weak and upright in growth, with a slender stem. The stem is similar to that of Lacatan in color markings, reaching a height from 140 to 145 cm. with a diameter at base of from 15 to 18 cm. The leaves are elongate-oblong, slightly curved, the upper surface is slightly rough and the lower surface smooth and shining but not glaucous. The mature blade measures from 139 to 185 cm. in length and with a diameter of from 51 to 71 cm., the color is dark dull yellow, and the margin is entire and of bay color, the tip is slightly round. The petiole is 38 to 50 cm. long; slightly sloping, the margin is spectrum-red and the rest light dull green-yellow. The midrib, in color is like the petiole with shades of orient-pink at the middle.

The heart is lanceolate, livid brown on the outside and etruscan-red in the inside with some yellow stripes and dark brown at the margins. The outside is glaucous, but the inside shining and smooth. The bracts are deciduous. The flower is from 6.6 to 7.4 mm. long, 1 to 1.2 cm. wide and 1 to 1.1 cm. deep. The scale is 2.5 to 2.6 cm. long, 8 to 10.5 mm. wide, white, oblong, surface much inflated; apicula serrated and acute. The perigonium is white at the base and yellow on the limbs. The pistil is 4 to 4.1 cm. long, slightly shorter than the perigonium. The stamens are five, none sterile, longer than perigonium and pistil.

The fruits are loose in the bunch, with an average of 4 to 5 hands to the bunch, totaling 54 fruits and an average of 12 fruits to the hand. The fruits are held at right angles to the rhachis, subsylindric; elongate oblong; like Maori in shape, style and calyx deciduous, apex rounded and the pedicel short. The fruit measures from 11.8 to 12.5 cm. in length with from 4 to 4.1 cm. in cross section diameter. The skin is light bice-green to mustard-yellow when ripe; the flesh is cream color, very delicate, soft, sweet, slightly oily, with slight odor. The angles are not very prominent and appear round in cross section. The seeds are absent, or when present do not exceed more than two to a fruit. The bunch weighs on an average, 4.520 kg. It requires at least 18 months to mature from the time of planting. It is a very good eating banana, almost equals the Lacatan in flavor and delicacy.

Origin: Bureau of Agriculture, No. 3944. From Papua.

Musa sapientum Linn. var. *tuldoc* Teodoro. Tuldoc.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 407. (1915).

Musa sapientum Linn. var. *radja*. var. nov. Pisang radja. (C. A. No. 5135).

(Plate V, Fig. 20; VII, 58; IX, 115; XI, 170–171; XXI, 2).

Producing from 1 to 4 stems. It is here a very poor cropper and stooler. The stem reaches a height of from 200 to 230 cm. and has a diameter at the base of from 12 to 14 cm. The stem is similar to that of Nam Chang Rai in color markings, medium resistant to wind and rather inclined in its mode of growth.

The leaves are large, pendant, with curved petioles. The mature blade is 173 to 196 cm. long and 45 to 46 cm. wide; linear elliptic in form, apex somewhat rounded and the base pointed and elongated. The upper surface is smooth and shining and the lower portion is slightly glaucous. The petiole is curved, not broad at the base, and of pale dull yellow-green in color, 40 to 50 cm. long; the margin is garnet-brown and the midrib is light-green.

The heart is elliptic-lanceolate; bracts sometimes persistent, deep purplish-vinaceous on the outside and garnet-brown on the inside, apices rounded.

The flower is from 7.3 to 7.5 cm. long, 1.1 to 1.2 cm. wide and 1 to 1.2 cm. deep. The scale is 3.1 to 3.3 cm. long and 8 to 9 mm. wide, white in color, lanceolate, not depressed, much inflated at the middle, distinctly rugose, apicula mucronate. The perigonium is cream-colored with baryta-yellow limbs. The pistil is 4.7 to 4.9 cm. long; stigma cream colored, without distinct groove, cerebriform. The stamens, are five in number, cream colored with light brown anthers, longer than the pistil and perigonium.

The fruits are quite recurved; each with slightly prominent apex and pedicel, conspicuously 5-angled, skin thick; calyx and style deciduous; they are held on the stem at right angles to the rhachis and resemble those of Ternate in form; measuring from 12.8 to 12.9 cm. in length with from 3.7 to 3.9 cm. in diameter of cross section. The skin is thick, spinach green to buff-yellow when ripe; the flesh is sweet, not delicate, a little juicy, cream colored with the center orange buff; quality very good; texture fine, smooth. A very good cooking banana, juicy and well flavored. Too coarse for eating raw. The bunch holds an average of 5 hands, numbering in all 52 fruits with an average of 10 fruits to the hand. The bunch weighs about 4.820 kg. Seeds absent. It is very late maturing variety, requiring about 20 months from the time of planting.

Origin: Bureau of Agriculture, No. 3287. From Buitenzorg, Java.

Musa sapientum Linn. var. *pamotion* var. nov. Pamotion, (C. A. No. 5026). (Plate V., Fig. 21; VII, 59; IX, 116; XI, 172–173; XXII, 1).

Producing from 8 to 10 stems. The stem is slender, upright in growth and rather a slow grower. It assumes a height from 200 to 216 cm. with a base diameter of from 8 to 10 cm., and is dull orange in color blotched with black.

The leaves are medium in length, rather upright and not brittle, smooth on both sides but lower surface shining instead of glaucous; the apex and base, obtuse; the margin is entire and garnet-brown. The mature blade measures from 125 to 135 cm. in length and from 45 to 50 cm. in width, cedar-green in color. The petiole is 35 to 40 cm. long, of light viridine-yellow color and blotched with pinkish in some parts; margin maroon-color. The midrib is pale dull green with light shades of orient-pink, vanishing near the apex.

The heart is very small, about 6 to 10 cm. long ovate, with apex not very acute. The bracts are dull indian-purple outside and light carrot-red inside, and freely deciduous. The scale is lanceolate, tricuspidate, inflated and without depressions, white in color and measures from 2.3 to 2.4 cm. long and 5½ to

7 mm. wide. The perigonium is light maize-yellow, with long limbs of pinard-yellow color. The pistil is pinard-yellow in color, 2.9 to 3.1 cm. long; stigma tetra-lobed. The stamens are five, longer than the pistil and the perigonium.

The fruits are very loose in the bunch, similar to those of Pinagbilinan or Daryao in this character. They measure from 11.3 to 13.3 cm. in length, 2.8 to 2.9 cm. diameter of cross section, subcylindric, the apex more or less compressed and of the same length as pedicel, angles disappearing at maturity, skin thin and adherent, chartreuse-yellow to amber-yellow when ripe, smooth. The flesh is similar to Saba in taste, odorless and nearly baryta-yellow in color, soft and mild subacid in taste.

The fruits total 45 and with an average of 11 fruits to the hand. The bunch weighs about 2.300 kg. It is an early maturing variety and matures within a year from the time of planting.

Origin: Bureau of Agriculture, No. 2770. From Surigao, Mindanao.

Musa sapientum Linn. var. *principe* var. nov. Principe (C. A. No. 5016). (Plate V, Fig. 22; VII, 61; IX, 117; XI, 174–175; XXII, 2).

Producing from 4 to 7 stems. Usually, it is a poor stooler and medium cropper. The stem is upright and as tall as the Angao. It reaches a height of from 300 to 320 cm. and has a base diameter of from 20 to 23 cm., cylindrical, deep green, with dark reddish brown patches.

The leaves are broader and longer than the Saba. They measure from 240 cm. to 250 cm. in length and from 75 to 82 cm. in width. The surface above is smooth but not shining, below slightly glaucous; the margin is deep red with brown at the very edge; the midrib is long, greenish yellow in color. In the young plants, the midrib is greenish yellow with shades of lilac all over, which disappear as the plant approaches maturity. The petiole is from 70 to 72 cm. long, rather straight and broad at the base, of violet pink color. The apex and base of the leaves are nearly round.

The heart is cordate; bracts dull violet-black on the outside and coral-red on the inside with maize-yellow at the base, apices pointed. The flower is from 6.6 to 6.7 cm. long, 1 to 1.2 cm. wide and 1.1 to 1.3 cm. deep. The scale is lanceolate, depressed at the center, white in color and measuring 3 to 3.2 cm. long and 1 to 1.2 cm. wide, apical tricuspidate. The perigonium is white with long amber yellow limbs. The pistil is 4.4 to 4.6 cm. long with cerebriform stigma and amber-yellow in color. The stamens are five, longer than the pistil and the perigonium.

The fruits are held in the bunch similar to those of Morado. They are oblong; apex and base tapering; pedicel short; apex truncate, similar to Morado in form except the color of the skin which is deep chrysolite-green to mustard-yellow when ripe; measuring from 13.3 to 13.7 cm. in length with 4.3 to 4.4 cm. cross section diameter. The flesh is sweet, juicy, slightly resembles Boñgolan in flavor, naples-yellow in color, and slightly fibrous than Boñgolan. The calyx and style are deciduous. Seeds absent. It produces from 4 to 7 hands to the bunch, numbering from 49 to 85 fruits and with an average of from 12 to 14 fruits to the hand. The bunch weighs from 3.970 kg. to 7.520 kg. From planting to blooming requires about 18 months and from blooming to maturity 3 months.

Origin: Bureau of Agriculture, No. 2380. From the Philippines but Bureau's record did not specify the town or province.

Musa sapientum Linn. var. *baca* var. nov. Sungay Baca. (C. A. No. 5149). (Plate V, Fig. 23; VII, 60; IX, 118; XI, 176–177).

Producing from 7 to 9 stems. It is here a poor cropper and rather upright in growth. It is not a very tall variety usually reaching a height from 184 to 210 cm. and has a base diameter of from 14 to 15 cm. The stem is characterized by dark brown patches all over and with some fine deep rose and purple shades by which the yellow color of the stem is nearly hidden.

The leaves are medium in length, both surfaces smooth and cedar-green in color, with the margins brown. The mature blade varies from 151 to 182 cm. in length and from 54 to 61 cm. in width. The petiole is 32 to 45 cm. long, reed-yellow in color, and with a margin of light scarlet-red and with the channel broadly open.

The heart is lanceolate-ovate, with apex pointed. The rhachis and the heart are livid brown, with the bracts pink. The flower is 5.8 to 6.1 cm. long, .75 to .85 cm. wide, and 9 to 11 mm. deep. The scale is lanceolate, depressed at the middle, 2.35 to 2.4 cm. long and .75 to .80 cm. wide, white, apicula tricuspidate. The perigonium with limbs short and unequally divided. The pistil is 3.8 to 3.85 cm. long with stigma trilobed. The stamens are five, longer than the pistil and the perigonium.

The fruits are held in a position similar to those of Dool and they resemble that of Dool in form; subcylindric, elongate-oblong, not very angular; apex obtuse and blunt, pedicel very short and almost sessile; calyx and style persistent; 10 to 10.3 by 2.7 to 2 cm.; skin from kildare-green to mustard-yellow when ripe. The flesh is cream color, good in quality, medium fine in texture and slightly smooth; with decided banana flavor and mildly subacid. It is a good eating banana. There are usually 3 hands to the bunch, totaling 41 in the number of fruits and with an average of 13 to the hand. The seeds absent. The bunch weighs about 2.150 kg. It takes about 20 months to mature from the time of planting.

Origin: Bureau of Agriculture, No. 3356, From Silang, Cavite.

Musa sapientum Linn. var. *nam* var. nov. Nam Chang Rai (C. A. No. 5194).

(Plate V, Fig. 24; VII, 62; IX, 119; XI, 178–179; XXIII, 2).

Producing from 22 to 31 stems. It is a good cropper and a very good stooler. It is generally heavily foliaged. The stem is of upright growth, strong and not slender. It varies in height from 272 to 335 cm. and has a base diameter of from 18 to 20 cm., and is deep green, rather glaucous, the upper part similar to that of Saba.

The leaves are large and long, rather pendant and not brittle. The mature blade measures from 200 to 271 cm. in length and from 46 to 82 cm. in width. The upper surface is smooth and the lower not glaucous though also smooth. The color is cedar-green with margin entire and of auburn color. The apex is somewhat rounded with slightly acute tip and the base obtuse. The petiole is 50 to 60 cm. long and the color is pale cendre-green with patches of deep ash color. The midrib is pale dull green yellow throughout.

The flower is from 5.5 to 5.65 cm. long, 6.5 to 8.5 mm. wide and 10 to 11 mm. deep. The scale is 20 to 21 mm. long and 6 to 6.5 mm. wide, white, lanceolate; apicula tricuspidate. The perigonium is white and with whitish yellow limbs which are short and unequally divided. The pistil is 3.4 to 3.6 cm. long with stigma trilobed. Stamens five in number, longer than the pistil and the perigonium. Sometimes a sterile stamen occurs.

The fruits are compact in the bunch, held almost at right angles to the rhachis with those on the upper part bent upward, oblong-lanceolate, angular and similar in this to Ternate; apex conspicuous; pedicel not long, style and calyx deciduous; 13.5 to 15 cm. long and 4 to 4.5 cm. across section diameter. The skin is thick, deep turtle-green to colonial-buff when ripe. The flesh is rather dry and white; quality good, medium fine texture and rather firm; flavor subacid; odor-none. It is not a very good eating banana due to its dryness and firmness, but it cooks well. There are 5 to 7 hands to the bunch, totaling from 64 to 104 fruits with an average of from 12 to 17 fruits to the hand. The bunch weighs from 6.5 to 16.24 kg. It is a medium maturing variety requiring about 17 months from the time of planting. Seeds are absent.

Origin: Bureau of Agriculture, No. 3503.

Musa sapientum Linn. var. *yanaikonban* var. nov. Yanaikonban, (C. A. No. 5380).

(Plate V, Fig. 25; VII, 63; IX, 120; XI, 180–181; XXIV, 1).

Producing from 6 to 9 stems. The stem is similar to that of Languma in color characters, a poor cropper and of upright growth. It is rather slender and in this resembles Kinamay Dalaga. It varies from 220 to 230 cm. in height and has a diameter base of from 15 to 17 cm.

The leaves are oblong, and rather short, not brittle. The mature blade is cerro-green and measures from 170 to 175 cm. in length, and 60 to 68 cm. in width. The apex is somewhat rounded and the base obtuse; the upper and lower surfaces are smooth. The petiole is light viridine-yellow, 35 to 45 cm. long, with a margin of pale dull green-yellow with some shade of pink.

The heart is lanceolate in form, with the apex pointed. The bracts are irregularly colored, upper part blotched with light yellow, the middle brownish vinaceous, and darker as it approaches the apex and the margins; the inside is congo-pink near the tip and straw-yellow at the base. The flower is from 5.7 to 6 cm. long, 7 to 8 mm. wide and 7 to 8 mm. deep. The scale is lanceolate, white, with a deep depression at the middle which extends downward to the base; apicula tricuspidate, declinate and not very acute. The perigonium is white with amber-yellow curled and short limbs. The pistil is 3.5 to 3.6 long; stigma warm buff in color, trilobed. The stamens are five in number, longer than the pistil and the perigonium; anthers buff pink in color.

The fruits are subcylindric, declinate, tapering, 13.2 to 14.3 cm. long, 3 to 3.2 cm. in cross section diameter, rather loose in the bunch, held similarly to those of Dool; pedicel long; style persistent and calyx deciduous. In form, the fruits resemble very much the Boñgolan and Dwarf Hawaiian except that the tip is more compressed and blunt and very much smaller than either of these. The flesh is white and succulent, with a jelly-like substance at the center; quality good; texture fine, flavor subacid and fair soft and delicate. It is a very good eating banana though it does not have an exceptionally good flavor. Seeds absent. There are 4 hands to the bunch, on an average totaling 51 fruits with an average of 12 fruits to the hand.

The bunch weighs about 3.72 kg. It is one of the early maturing varieties requiring only about a year from the time of planting.

Origin: Bureau of Agriculture, No. 4797. From Lal-bagh, Bangalore, India.

Musa sapientum Linn. var. *rachidis* var. nov. (C. A. No. 4980). (Plate V, Fig. 26; VII, 64; IX, 121; XI, 182–183; XXIV, 1).

Producing from 14 to 26 stems. It is a good cropper and very good stooler; similar to Klum in stooling and in stem markings, but more inclined in its growth. The stem is viridine-green with dark brown and black patches, reaching a height from 305 to 320 cm. with a base diameter of from 18 to 21 cm.

The leaves are broadly elliptical with rounded apex and base; shining and smooth on both surfaces and fairly thick. The mature blade measures 184 to 244 dm. in length and from 60 to 80 cm. in width. The color is the same as that of Klum. The petiole is quite short and deeply channelled with light carmine margins, measuring from 40 to 49 cm. in length with a color of light coose-green; midrib same color as the petiole.

The rhachis is very long, in many cases reaching the ground. The heart is lanceolate oblong with a rather pointed apex. The bracts are vinaceous-lilac on the outside and light eugenia-red on the inside; at the margins dark brown and at the apex yellow.

The flower is maize-yellow in color; 6.8 to 6.9 cm. long, 8 to 10 mm. wide and 11 to 12 mm. deep. The scale is maize yellow in color; 2.7 to 2.8 cm. long and 7 to 9 mm. wide, not depressed; evenly inflated; apicula polycuspidate; apex short and acute, with rugae. The perigonium is maize-yellow with light cadmium limbs, curled and short. The pistil is 4.5 to 4.6 cm. long; stigma pale orange-yellow and the style white. The stamens are five in number, none sterile.

The fruits are subcylindric, oblong-lanceolate, 13.5 to 14 cm. long with 3.5 to 3.6 cm. cross section diameter, similar to Klum in form and color markings. The calyx and style are deciduous. The skin and flesh are similar to those of Klum; the flesh being subacid and rather dry. There are from 6 to 7 hands to the bunch, totaling from 91 to 108 with an average of from 13 to 16 fruits to the hand. The bunch weighs from 4.146 to 7.390 kg. Seeds are absent. It is a medium maturing veriety requiring from 16 to 17 months from the time of planting.

Origin: Bureau of Agriculture, No. 1940. From Dept. of Agr., Federated Malay States.

Musa sapientum Linn. var. *dinalaga* var. nov. Dinalaga, (C. A. No. 5240). (Plate V, Fig. 31; VII, 66; IX, 122; XI, 184–185; XXVII, 1).

This variety is a fast stooler and a medium cropper, producing from 25 to 28 stems from the base. The stem has an upright growth and is rather weak, reaching a height of from 310 to 330 cm. and has a base diameter from 17 to 20 cm. It resembles the Inarnibal in color markings.

The leaves resemble those of Inarnibal, in texture, color, shape and margin characters. The mature blade measures from 192 to 212 cm. in length, and from 45.50 cm. in width, elongate oblong with apex truncate and base nearly round. Both surfaces of the leaf are smooth and shining and the color is oil-green and lighter beneath. The margin is garnet-brown in color. The petiole is 47 to 53 cm. long, the color is pale green yellow with brazil-red margins.

The heart is cordate. The bracts are prussian-red on the outside and cinamon-buff on the inside. The flower is 5.5 to 5.7 cm. long, 6 to 7 mm. wide and 7 to 9 mm. deep. The scale is lanceolate, depressed near the base of apicula, 2.2 to 2.3 cm. long and 6 to 7 mm. wide, apicula polycuspidate, short, acute, and rugose. The perigonium is light cream, with base light green and limbs straw-yellow and coiled. The pistil is 3 to 3.1 cm. long; stigma mustard-yellow. The stamens are five, light violet-pink anthers, longer than the perigonium and the pistil.

The fruits are oblong-ovate, similar to those of Inarnibal in form and color characters. They differ from the latter in being much larger and when mature devoid of brown patches. The skin is coose-green to mustard-yellow when ripe. The flesh is sweet, succulent and buff-yellow in color, quality good and delicate; texture, medium fine; odor, slight. It is a very good eating banana, having a delicate flavor and in fact is one of the sweetest varieties. The calyx and style are deciduous. Seeds are absent. The fruit measures from 10.2 to 10.4 cm. in length and 3 to 3.1 cm. cross section diameter. There are 5 to 6 hands to the bunch, totaling 98 to 104 fruits with an average of 19. The bunch weighs from 2.35 to 4.21 kg. It is an early maturing variety, requiring about 12 to 15 months.

Origin: Bureau of Agriculture, No. 3742 From Mauban, Tayabas, Philippines.

Musa sapientum Linn. var. *raines* var. nov. Raines na puti. (C. A. No. 5120).

(Plate V, Fig. 27; VII, 65; IX, 124; XI, 186–187; XXV, 1).

Producing from 4 to 5 stems. It is a poor cropper and of upright growth. The color markings of the stem are similar to those of Boñgolan. The stem is from 200 to 235 cm. in height with a base diameter of from 22 to 25 cm.

The leaves are oblong-lanceolate; apex acute and base obtuse; thin and with shallowly channelled veins, smooth above and very glaucous below. The petiole is deeply channelled, and measures from 50 to 60 cm. lumiere-green in color and with margins broad and deep vinaceous. The midrib is long and pale green-yellow, shaded near the base with hydrangea-pink.

The heart is cordate; bracts deciduous and with apices pointed. They are dull violet-black on the outside, and dragon's-blood on the inside, and light yellow at the base. The flower is 7.8 to 8.1 cm. long, 1 to 1.2 cm. wide and 1.1 to 1.2 cm. deep. The scale is 3.6 to 3.7 cm., lanceolate, greatly depressed near the apicula; apicula tricuspidate or nearly so. The perigonium with white to yellow limbs. The pistil is 5 to 5.1 cm.; stigma swollen and slightly curved and tetralobed. The stamens are very much shorter than the perigonium and the pistil, five in number.

The fruits are 13.1 to 13.3 cm. long and 4 to 4.2 cm. cross section diameter, lanceolate-oblong; apex blunt pedicel very short, and quite conspicuously 5-angled; style persistent and calyx deciduous; skin is rather thick, lettuce-green to apricot-yellow when ripe. The flesh is deep cream, juicy odorless, slightly sweet; quality good and with a fine and smooth texture. It is a very good eating banana, the equal of the Morado and Principe. The fruits are held in the bunch similarly to those of the Morado and Principe with the upper fruits curved and loose; average more or less straight and somewhat compact. Seeds are absent. There are 4 hands to the bunch, totaling 53 fruits with an average of 13. The bunch weighs approximately 6.27 kg. It is quite a late maturing variety, requiring about 20 months from the time of planting.

Origin: Bureau of Agriculture, No. 3265. From Polillo, Tayabas, Philippines.

Musa sapientum Linn. var. *cochinchinensis* var. nov. Chuoi Ticu Huong (C. A. No. 5256).
(Plate V, Fig. 29; VII, 68; IX, 123; XI, 188–189; XXVI, 1).

It is a very good stooler, rapid grower, and very good cropper, producing from 15 to 21 stems. The stem is slender, rather weak and nearly upright in growth. Its height varies from 280 to 290 cm. and the base diameter is from 13 to 15 cm. It is deep orange-straw with blotches like that of Boñgolan.

The leaves are held almost upright. The mature blade measures from 174 to 180 cm. in length and from 45 to 50 cm. in width; cerro-green above and lighter below. The apex is round and the base pointed and elongated; slightly asperous on the upper surface and partly smooth below and not glaucous. The petiole is 60 to 65 cm.; yellowish green in color with the margins brown; the midrib is marguerite-yellow and thin.

The flower is 6.6 to 6.7 cm. long, 1 to 1.1 cm. wide and 7 to 8 mm. deep. The scale is white, lanceolate in form and greatly depressed near the apicula; sinuses 2–3, prominent, and with rugae, apicula tricuspidate. The perigonium is light yellowish white with yellow limbs. The pistil is 4 to 4.2 cm. long, stigma funnel shape. The stamens are five, shorter than the perigonium and the pistil.

The fruits are elongate and straight in the upper hands; those in the basal and the middle portions curved, finger-like, slightly subcylindric, angles disappearing at maturity, with distinct apex and pedicel, the latter quite long; style and calyx deciduous; 9.5 to 11.2 cm. long, 2.3 to 2.8 cm. cross section diameter. The skin is medium thick, viridine-yellow to baryta-yellow when ripe. The flesh is maiz-yellow in color; quality rather poor and peculiar; odor slight. It is an eating banana, but rather poor. Seeds are absent. There are 6 to 7 hands, totaling 104 fruits with an average of 14 to 17 fruits to the hand. The bunch weighs from 3.5 to 3.8 kg. It is a medium maturing variety requiring about 16 months from the time of planting. Blooming takes place after 10 months.

Origin: Bureau of Agriculture, No. 3823. From Botanical Garden, Saigon, Cochin-China.

Musa sapientum Linn. var. *kinamay* var. nov. Kinamay Dalaga, (C. A. No. 5009).

(Plate V, Fig. 32; VII 67; IX, 125; XI, 190–191; XXIII, 1).

A very fast stooler. The color markings of the stem are similar to those of Sungay Baca, producing from 43 to 50 stems. The stem is slender and rather weak, varying in height from 244 to 258 cm. and has a base diameter of from 12 to 13 cm.

The leaves are elongate-elliptic; with apex and base rounded, not brittle, both surfaces are smooth, texture medium thick and not coarse. The mature blade measures from 172 to 184 cm. in length and from 52 to 54 cm. in width; cedar-green color. The margin is amber-yellow in color. The petiole is 40 to 55 cm. and the same as in the Languma in characters; the midrib is similar to that of Languma also.

The heart is comparatively small, lanceolate-ovate in form; the bracts are sometimes persistent though in most cases deciduous, purple on the outside and morocco-red on the inside.

The flower is 5.6 to 5.7 cm. long, 6 to 7 mm. wide, and 8 to 9 mm. deep. The scale is lanceolate; inflated, without depressions, 2.2 to 2.3 cm. long and 6 to 7 mm. wide; apicula tricuspidate. The perigonium is white, with baryta-yellow colored limbs. The pistil is 3.7 to 3.8 cm. long; style long and very slender; stigma bilobed and slightly curved and of cream-buff color. The stamens are five, very much shorter than the perigonium and the pistil.

The fruits are subcylindric; lanceolate; apex compressed and distinct, as long as the pedicel; calyx and style persistent; 11 to 11.3 cm. long and with 2.5 to 3.2 cm. diameter in cross section. The skin is thin, biscay-green to naples-yellow when ripe. The flesh is white; quality fairly good; texture smooth and fine; taste mild, with peculiar mint flavor; slightly odorous. It is a fairly good eating banana due to its delicacy and peculiar flavor. No seeds present. There are 5 to 6 hands; totaling from 58 to 79 fruits with an average of from 11 to 15 fruits to the hand. The bunch weighs from 1 to 2.79 kg. It is a fairly early maturing variety requiring only 15 months, approximately from the time of planting.

Origin: Bureau of Agriculture, No. 2373. From Pulilan, Bulacan, Philippines.

Musa sapientum Linn. var. *angao* var. nov. Angao, (C. A. No. 4981). (Plate V, Fig. 30; VII, 69; IX, 126; XI, 192–193; XXVI, 2).

Producing from 10 to 11 stems. The stem is cylindrical, of upright growth and strong; color markings same as in Latundan. It varies in height from 260 to 300 cm. and has a base diameter of from 10 to 11 cm.

The leaves are broad and long, a little shorter than those of Saba, not brittle, cedar-green with garnet-brown margins. The petiole is 55 to 60 cm. long, of medium width, with garnet-brown margins and with shades of purple at the base. The mature blade measures from 175 to 180 cm. in length and in width from 60 to 66 cm. The petiole is slightly curved, light green in color and glaucous.

The flower is 7.5 to 7.6 cm long, 10 to 11 mm. wide and 13 to 14 mm. deep. The scale is lanceolate, white in color; apicula tetra to hexacuspidate without depressions, inflated and with one sinus, the apex turned ventrad. The perigonium is white, with deep orange limbs. The pistil is 5.4 to 5.6 cm. long; style white at the base and scarlet red dots near the stigma; the stigma is buff-yellow, erect and slender, conical in form. The stamens are five, very much shorter than the perigonium and the pistil.

The fruits are held in the rhachis similar to those of Ternate, approach those of Ternate in form, very angular and with the same characteristic angles, measuring from 13.5 to 13.8 cm. long and 4 to 4.2 cm. diameter in cross section. The style is persistent and the calyx is deciduous; pedicel long and apex rather tapering and blunt. The skin is rather thick, coose-green to primuline-yellow when ripe. The flesh is cream color, quality rather poor; texture dry and starchy; not sweet and odorless. It is a poor eating banana and almost as poor when cooked. When cooked, it is dry, starchy, and lacking in flavor. No seeds present. The bunch has an average of 7 hands, totaling 100, with an average of 14 fruits to the hand. It is a late maturing variety requiring about 20 months from the time of planting.

Origin: Bureau of Agriculture, No. 1999. From Tagoloan, Misamis, Mindanao.

Musa sapientum Linn. var. *katali* var. nov. Katali, (C. A. No. 5032). (Plate V, Fig. 28; VII, 74; IX, 128; XI, 194–195; XXV, 2).

Producing from 15 to 18 stems. It is a fairly good stooler. The stem is rather weak, and with color markings similar to those of Latundan. It varies from 273 cm. in height and has a base diameter of from 18 to 20 cm.

The leaves are medium in length. The mature blade is cedar-green with dark straw color margins, and measures from 126 to 130 cm. in length with a width of from 45 to 47 cm. The surface above is smooth and that below is glaucous; the margin is entire and the leaf not brittle. The apex and the base subtruncate. The petiole is 45 to 55 cm. long, deep green in color, with the margins sanford-brown and the channel rather shallow and compressed. The midrib is naphthalene-yellow color throughout.

The heart is lanceolate-ovate. The bracts are vinaceous-lilac on the outside and peach-red in the inside. The apices are rounded. The flower is 6 to 6.4 cm. long, 7 to 8 mm. wide and 9 to 10 mm. deep. The scale is white, without depression, in flated, 2.3 to 2.4 cm. long and 4 to 5 mm. wide; apicula tetra-hexacuspidate and with one sinus, apex of scale slightly curved dorsad. The perigonium is light pink with orange limbs. The pistil méasures from 4.6 to 4.7 cm. in length; stigma almost rounded. The stamens are five, very much shorter than the pistil and the perigonium.

The fruits are similar to Ternate in form oblong-lanceolate, with distinct apex and long pedicel; 13.3 to 13.6 cm. long and 4 to 4.3 cm. diameter cross section. The skin is quite thick;

kildare-green to light buff-yellow, almost like the Saba in color when ripe. The flesh is rather firm and coarse; quality very good; texture fine and rather smooth; flavor good, sweet, and juicy; odor none. Calyx and style deciduous. Seeds quite numerous. It is a fairly good eating banana, but is a better cooking variety. The presence of seeds lessens the value both for eating raw and cooking. There are 3 to 4 hands to the bunch; totaling from 32 to 43 fruits with an average of 10 fruits to the hand. The bunch weighs from 2.010 to 4.300 kg. It is quite late maturing variety, requiring 14 months, approximately, to bloom from the time of planting, and from blooming to maturity about 5 months more.

Origin: Bureau of Agriculture, No. 2806. From Beadon Row, Calcutta, India.

Musa sapientum Linn. var. *compressa* (Blanco) Teodoro. Saba.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 408–410. (1915).

Musa sapientum Linn. var. *khai* var. nov. Khai Pet. (C. A. No. 5195.) (Plate V, Fig. 38; VII, 72; IX, 127; XI, 196–197; XXVIII, 2).

Producing from 10 to 18 stems. The stem is cylindrical, inclined in growth much more than Yan Vat Ching. It is a very good cropper and quite a fast stooler. The character of stooling and color markings is similar to those of Yan Vat Ching. It varies in height from 300 to 345 cm. and has a base diameter of from 26 to 28 cm.

The leaves are like those of Pelipia in form; long and uniformly broad. They are smooth and shiny on the upper surface and very glaucous below. In color they are similar to Saba. The mature blade measures from 190 to 216 cm. in length and from 60 to 68 cm. in width. The petiole is rather long, and not deeply channelled.

The heart is oblong-lanceolate, the bracts are deciduous, dark purple on the outside and morocco-red in the inside. The apices of bracts are obtuse and with yellow margins. The flower is 7.5 to 7.9 cm. long, 12 to 13 mm. wide, and 13 to 15 mm. deep. The scale is rose-pink, with the base and apex white, 3.3 to 3.4 cm. long and 13 to 14 mm. defformed, with rugae, sinuses irregular and conspicuous, broadened at the apical two-thirds; apicula quite broad. The perigonium is dull magenta-purple on the outside and deeper colored inside; the base is paler; apices quite short, pale yellow in color. The pistil is 4.7 to 4.9 cm. long; longer than the stamens; stigma more or less rounded. The stamens are five, none sterile.

The fruits are numerous, similar to Yan Vat Ching in the position on rhachis, in form very much like that of Yan Vat Ching, except that the Khai Pet is smaller, with apex narrower and with a very long pedicel; measure from 12.6 to 12.8 cm. in length, and 4.4 to 4.5 cm. diameter of cross section. The color of the skin is similar to that of Yan Vat Ching and also the thickness. The flesh is of the Saba type in color; quality good; flavor acid. Style and calyx deciduous. Seeds are present but few in number. It is a good cooking banana with an acid flavor but is not fit for direct eating, being very fibrous. There are 7 to 8 hands to the bunch, totaling 94 to 100 fruits, with an average of from 13 to 14 fruits to the hand. The bunch weighs from 6.250 to 7.800 kg. It takes about 17 months to mature from the time of planting.

Origin: Bureau of Agriculture, No. 3504. From Siam, Bangkok.

Musa sapientum Linn. var. *krie* var. nov. *Krie,* (C. A. No. 5396).
(Plate V, Fig. 33; VII, 73; IX, 129; XI, 198–199; XXVII, 2).

Producing from 12 to 23 stems. It is a fast stooler and a good cropper. The stems are rather inclined in growth, quite strong. It varies in height from 246 to 330 cm. and has a base diameter of from 20 to 23 cm. The color markings of the stem are similar to those of Maduranga.

The leaves are brittle, almost upright. The mature blade measures from 148 to 167 cm. in length and has a diameter of from 46 to 50 cm. The upper surface of the leaf is smooth and shining and the lower glaucous. The color is cedar-green with an entire margin of buckthorn-brown color. The petiole is medium in length; the channel very compressed; of clear dull green-yellow color, with claret brown margins and the base not very much blotched. The midrib is slightly compressed, of pale dull green-yellow along lower part of blade and base, and light orient-pink at the middle and extending up to the apex. The apex of the leaf is somewhat rounded with the edges sharp, and the base almost obtuse.

The heart is medium in size and lanceolate in form. The bracts are dull purple-brown on the outside and nopal-red in the inside. The outside is glaucous and the inside smooth, and they are deciduous. The flower is 7.4 to 7.6 cm. long, 8 to 9 mm. wide and 8 to 10 mm. deep. The scale is 2.9 to 3.1 cm. long and 7 to 8 mm. wide; white at the base, rhodonite-pink at the middle, and pale greenish-yellow at the apex, more or less compressed, not broadened at the apical two-thirds, with depressions, nearly lanceolate, and with rugae. The perigonium is roseline-purple on the outside and rose-doree on the inside, the edge is pale yellow with deep orange limbs, the latter being fine and short and not well divided. The pistil is 4.3 to 4.55 cm. long; stigma warm buff in color. The stamens are five, shorter than the pistil and the perigonium.

The fruits are loose and held almost horizontally, with the apex quite acute, and very tapering. They resemble the fruits of the *Saba* type with the exception that instead of being flat the sides are slightly inflated. They are from 12.5 to 15.2 cm. long and 3.9 to 4.3 cm. diameter cross section. The skin is coarse, very glaucous, this giving a characteristic silver white color; pale orange yellow when ripe. The flesh is similar to that of *Saba* in color, odor and taste; the quality is fair; the texture is firm and it cooks rather dry; flavor slightly sweet; medium juicy. It is a fairly good cooking banana and makes a fine "fig". The calyx and style are deciduous. Seeds are absent. There are 3 to 6 hands to the bunch; totaling 40 to 90 fruits with an average of from 10 to 15 fruits to the hand. The bunch weighs from 3.54 to 6.340 kg. It is quite a late maturing variety requiring about 17 months from the time of planting.

Origin: Bureau of Agriculture, No. 3458.

Musa sapientum Linn. var. *yan* var. nov. Yan Vat Ching, (C. A. No. 5203).

(Plate V, Fig. 37; VIII, 75; IX, 130; XII, 200–201).

A very good cropper and a good stooler, producing from the base from 15 to 19 stems. The color markings of the stem are like those of Saba. The stem is inclined, sometimes nearly lying on the ground. The stem varies in height from 310 to 330 cm. and has a base diameter of from 18 to 20 cm.

The leaves are not brittle. The mature blade measures from 175 to 180 cm. length and from 55 to 60 cm. in width. The surface above is smooth and shining and below is very glaucous and with deep grooves. The color is cedar-green, with a margin light brown in color. The apex and base of the leaf are rounded. The petiole is light green in color and very glaucous, with light brown margins and rather compressed and light green throughout. The midrib is light green.

The heart is similar to that of Saba in shape and bract characters. The flower is 6.5 cm. long, 10 to 11 mm. wide and 8 to 9 mm. deep. The scale is almost half the length of perigonium, purple all around, depressed at the middle, almost oblanceolate in form; apicula short and acute and with one sinus. The perigonium is purple with white stripes; limbs deep yellow; the pistil is slightly shorter or of the same length as the stamens and the perigonium. The stamens are five, longer than the pistil and as long as the perigonium. The anthers are light yellowish brown.

The fruits resemble those of *Saba* but with apex more tapering, angled, measure from 8.5 to 12 cm. in length and diameter cross section of from 2.5 to 3.8 cm. The skin is forest-green to wax-yellow when ripe. The flesh is buff-yellow near the center and whitish naphthalene-yellow at the edge. The quality is rather good except that it is a little too seedy; the taste is slightly tart, resembling very much in consistency that of Saba. It is as good a cooking banana as Saba, but rather dry when eaten raw. There are 8 to 10 hands, totaling 116 to 152 fruits with an average of 16 fruits to the hand. It takes about 10 months to bloom from the time of planting, and five at most to mature from blooming.

Origin: Bureau of Agriculture, No. 3529.

Musa sapientum Linn. var. *padilat* var. nov. Padilat, (C. A. No. 5353). ((Plate V, Fig. 38; VII, 71; VIII, 88; XII, 202–203; XXVIII, 1).

Producing from 15 to 22 stems. It is a good cropper. The stem is large, even larger than Saba sometimes; somewhat inclined. The color markings and characters are similar to Saba. It varies in height from 250 to 385 cm. and has a base diameter of from 24 to 27 cm.

The leaves are oblong-lanceolate with apex and base acute, brittle, cedar-green in color. The mature blade measures from 170 to 200 cm. in length and from 67 to 69 cm. in width. The surfaces are smooth but glaucous below. The petiole is 60 to 70 cm. long and rather upright.

The heart is nearly ovate; bracts with apices rounded, color dark lavender on the outside and pomegranate-purple in the inside. The flower is 6.5 to 6.7 cm. long, 8 to 10 mm. wide and 10 to 11 mm. deep. The scale is 3 to 3.1 cm. long, pale vinaceous-lilac, with the apex light yellow, depressed, nearly lanceolate in form, and with three sinuses; apicula long. The perigonium is laelia-pink with chrome-yellow limbs. The pistil is 4 to 4.5 cm. long, slightly shorter than the stamens. The stamens are as long as the perigonium.

The fruits are much compressed, wider and longer than those of Yan Vat Ching; apex tapering and almost of the same width throughout, held almost at right angles to the rhachis, in form very much like the fruit of Saba but much longer, measuring from 16 to 18 cm. in length and with a diameter of cross section of from 5.3 to 5.6 cm. The skin is biscay-green to apricot-yellow when ripe. The flesh is cream color, white at the center;

quality fair; texture rather coarse, dry and firm and lacking in juiciness; the flavor is mild, not very sweet. When baked, it is not very good eating, being too dry and lacking in flavor. When fried or boiled, it is more palatable and juicy. The style is deciduous and the calyx usually persistent. Seeds are absent. There are 6 to 7 hands to the bunch, totaling from 84 to 87 fruits with an average of from 12 to 14 per hand. The bunch weighs from 9.500 to 16.500 kg. It is one of the late maturing varieties requiring 19 months from the time of planting.

Origin: Bureau of Agriculture, No. 4205 from Dalupiri Island, Babuyan Islands, Cagayan Province, through the courtesy of Dr. Frank G. Gearheart.

Musa sapientum Linn. var. *garangao* Teodoro. Garangao.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 401–402 (1915).

Musa sapientum Linn. var. *grandis* Teodoro. Sabang Iloco.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 410. (1915).

Musa sapientum Linn. var. *binutig* Teodoro. Binutig.

Teodoro, N. G. *Philippine Journal of Science, Section C* **10**; 401. (1915).

Musa sapientum Linn. var. *hazara* var. nov. Hazara, (C. A. No. 4972). (Plate V, Fig. 34; VII, 70; XII, 204–205).

Producing from 17 to 22 stems. The stem is rather reclining in its growth; color markings similar to those of Maduranga. It varies in height from 260 to 335 cm. and has a base diameter from 20 to 29 cm.

The leaves are long and narrow; elongate-elliptic; apex acute and base round. The mature blade is 260 to 280 cm. in length and from 56 to 65 cm. in width; cedar-green, the upper surface is smooth and the lower very glaucous, thick; the margin is straw colored. The petiole is recurved; 68 to 70 cm. long, with color similar to Saba; deeply channelled.

The flower is 6 to 6.2 cm. long, 9.5 to 10 mm. wide and 9 to 9.5 cm. deep. The scale is 2.3 to 2.4 cm. long, and 8.5 to 9 mm. wide, the apex is white and the base is cameo-pink, oblanceolate in form, base of apicula very much more inflated than the remainder; apicula acute but without twisted apex. The perigonium is as long as the stamens striped with white and thulite-pink; the limbs primuline-yellow. The pistil is 4.2 to 4.5 cm. long with pale orange-yellow stigma, shorter than the stamens; stigma lobed. The stamens are five, basal half of the filaments is light pink.

The fruits are very much like those of Maduranga in form except that in the latter they are much more flattened and have a rather square cross section, subcylindric, with few cracks; the pedicel is long and the apex though tapering, has a distinct shoulder, style and calyx deciduous; angular but not conspicuously so. The skin is thick and of the same color as in Maduranga when green, pinard-yellow when very ripe, spotted and shaded with light mahogany-red. The flesh is maize-yellow near skin, buff yellow at the middle portions; the quality is poor, texture firm and coarse; flavor, subacid-slightly astringent, odor none. It is a poor eating kind; and rather poor for cooking also, due to its firmness. Fruits measure from 21 to 23.5 cm. in length and from 4.6 to 4.7 cm. in diameter. Seeds are absent. There are 5 to 7 hands to the bunch; totaling 55 to 92 fruits with an average of from 11 to 12. The bunch weighs from 6.200 to 15.440 kg. It takes about 16 months to mature from the time of planting.

Origin: Bureau of Agriculture, No. 1302 Saharanpur, India, through the courtesy of Mr. Hartless.

Musa sapientum Linn. var. *maduranga* var. nov. Maduranga.
(Plate VIII, Figs. 76–77, 89; XII, 210–211; XXV, 1).

Producing from 15 to 22 stems. The stem is reclining but not as much as in Hazara. It is a fairly good cropper. The stem is bright yellow green with brown patches. It varies in height from 250 to 345 cm. and has a base diameter of from 20 to 24 cm.

The leaves are rather brittle, the surface above is lightly shining, smooth, and that below is glaucous. The apex is subacute and the base is subtruncate. The mature blade measures from 150 to 155 cm. in length and from 50 to 54 cm. in width; the color is parrot-green. The petiole is quite long, reaching a length of from 50 to 55 cm.; greenish white in color and with brown patches at the base. The margin is green. The midrib is pale whitish green, with a shade of light pink near the apex.

The flower is 7.2 to 7.8 cm. long, 12 to 15 cm. wide and 12 to 12 mm. deep. The scale is rather long, large, oblanceolate in form; base of apicula not like that of Hazara inflated uniformly, with the apex twisted and acute; 3.7 to 3.8 cm. long and 11 to 13 cm. wide, light yellow in color, apex with the rest of the body, pale laelia-pink. The perigonium is similar to that of Hazara in color characters, with the base pink. The pistil is 4.7 to 5.2 cm. long; almost as long as the stamens and perigonium; stigma rather large and light ochraceous-buff in color. The stamens are five.

The fruits are not compactly set, large and heavy. Their position on the stem is similar to that in Binutig. Each fruit has a rounded apex somewhat similar to that of Hazara; in form and angle characters, neck distinct; pedicel long, style persistent and calyx deciduous. They measure from 17.4 to 21.2 cm. long and have a base diameter cross section of from 4.6 to 5.1 cm. The skin is medium thick, similar to Hazara in color characters. The flesh is similar to that of Hazara also; fair in quality; texture medium fine and fair juicy; flavor poor, not sweet, and slightly subacid. It is a much better cooking variety than Hazara, being more juicy and pulpy and less fibrous. Seeds are absent. There are 5 to 6 hands, totaling from 52 to 87 fruits, with an average of from 10 to 12 fruits per hand. The bunch weighs from 12.540 to 14.030 kg. It is a much earlier maturing variety than Hazara, requiring only about a year from the time of planting.

Origin: Bureau of Agriculture, No. 3092. From Lal Bagh, Bangalore, India.

Musa sapientum Linn. var. *flabellata* var. nov. Inabaniko. (C. A. No. 5015). Binendito (C. A. No. 2794).
(Plate V, Fig. 35; VIII, 78, 87; XII, 208–209; XXIX; 2).

Producing from 14 to 18 stems. The stem is almost upright, cylindrical and large very tall, reaching a height similar to that of Saba. Quite a good stooler and fairly good cropper. The diameter of the base of the stem is from 25 to 27 cm. The color character of the stem is similar in all respects to that of Saba.

The leaves are broad, long, elongate-elliptic; upper surface smooth and shining and the lower portion glaucous. The petiole is 50 to 60 cm. long; same color as in Saba. In fact, this variety is very similar to Saba and only the fruit and flower characters distinguish it from the latter.

The heart is oblanceolate with apex subtruncate. The bracts are brazil-red inside and indian-red on the outside. The flower is 6.9 to 7.1 cm. long, 9 to 10 mm. wide and 10 to 11 mm. deep. The scale is white, rudimentary yellow apicula, 3 to 3.1 cm. long and 7 to 8 mm. wide, obovate in form. The perigonium is cylindrical, dorsal surface striped with rhodomite pink; the limbs primuline-yellow. The pistil is 5 to 5.1 cm. long. The stamens are five; pistil shorter than the stamens and almost as long as the perigonium.

The fruits are adnate; a detached one is compressed at the base and swollen at the apex; apex blunt; style and calyx deciduous. It produces an average of 8 hands to the bunch, totaling 116 fruits with an average of 19 fruits to the hand. They vary in size from 10 to 13.8 cm. long and with a diameter cross section of from 3 to 4 cm. The color of the skin is very much like that of Saba. The flesh is the same as that of *Saba* in texture, taste, odor, color, and quality. The bunch weighs about 2,200 kg. Seeds are absent. This variety is fitted only for cooking, by baking and frying. It is poor when eaten raw due to its firmness and dryness of flesh, and rather coarse texture. It is a late maturing variety, similar to Saba, and takes about 2 years to mature from the time of planting.

Origin: Bureau of Agriculture, No. 2379. This is known as Binendito in Calamba, Laguna, and the same is called Inabaniko in Baliwag, Bulacan.

Musa paradisiaca Linn.

Kew Bull., Add ser. VI pt. 2 (1906) 22.

Musa paradisiaca Linn. var. *magna* (Blanco) Teodoro. Tundoc, Tundoc, Tindoc, 5029; Tondok, Tondok dagang 5096, Boracho; Tondoc (Tag.) Tandon 5222 (Borneo). (C. A. No. 1117). Blanco. 1. Filip. ed. 1. 244 (1837).

(Plate XII, Figs. 212–213).

This variety has many names, but plants under various names have been studied and found to belong to one and the same variety. The type for floral characters and description is the Tindok (C. A. No. 5029), a native of Surigao, Mindanao, and recently added to the College of Agriculture collection through the courtesy of the Bureau of Agriculture.

It is a very tall plant, and typical of the plantains. It is of upright growth but rather weak stem, and support is needed when in fruit; it produces at first one flowering stem but after the harvest it shoots out an unusual number, from 22 to 27 suckers. Its height varies from 340 to 365 cm., with a base diameter of 19 to 22 cm. The stem is slight orange citrine with reddish brown patches in some places.

The leaves are oblong, broad but not very long; upright in growth. The mature blade measures from 193 to 208 cm. in length and from 75 to 80 cm. in width, deep green parrot on top, both surfaces smooth; tip obtuse and base rounded with garret brown margin. The young leaves always have blood red to deep red patches, a constant character of most plantains. The petiole is from 33 to 63 cm. long, large, usually of a lumiere green color on the upper surface, base not patched except with some shades of light carmine. The midrib is large and long; light charcedony yellow with light shades of light pink.

The inflorescence is somewhat pendant, large, rather acute tip; three fascicles to the bunch. The flower is twice as large as any ordinary banana flower and almost as long as that of

Khai Pet; the scale is wide and much larger than the scale of dry banana; two in number one being present as a rudiment only; 5 to 6 stamens, enlarged at the middle, with apex needle like, and there compressed; perigonium two, one of them being rudimentary, and located ventrad. Besides the fertile stamens present, there can be found also one to two sterile ones. The terminal flowers found in banana are generally absent. Terminal flowers are sometimes present in Tiparot. Limbs of perigonium very long and curving, deep maize yellow, apices light orange. Stigma triangular and somewhat hairy. (Plates I, II and III.)

Fruits are large and long, measuring from 21 to 25 cm. in length and a cross section diameter of from 4.8 to 5.3 cm.; cylindrical, slightly angular to rounded 4-5 angled; pedicel short; more or less cresent in shape. The skin varies from apple green to mustard yellow when ripe and black when very ripe; $1\frac{1}{2}$ to 2 mm. thick, smooth; flesh medium coarse, heavy and moderately firm, pale yellow orange; sides somewhat rounded; style persistent; calyx deciduous; seeds absent; quality fair to excellent; flavor, slightly subacid, fair, not juicy, spicy and not as sweet as Pisang Tondok; odorless; good for cooking. The bunch weighs from 7.11 to 12.24 Kg.; 2 to 8 hands to the bunch; 23 to 116 bananas, with an average of from 8 to 16. It takes 24 to 28 months from planting to maturity. It is a very late maturing variety.

Musa paradisiaca Linn. var. *enosa* var. nov. Enosa (Phil.); Pisang Tondok (Java).
(Plate XII, Figs. 217–218; XXX, 2).

These two varieties have entirely different origin but are synonymous. Description was based on Pisang Tondok, it being a more common type than Enosa.

The plant is similar to Tandon and Tundok in height, stem characters, leaves, etc. The differences were based on fruit characters. In habit they are the same.

The fruits (Plate XII) are pendant, 28.5 to 34.5 cm. long and 4.5 to 4.7 cm. cross section diameter, long and pointed; the skin varies from apple green to mustard yellow when ripe, soft; flesh delicate, not as juicy and coarser and less fibrous than Tandon, mild subacid, rather sweet and good; odor similar to Saba; very angular with 3–6 sharp angles; calyx and style deciduous. It is not as good a cooking variety as Tandon. Seeds are absent.

Pisang Tondok came from Buitenzorg, Java.

Musa paradisiaca Linn. var. *tiparot* var. nov. Tiparot, (C. A. No. 5186).
(Plate VIII, Figs. 81–82, 93; XII, 214–216).

This variety came from the Bureau of Agriculture and its origin can not be traced through their records. It is, however, an exotic banana which was recently introduced into the Islands.

Good cropper, producing from 20 to 31 flowering stems to the clump. It resembles the Saba in stem characters, and in many other respects but differs in habit of growth and stooling, the Tiparot being more fecund and not erect. The height varies from 355 to 345 cm. and has a diameter of from 24 to 25 cm. at the base.

The leaves are long and broad, oblong-lanceolate; smooth and shiny on the top and very glaucous underneath; apex obtuse and base rounded; the length is 170 to 210 cm., the width from 56 to 70 cm.; the color of the mature blade resembles that of the Padilat; petiole rather long, deeply channeled; measuring from 53 to 68 cm. The color of the midrib and petiole resembles that of Saba.

The inflorescence is not constant in character. When the terminal flowers are deciduous, the spathe is pointed and lanceolate, but when the terminal flowers are persistent, the spathe is more or less lanceolate-ovate. The sterile flowers resemble those of the Saba group in color. The heart is lanceolate, morroco red on the outside and brazil red in the inside; apex acute; bracts with apices rounded. The flower is from 6.4 to 6.5 cm. long 9 to 10 mm. wide and 10 to 11 mm. deep; the scale is very much inflated, oblong, livid pink in color; 2.7 to 2.8 cm. long and 7 mm. wide; margin scarious; no depressions; apicula acute and yellow orange in color. Perigonium 6.4 to 6.5 cm. long; base, livid pink, center light buff and limbs antimony yellow. The pistil is from 4.2 to 4.4 cm. long, more or less erect; stigma not rounded, 3-4 lobes, light buff in color. Stamens five, with no sterile ones, as long as the perigonium and longer than the pistil; anthers buckthorn brown.

The fruits are large and approach the characters of Sabang Iloco type except that the tip is blunt. It produces 3 to 5 hands to the bunch, numbering from 25 to 42 bananas, with an average of 33; bunch weighing from 7.9 to 8.811 kg. Fruits measure from 19.5 to 20 cm. in length, and 5.5 to 7.0 cm. diameter cross section, at right angles to the stalk, rectangular in form and slightly compressed like the Saba; apex blunt and round; the skin 3 to 4 mm. thick, firm and coarse, cracking like Hanatuco Morado; color spinach green to chamois (deep pale orange) when ripe. The flesh is odorous like Nanka (*Artocarpus integrifolia*), delicate but fibrous; cross section 4-celled; juice somewhat sticky; angular like Pisang Tondok but as compressed as

Sabang Iloco; usually four-angled. The style and calyx are deciduous, the former being sometimes persistent. Seeds are absent. It is a good cooking banana like the Saba; slightly sweet and spicy when cooked. It matures at the age of from 16 to 18 months. Due to activity in stooling and mode of growth it should be planted a greater distance apart than the ordinary banana, Latundan.

Musa cavendishii Linn.

Baker, Kew Bull. Add. Ser. VI pt. 2 (1906), 16.

There are but few of the endemic varieties of Philippine dwarf bananas that can be enumerated here. Tampohin or Tampihan and Poot are quite extensively cultivated in many localities in the Islands. These are often called the "fretful bananas" by the natives. The natives believe that mutilation of the leaves will cause the death of the whole plant. The only explanation for this belief is that the mutilation of the leaves especially during the hot weather affects the vitality of the plant. Tenants seldom plant these varieties for they say that if they do bad luck always comes to them. Other varieties belonging to this species are: Salebaguito, Obob, Tucol, Ihalena, Gubon, Tucol and Amoa. None of these varieties have yet received thorough examination as to their botanical characters.

USES OF BANANA.

Among the many staple foods used by mankind, especially in the tropics, the banana commands the most esteem. In the temperate countries where often the cost of bananas is much higher than in the tropics, they are used only in many regions as a luxury. There has been much written about the uses of bananas in Europe as well as in America, that leads to the conclusion that the banana ranks high in food value, and that its place in the future as a food producer is bound to be an important one.

The *leaves* are used for wrappers, binders, shelter and shade for shed loving plants, such as cacao, coffee, etc., and lately it has been reported that the leaves are being used to heal wounds and cuts. Compost made of banana leaves is very excellent.

The *fruit* is the most useful part of the plant. It forms a diet for invalids, as well as for little children and convalescents from typhoid. The use depends upon the variety, of course; some varieties are fitted for the manufacture of vinegar, oil of banana, alcohol, Bananina (Banana extract), wine, jelly, flour or meal and "figs." Many varieties are eaten raw while others need boiling, frying, and baking to make them palatable. Mr. Kable, a German yeast manufacturer, said, in the *Tropical Agriculturist* that banana flour is particularly suitable for the manufacture of the yeast used in breweries.

VARIETIES GROUPED ACCORDING TO USE OF FRUITS.

I. *Eaten raw.*—Kileng, Klum, Tinumbaga, Lacatan, Dool, Sisi-on, Putian, Eda-an, Saloor, Galatayan, Hum Chuntara, Latundan, Morado, Durugo, Cuban Red, Inarnibal, Pop, Canaya, Sicsec, Maori, Apple banana, Bungulan, Tudlong dato, Ternate, Languma, Tuldoc, Pisang radja, Pamotion, Principe, Sungay Baca, Nam Chan Rai, Yanaikonban, Manka, Dinalaga, Raines na puti, Chuoi Ticu Huong, Kinamay dalaga, Angao, Katali.

II. *For boiling purposes.*—Saba, Khai Pet, Yan Vat Ching, Padilat, Garangao, Sabang Iloco, Binutig.

III. *For "figs."*—Veintecohol, Oanga, Dool, Canara, Sarocsoc, Pelipia, Inarnibal, Tudlong dato, Daryao, Dinalaga, Krie, Pitogo, Bungulan, Ternate, Tundok, Tandon.

IV. *For frying.*—Saba, Inabaniko, Padilat, Sabang Iloco, Hanatuko Morado, Hazara, Maduranga.

V. *For vinegar.*—Veintecohol, Botoan, Saba, Saguing maching, Tudlong dato, Misi Luki.

VI. *For flour or meal.*—Saba, Sabang Iloco and Inabaniko types are best, being very starchy at the stage just before maturity of fruits.

VII. *Flowers boiled and used as salad.*—Saba is the most desirable.

VIII. *Stem for fiber, cordage, etc.* From the stem of *Musa textilis* Neé (Manila hemp) abaca cloth known as *Sinamay* and strong cordage fibres are obtained. The former is used for mosquito nets, skirts and camisas. Besides *Musa textilis* Neé, other species produce fiber useful for cordage, for mats, for making paper, for packing materials and the manufacture of *papier maché.* Saguing maching, Tudlong dato and Butuan are sources of cordage fibers.

IX. *Chopped stems; feed for hogs;* nearly all varieties.

X. *For medicinal purposes;* Botoan, Tundok.

XI. *The sap, for indelible ink and dyes.*—The sap or juice from the stem or fruits may be used as a writing fluid or indelible dye, which no series of washing will remove.

XII. *For wrappers and binders.*—Saba, Botoan, and those bananas with non-brittle leaves.

XIII. *For ornamental purposes.*—Abyssinian banana, red flowered banana, *Musa ornata* Roxb., Virgen.

SPECIES AND VARIETIES OF THE GENUS MUSA GROWN IN THE COLLEGE AND BUREAU OF AGRICULTURES PLANTATIONS AND REPORTED FROM THE PHILIPPINE ISLANDS.

1. *Musa ensete* Gmel.......... Abyssinian banana.
2. *Musa glauca* Roxb.......... Virgen.
3. *Musa ornata* Roxb.
4. *Musa coccinea* Andr.......... Red-flowered Banana.
5. *Musa textilis* Neé.......... Abaca, Manila hemp.
6. *Musa errans* (Blanco) Teodoro.......... Saguing maching, saguing na ligao.
   Var. *botoan* Teodoro. Botoan, Butuhan, Butuan, Tag.; Lisohan Vis.
   Var. *basilisae* var. nov.
7. *Musa humilis* Perr.......... Pitogo, Sadiao, Inadiao, Higo "Fig Banana," Igos.
8. *Musa sapientum* Linn. True bananas.
   1. Var. *gladiata* var. nov. Kileng.
   2. Var. *oanga* var. nov. Oanga, Vangofi.
   3. Var. *klum* var. nov. Klum, Choi Mak, Choui La.
   4. Var. *tombak* (Blanco) Teodoro. Tinumbaga, Tombaga, Goyoran.
   5. Var. *misi* var nov. Misi Luki.
   6. Var. *lacatan* (Blanco) Teodoro. Lacatan.
   7. Var. *dool* var. nov. Dool, Duol.
   8. Var. *sision* var. nov. Sisi-on.
   9. Var. *putian* var. nov. Puttean, Putian.
   10. Var. *eda* var. nov. Eda-an.
   11. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri.
   12. Var. *canara* Teodoro, Canara.
   13. Var. *sarocsoc* var. nov. Sarocsoc.
   14. Var. *galatayan* var. nov. Galatayan.
   15. Var. *chuntara* var. nov. Hum Chuntara.
   16. Var. *cinerea* (Blanco) Teodoro. Letondal, Letundan, Tordan, Lotondan, Latundan, Litondan, Tundan, Maglihim, Cantony, Retundal, Martaban, Baluman.
   17. Var. *pelipia* var. nov. Pelipia.
   18. Var. *violacea* (Blanco) Teodoro, Morado.
   19. Var. *glaberrima* (Blanco) Teodoro. Durugo, Dinuguan.
   20. Var. *americana* Teodoro. Cuban Red, Morado de Cuba.
   21. Var. *inarnibal* Teodoro. Inarnibal.
   22. Var. *glauca* (Blanco) Teodoro. Veintecohol.
   23. Var. *pop* var. nov. Pop.
   24. Var. *canaya* var. nov. Canaya.
   25. Var. *sicsec* var. nov. Sicsec.
   26. Var. *maori* var. nov. Maori.
   27. Var. *cubensis* Teodoro. Apple Banana, Manzana de Cuba.
   28. Var. *suaveolens* (Blanco) Teodoro. Bun̄gulan.
   29. Var. *tudlong* Teodoro. Tudlong dato.
   30. Var. *ternatensis* (Blanco) Teodoro. Ternate, Gloria.
   31. Var. *daryao* Teodoro. Daryao.
   32. Var. *languma* var. nov. Languma.
   33. Var. *tuldoc* Teodoro. Tuldoc.
   34. Var. *radja* var. nov. Pisang radja.

35. Var. *pamotion* var. nov. Pamotion.
36. Var. *principe* var nov. Principe.
37. Var. *baca* var. nov. Sungay Baca.
38. Var. *nam* var. nov. Nam Chang Rai.
39. Var. *yanaikonban* var. nov. Yanaikonban.
40. Var. *rachidis* var. nov.
41. Var. *dinalaga* var. nov. Dinalaga.
42. Var. *raines* var. nov. Raines na puti.
43. Var. *cochinchinensis* var. nov. Choui Ticu Huong.
44. Var. *kinamay* var. nov. Kinamay Dalaga.
45. Var. *angao* var. nov. Angao.
46. Var. *katali* var. nov. Katali.
47. Var. *compressa* (Blanco) Teodoro. Saba.
48. Var. *khai* var. nov. Khai Pet.
49. Var. *krie* var. nov. Krie.
50. Var. *yan* var. nov. Yan Vat Ching.
51. Var. *padilat* var. nov. Padilat.
52. Var. *garangao* Teodoro. Garangao.
53. Var. *grandis* Teodoro. Sabang Iloco.
54. Var. *binutig* Teodoro, Binutig.
55. Var. *subrubea* (Blanco) Teodoro. Hanatuco Morado.
56. Var. *hazara* var. nov. Hazara.
57. Var. *maduranga* var. nov. Maduranga.
58. Var. *flabellata* var. nov. Inabaniko, Binendito.

9. *Musa paradisiaca* Linn. Plantains.
   1. Var. *magna* (Blanco) Teodoro. Tundoc, Tundok, Tindok, Tondok, Dagang, Boracho, Tondoc, Tag., Tandon, Borneo.
   2. Var. *enosa* var. nov. Enosa. Pisang Tondok.
   3. Var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer.
   4. Var. *ulnaris* (Blanco) Teodoro.
10. *Musa cavendishii* Lamb. The Dwarf Bananas.
   1. Var. *hawaiiensis* Teodoro. Hawaiian Dwarf banana.
   2. Var. *pumila* (Blanco) Teodoro. Tampohin.

PLATE IV

Musa sapientum L.

FIGURE 1. Var. *gladiata* var. nov. Kileng. Flower, side view.
2. Var. *oanga* var. nov. Oanga, Vangofi. Flower, front view.
3. Var. *klum* var. nov. Klum, Choi Mak, Chuoi La.
4. Var. *tombak* (Blanco) Tinumbaga, Tombaga, Goyoran.
5. Var. *misi* var. nov. Misi Luki.
6. Var. *dool* var. nov. Dool, Duol.
7. Var. *sisi on* var. nov. Sisi on.
8. Var. *putian* var. nov. Puttean, Putian.
9. Var. *eda* var. nov. Eda an.
10. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri.
11. Var. *sarocsoc* var. nov. Sarocsoc.
12. Var. *chuntara* var. nov. Hum Chuntara.
13. Var. *galatayan* var. nov. Galatayan.
14. Var. *pelipia* var. nov. Pelipia.
15. Var. *languma* var. nov. Languma.
16. Var. *maori* var. nov. Maori.
17. Var. *sicsec* var. nov. Sicsec.
18. Var. *canaya* var. nov. Canaya.
19. Var. *pop* var. nov. Pop.

Spathe of a Plantain (Pisang Tondok) with two bracts removed showing arrangement of fertile flowers

Spathe of a Plantain (Pisang Tondok) with one bract left showing inside view of fertile flowers and the rudimentary sterile flower (finger-like struoture)

Top view of a fertile flower of a Plantain (Pisang Tondok), showing young fruit at the base, scale (petal), stamens, pistil and calyx (perigonium). Flower type of Tondok

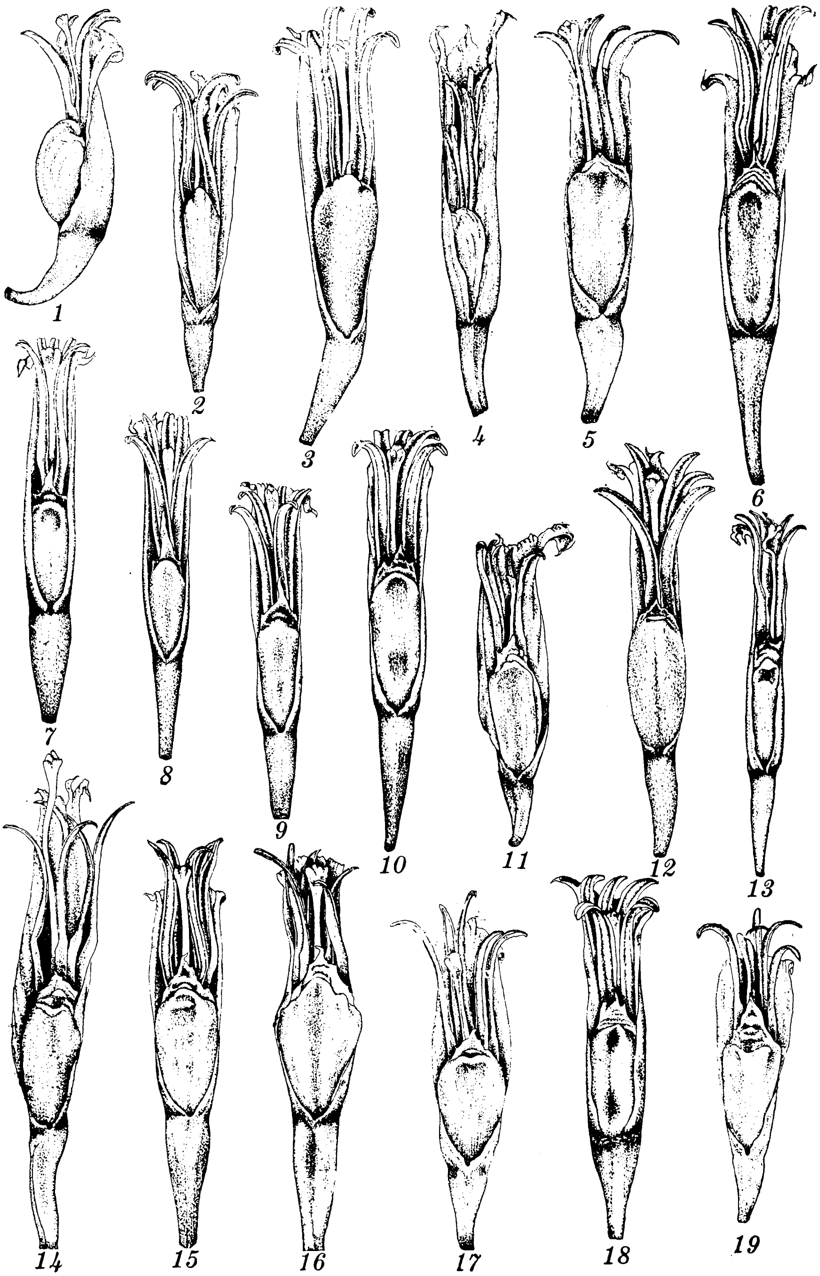
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PLATE V

Musa sapientum L.

FIGURE 20. Var. *radja* var. nov. Pisang radja. Flower, front view.
21. Var. *pamotion* var. nov. Pamotion.
22. Var. *principe* var. nov. Principe.
23. Var. *baca* var. nov. Sungay Baca.
24. Var. *nam* var. nov. Nam Chang Rai.
25. Var. *yanaikonban* var. nov. Yanaikonban.
26. Var. *rachidis* var. nov.
27. Var. *raines* var. nov. Raines na puti.
28. Var. *katali* var. nov. Katali.
29. Var. *conchinchinensis* var. nov. Chuoi Ticu Huong.
30. Var. *angao* var. nov. Angao.
31. Var. *dinalaga* var. nov. Dinalaga.
32. Var. *kinamay* var. nov. Kinamay Dalaga.
33. Var. *krie* var. nov. Krie.
34. Var. *hazara* var. nov. Hazara.
35. Var. *flabellata* var. nov. Inabaniko, Binendito.
36. Var. *padilat* var. nov. Padilat.
37. Var. *yan* var. nov. Yan Vat Ching.
38. Var. *khai* var. nov. Khai Pet.

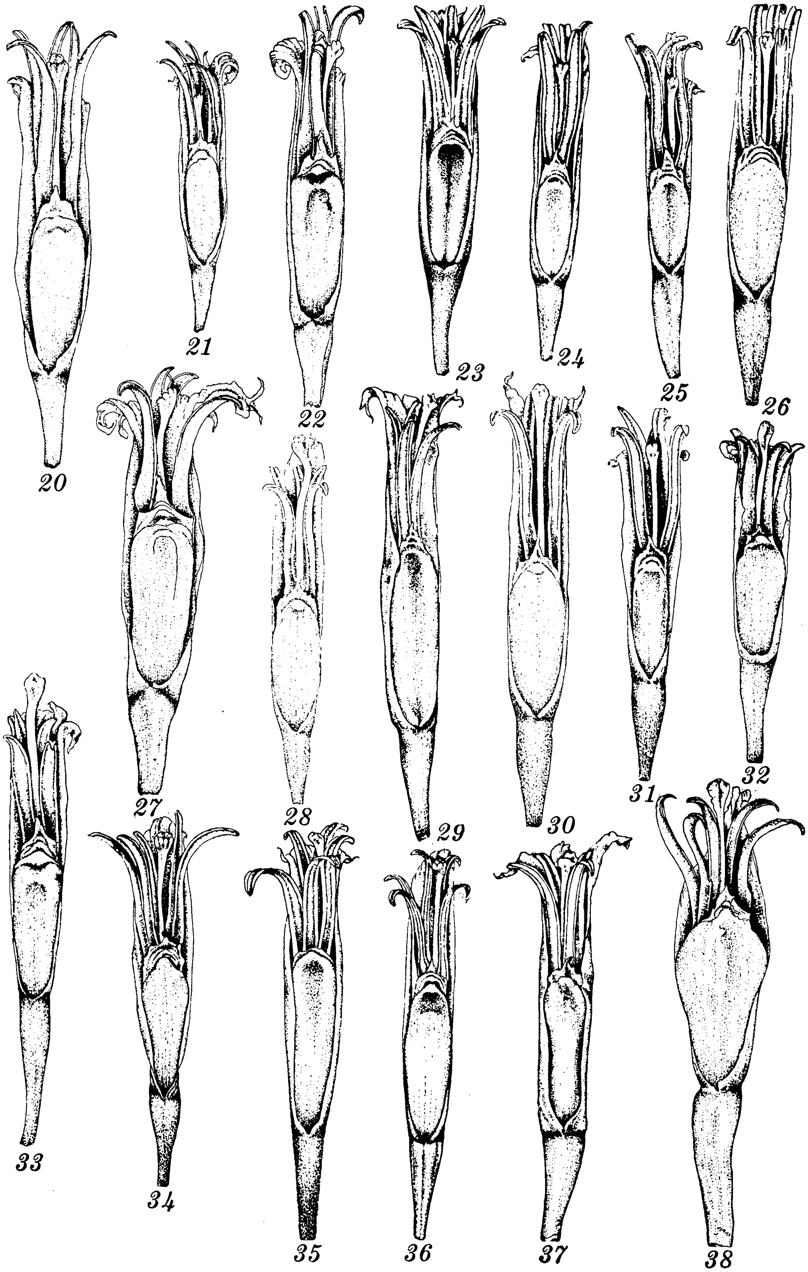
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Plate VI

Musa sapientum L.

FIGURE 39. Var. *gladiata* var. nov. Kileng. Flower, front view.
40. Var. *oanga* var. nov. Oanga, Vangofi. Flower, side view.
41. Var. *klum* var. nov. Klum, Choi Mak, Chuoi La.
42. Var. *tombak* (Blanco) Tinumbaga, Tombaga, Goyoran.
43. Var. *misi* var. nov. Misi Luki.
44. Var. *dool* var. nov. Dool, Duol.
45. Var. *sisi on* var. nov. Sisi on.
46. Var. *putian* var. nov. Puttean, Putian.
47. Var. *eda* var. nov. Eda an.
48. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri.
49. Var. *sarocsoc* var. nov. Sarocsoc.
50. Var. *galatayan* var. nov. Galatayan.
51. Var. *pelipia* var. nov. Pelipia.
52. Var. *chuntara* var. nov. Hum Chuntara.
53. Var. *pop* var. nov. Pop.
54. Var. *canaya* var. nov. Canaya.
55. Var. *maori* var. nov. Maori.
56. Var. *sicsec* var. nov. Sicsec.

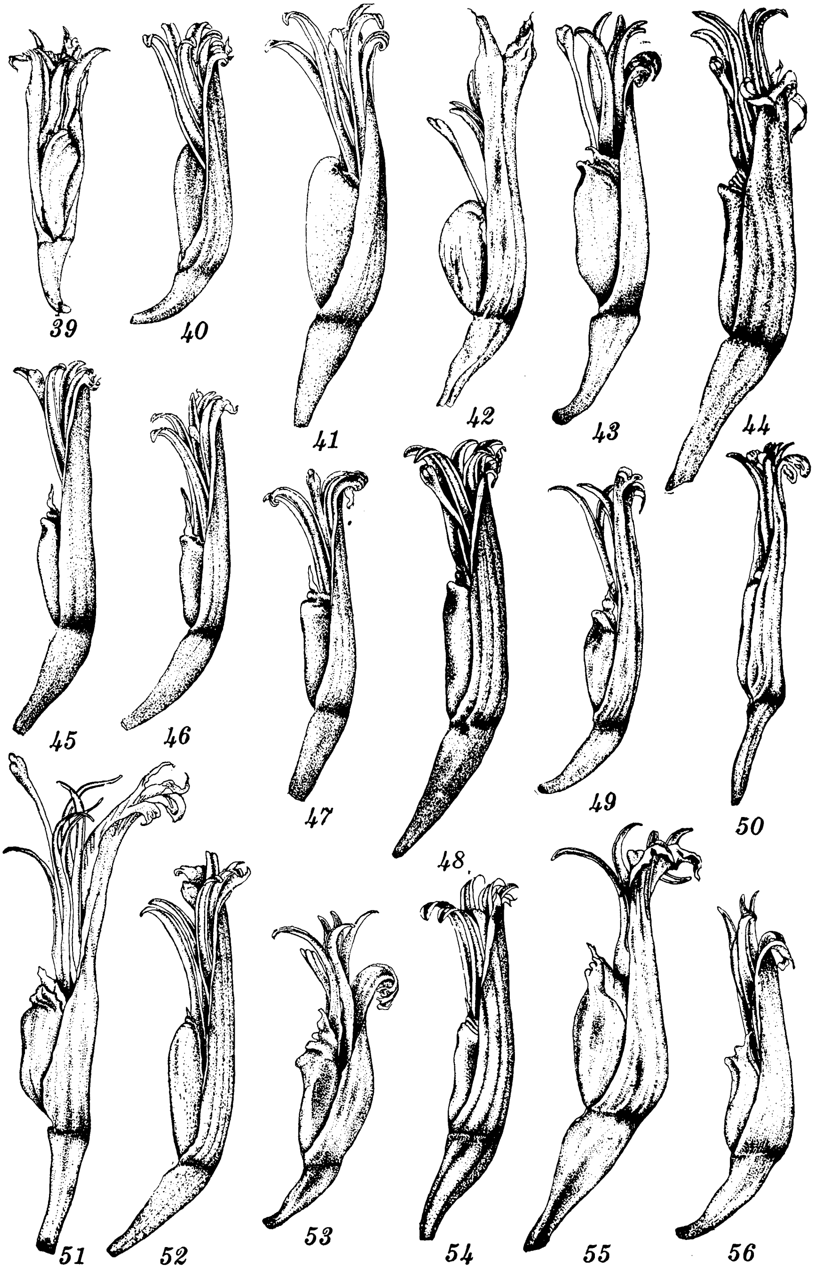
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PLATE VII

Musa sapientum L.

FIGURE 57. Var. *languma* var. nov. Languma. Flower, side view.
58. Var. *radja* var. nov. Pisang radja.
59. Var. *pamotion* var. nov. Pamotion.
60. Var. *baca* var. nov. Sungay Baca.
61. Var. *principe* var. nov. Principe.
62. Var. *nam* var. nov. Nam Chang Rai.
63. Var. *yanaikonban* var. nov. Yanaikonban.
64. Var. *rachidis* var. nov.
65. Var. *raines* var. nov. Raines na puti.
66. Var. *dinalaga* var. nov. Dinalaga.
67. Var. *kinamay* var. nov. Kinamay Dalaga.
68. Var. *cochinchinensis* var. nov. Chuoi Ticu Huong.
69. Var. *angao* var. nov. Angao.
70. Var. *hazara* var. nov. Hazara.
71. Var. *padilat* var. nov. Padilat.
72. Var. *khai* var. nov. Khai Pet.
73. Var. *krie* var. nov. Krie.
74. Var. *katali* var. nov. Katali.

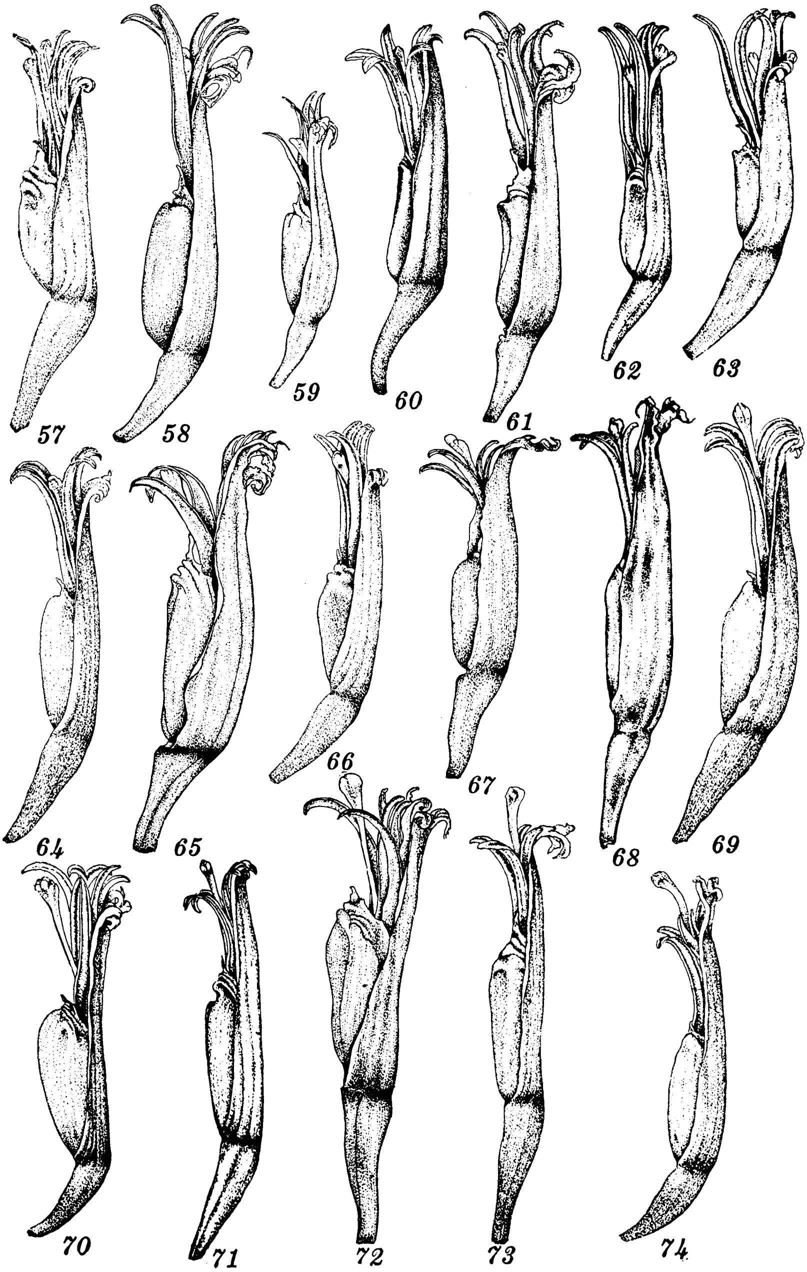
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PLATE VIII

FIGURE 75. *Musa saptientum* L. var. nov. Yan Vat Ching. Flower, side view.

76. Var. *maduranga* var. nov. Maduranga. Flower, front view.
77. Var. *maduranga* var. nov. Maduranga. Flower, side view.
78. Var. *flabellata* var. nov. Inabaniko, Binendito. Flower, side view.
79. *Musa ornata* Roxb. Fertile flower, side view.
80. *Musa ornata* Roxb. Fertile flower, front view.
81. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Flower, front view.
82. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Flower side view.
83. *Musa errans* (Blanco) Teodoro var. *basilisae* var. nov. Flower, front view.
84. *Musa errans* (Blanco) Teodoro var. *basilisae* var. nov. Flower, side view.
85. *Musa ornata* Roxb. Flower, front view.
86. *Musa ornata* Roxb. Flower, side view.
87. *Musa sapientum* L. var. *flabellata* var. nov. Inabaniko, Binendito. Scale, front view.
88. *Musa sapientum* L. var. *padilat* var. nov. Padilat. Scale, front view.
89. *Musa sapientum* L. var. *maduranga* var. nov. Maduranga. Scale, front view.
90. *Musa ornata* Roxb. Scale from fertile flower, front view.
91. *Musa ornata* Roxb. Scale from sterile flower, front view.
92. *Musa errans* (Blanco) Teodoro var. *basilisae* var. nov. Scale, front view.
93. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Scale, front view.
94. *Musa ornata* Roxb. Fertile flower, showing stamen and pistil.
95. *Musa ornata* Roxb. Sterile flower, showing stamen and pistil.

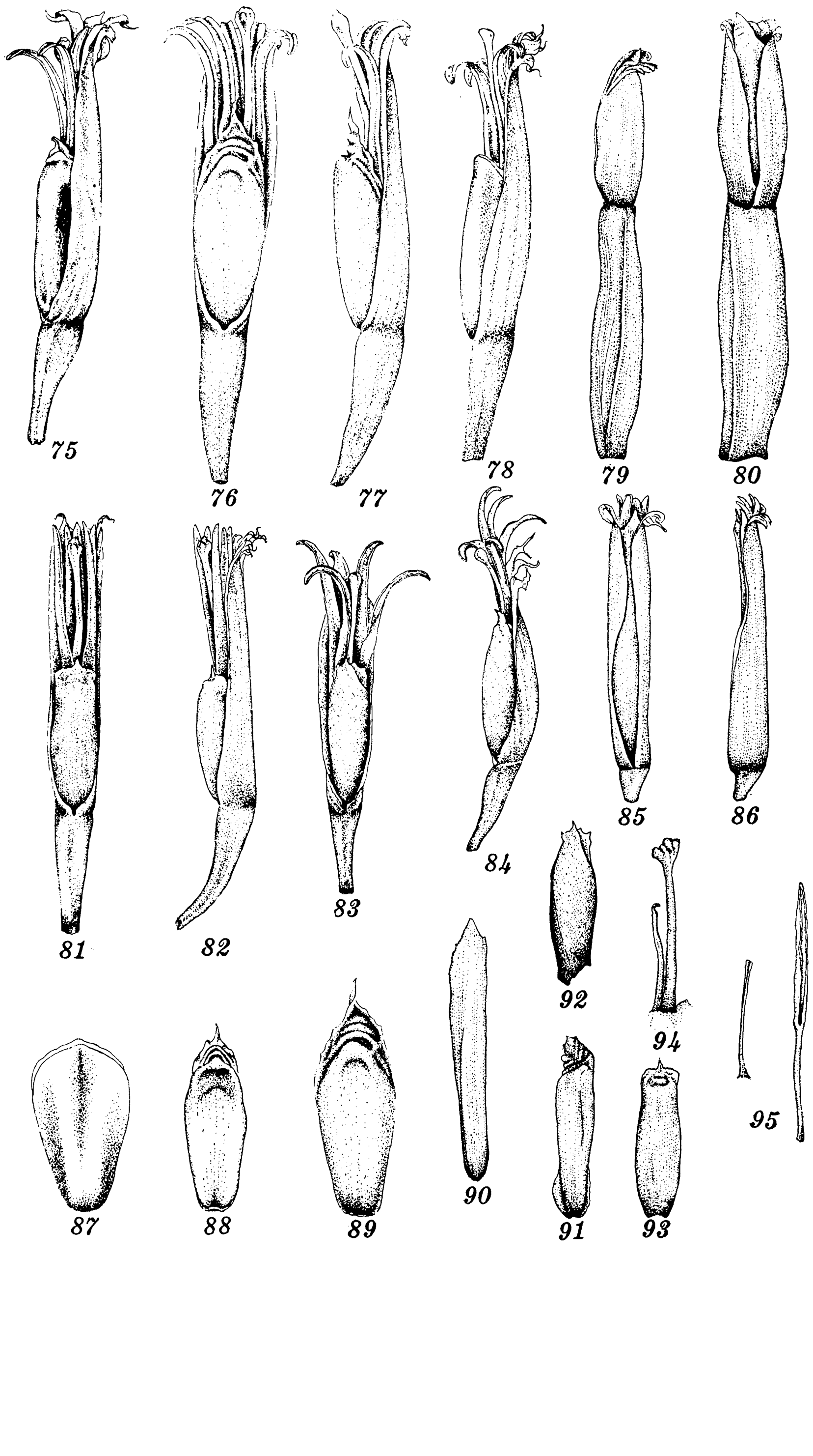
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PLATE IX

Musa sapientum L.

FIGURE 96. Var. *gladiata* var. nov. Kileng, showing Apicula, back view and Scale, front view.

97. Var. *oanga* var. nov. Oanga, showing Scale, front view and Scale, side view.
98. Var. *klum* var. nov. Klum, Choi Mak, Chuoi La. Scale, front view.
99. Var. *tombak* (Blanco) Tinumbaga, Tombaga, Goyoran showing scale, side view and scale, front view.
100. Var. *misi* var. nov. Misi Luki. Scale, front view.
101. Var. *dool* var. nov. Dool, Duol.
102. Var. *sisi on* var. nov. Sisi on.
103. Var. *putian* var. nov. Puttean, Putian.
104. Var. *eda* var. nov. Eda an.
105. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri.
106. Var. *sarocsoc* var. nov. Sarocsoc.
107. Var. *chuntara* var. nov. Hum Chuntara.
108. Var. *galatayan* var. nov. Galatayan.
109. Var. *pelipia* var. nov Pelipia.
110. Var. *pop* var. nov Pop.
111. Var. *canaya* var. nov. Canaya.
112. Var. *sicsec* var. nov. Sicsec.
113. Var. *maori* var. nov. Maori.
114. Var. *languma* var. nov Languma.
115. Var. *radja* var. nov. Pisang radja.
116. Var. *pamotion* var. nov. Pamotion.
117. Var. *principe* var. nov. Principe.
118. Var. *baca* var. nov. Sungay Baca.
119. Var. *nam* var. nov. Nam Chang Rai.
120. Var. *yanaikonban* var. nov. Yanaikonban.
121. Var. *rachidis* var. nov.
122. Var. *dinalaga* var. nov. Dinalaga.
123. Var. *cochinchinensis* var. nov. Chuoi Ticu Huong.
124. Var. *raines* var. nov. Raines na puti.
125. Var. *kinamay* var. nov. Kinamay Dalaga.
126. Var. *angao* var. nov. Angao.
127. Var. *khai* var. nov. Khai Pet.
128. Var. *katali* var. nov. Katali.
129. Var. *krie* var. nov. Krie.
130. Var. *yan* var. nov. Yan Vat Ching.
131. Var. *hazara* var. nov. Hazara.

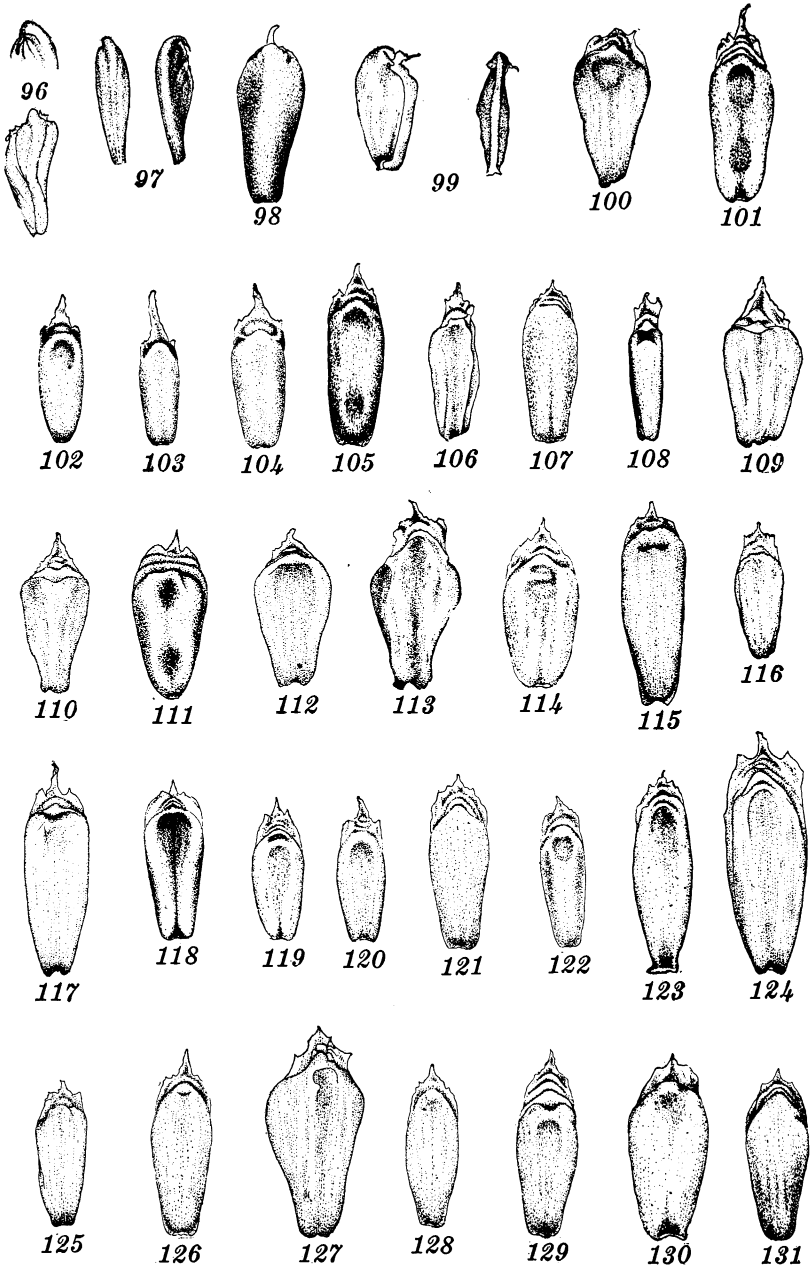
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PLATE X

Musa sapientum L.

FIGURE 132. Var. *gladiata* var. nov. Kileng. Fruit, side view.
133. Var. *gladiata* var. nov. Kileng. Fruit, cross section.
134. Var. *oanga* var. nov. Oanga, Vangofi, Fruit, side view.
135. Var. *oanga* var. nov. Oanga, Vangofi, Fruit, cross section.
136. Var. *klum* var. nov. Klum, Choi Mak, Chuoi La. Fruit, cross section.
137. Var. *klum* var. nov. Klum, Choi Mak, Chuoi La. Fruit, side view.
138. Var. *tombak* (Blanco) Tinumbaga, Tombaga, Goyoran. Fruit, cross section.
139. Var. *tombak* (Blanco) Tinumbaga, Tombaga, Goyoran. Fruit, side view.
140. Var. *misi* var. nov. Misi Lùki. Fruit, cross section.
141. Var. *misi* var. nov. Misi Luki. Fruit, side view.
142. Var. *dool* var. nov. Dool, Duol. Fruit, side view.
143. Var. *dool* var. nov. Dool, Duol. Fruit, cross section.
144. Var. *sision* var. nov. Sision. Fruit, side view.
145. Var. *sision* var. nov. Sision. Fruit, cross section.
146. Var. *putian* var. nov. Puttean, Putian. Fruit, side view.
147. Var. *putian* var. nov. Puttean, Putian. Fruit, cross section.
148. Var. *eda* var. nov. Eda an. Fruit, side view.
149. Var. *eda* var. nov. Eda an. Fruit, cross section.
150. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri. Fruit, side view.
151. Var. *saloor* var. nov. Saloor, Kanaibansi, Susu petri. Fruit, cross section.
152. Var. *sarocsoc* var. nov. Sarocsoc. Fruit, side view.
153. Var. *sarocsoc* var. nov. Sarocsoc. Fruit, cross section.
154. Var. *galatayan* var. nov. Galatayan. Fruit, side view.
155. Var. *galatayan* var. nov. Galatayan. Fruit, cross section.
156. Var. *chuntara* var. nov. Hum Chuntara. Fruit, side view.
157. Var. *chuntara* var. nov. Hum Chuntara. Fruit, cross section.
158. Var. *pelipia* var. nov. Pelipia. Fruit, side view.
159. Var. *pelipia* var. nov. Pelipia. Fruit, cross section.
160. Var. *pop* var. nov. Pop. Fruit, side view.
161. Var. *pop* var. nov. Pop. Fruit, cross section.
162. Var. *canaya* var. nov. Canaya. Fruit, side view.
163. Var. *canaya* var. nov. Canaya. Fruit, cross section.
164. Var. *sicsec* var. nov. Sicsec. Fruit, side view.
165. Var. *sicsec* var. nov. Sicsec. Fruit, cross section.

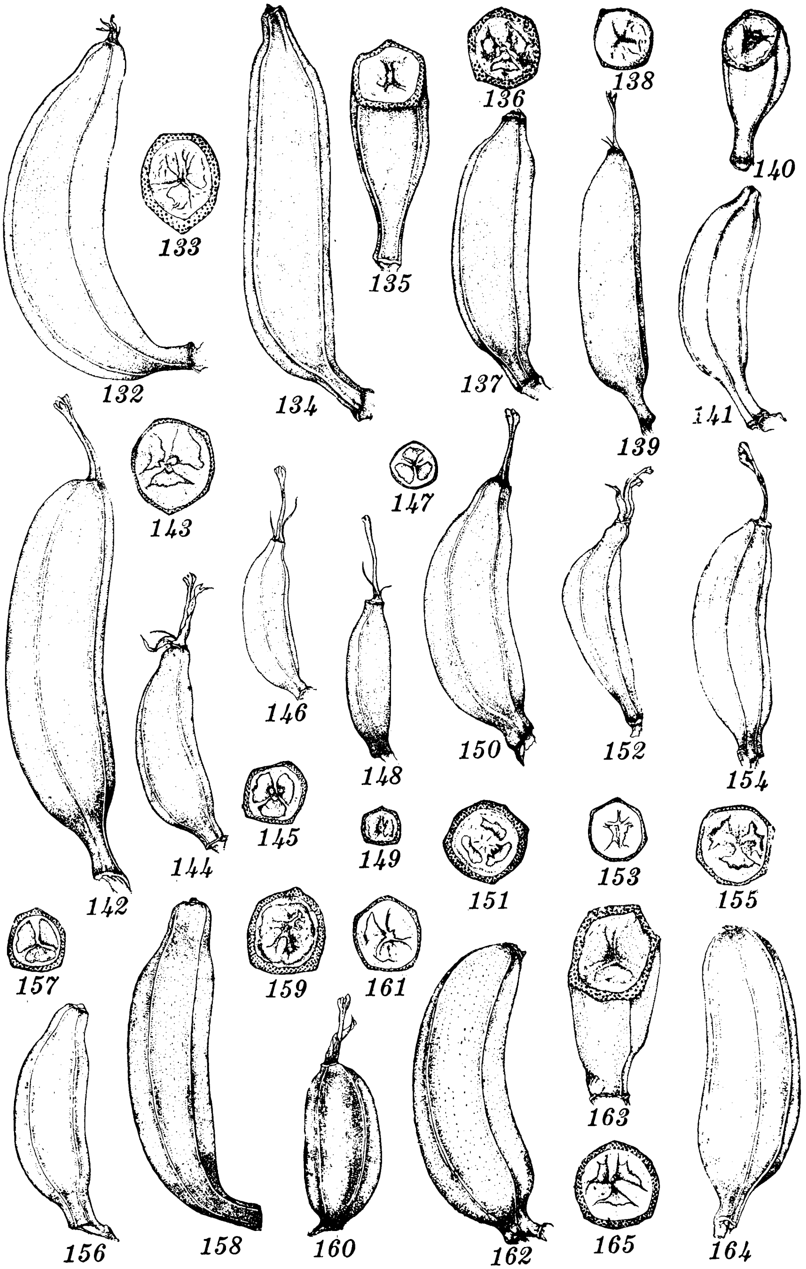
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PLATE XI

Musa sapientum L.

FIGURE 166. Var. *maori* var. nov. Maori. Fruit, side view.
167. Var. *maori* var. nov. Maori. Fruit, cross section.
168. Var. *languma* var. nov. Languma. Fruit, side view.
169. Var. *languma* var. nov. Languma. Fruit, cross section.
170. Var. *radja* var. nov. Pisang radja. Fruit, side view.
171. Var. *radja* var. nov. Pisang radja. Fruit, cross section.
172. Var. *pamotion* var. nov. Pamotion. Fruit, side view.
173. Var. *pamotion* var. nov. Pamotion. Fruit, cross section.
174. Var. *principe* var. nov. Principe. Fruit, side view.
175. Var. *principe* var. nov. Principe. Fruit, cross section.
176. Var. *baca* var. nov. Sungay Baca. Fruit, side view.
177. Var. *baca* var. nov. Sungay Baca. Fruit, cross section.
178. Var. *nam* var. nov. Nam Chang Rai. Fruit, side view.
179. Var. *nam* var. nov. Nam Chang Rai. Fruit, cross section.
180. Var. *yanaikonban* var. nov. Yanaikonban. Fruit, side view.
181. Var. *yanaikonban* var. nov. Yanaikonban. Fruit, cross section.
182. Var. *rachidis* var. nov. Fruit, side view.
183. Var. *rachidis* var. nov. Fruit, cross section.
184. Var. *dinalaga* var. nov. Dinalaga. Fruit, side view.
185. Var. *dinalaga* var. nov. Dinalaga. Fruit, cross section.
186. Var. *raines* var. nov. Raines na puti. Fruit, side view.
187. Var. *raines* var. nov. Raines na puti. Fruit, cross section.
188. Var. *cochinchinensis* var. nov. Chuoi Ticu Huong. Fruit, side view.
189. Var. *cochinchinensis* var. nov. Chuoi Ticu Huong. Fruit, cross section.
190. Var. *kinamay* var. nov. Kinamay Dalaga. Fruit, side view.
191. Var. *kinamay* var. nov. Kinamay Dalaga. Fruit, cross section.
192. Var. *angao* var. nov. Angao. Fruit, side view.
193. Var. *angao* var. nov. Angao. Fruit, cross section.
194. Var. *katali* var. nov. Katali. Fruit, side view.
195. Var. *katali* var. nov. Katali. Fruit, cross section.
196. Var. *khai* var. nov. Khai Pet. Fruit, side view.
197. Var. *khai* var. nov. Khai Pet. Fruit, cross section.
198. Var. *krie* var. nov. Krie. Fruit, side view.
199. Var. *krie* var. nov. Krie. Fruit, cross section.

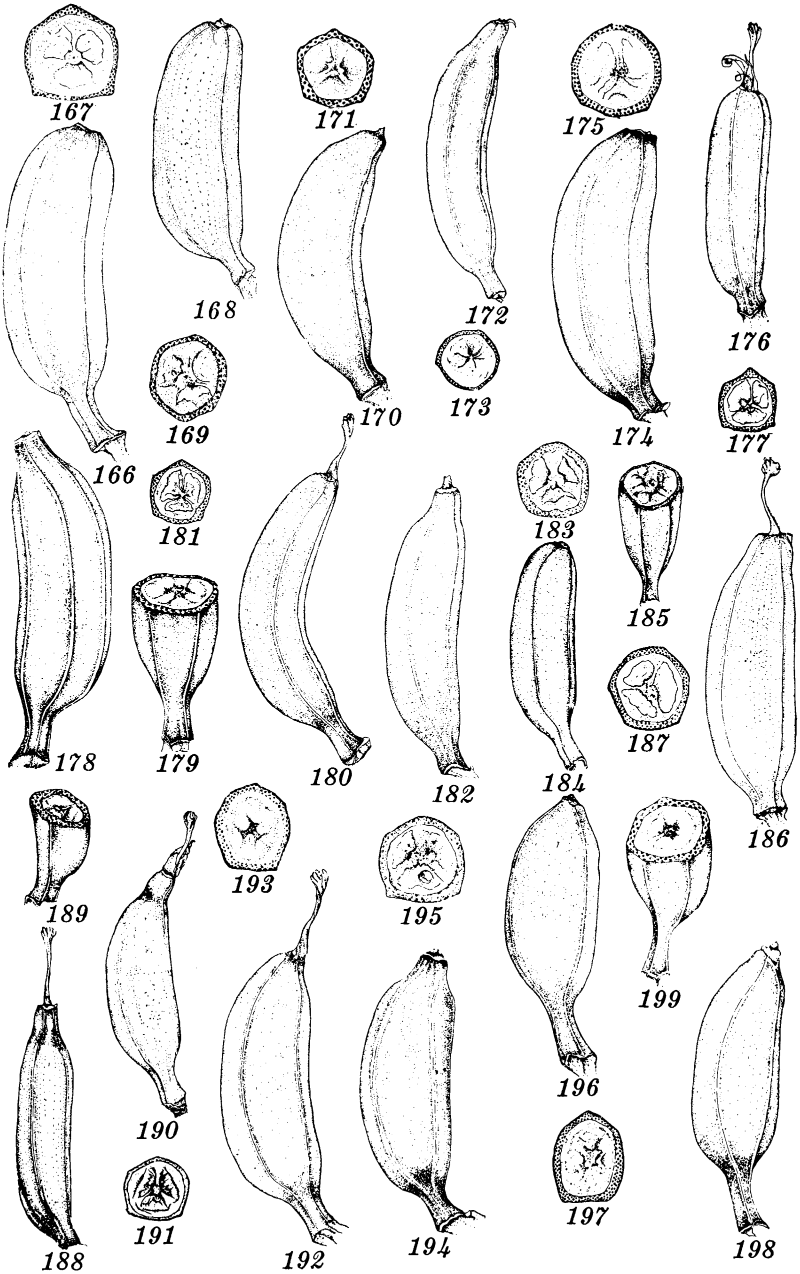
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PLATE XII

FIGURE 200. *Musa sapientum* L. var. *yan* var. nov. Yan Vat Ching. Fruit, side view.

201. *Musa sapientum* L. var. *yan* var. nov. Yan Vat Ching. Fruit, cross section.

202. *Musa sapientum* L. var. *padilat* var. nov. Padilat. Fruit, side view.

203. *Musa sapientum* L. var. *padilat* var. nov. Padilat. Fruit, cross section.

204. *Musa sapientum* L. var. *hazara* var. nov. Hazara. Fruit, side view.

205. *Musa sapientum* L. var. *hazara* var. nov. Hazara. Fruit, cross section.

206. *Musa errans* (Blanco) Teodoro var. *basilisae* var. nov. Fruit, side view.

207. *Musa errans* (Blanco) Teodoro var. *basilisae* var. nov. Fruit, cross section.

208. *Musa sapientum* L. var. *flabellata* var. nov. Inabaniko, Binendito. Fruit, side view.

209. *Musa sapientum* L. var. *flabellata* var. nov. Inabaniko, Binendito. Fruit, cross section.

210. *Musa sapientum* L. var. *maduranga* var. nov. Maduranga. Fruit, side view.

211. *Musa sapientum* L. var. *maduranga* var. nov. Maduranga. Fruit, cross section.

212. *Musa paradisiaca* L. var. *magna* (Blanco) Tundoc, Tundok, Tindok, Tondok, Dagang, Boracho, Tondoc, Tag.; Tandon, Borneo. Fruit, side view.

213. *Musa paradisiaca* L. var. *magna* (Blanco) Tundoc, Tundok, Tindok, Tondok, Dagang, Boracho, Tondoc, Tag.; Tandon, Borneo. Fruit, cross section.

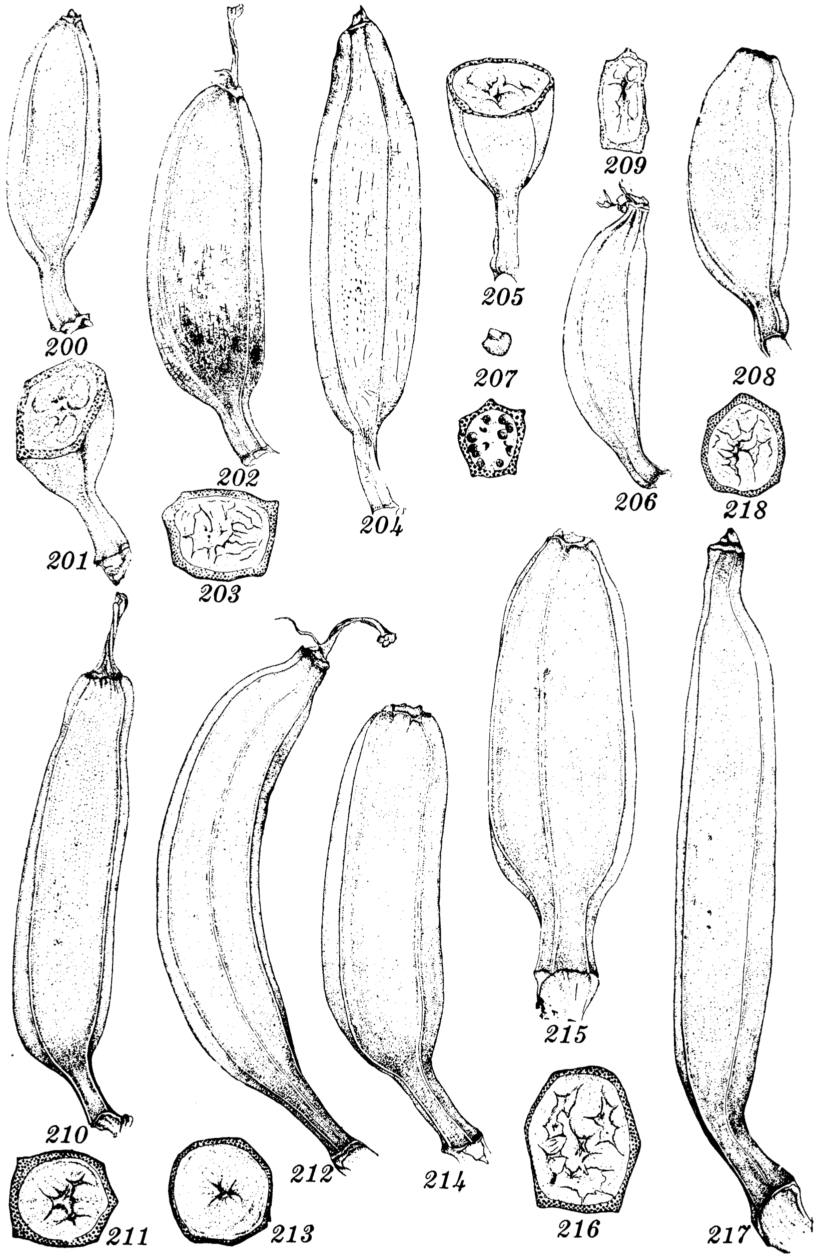
214. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Fruit, side view.

215. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Fruit, front view.

216. *Musa paradisiaca* L. var. *tiparot* var. nov. Tiparot, Klin Phaya Sawer. Fruit, cross section.

217. *Musa paradisiaca* L. var. *enosa* var. nov. Enosa, Pisang Tondok. Fruit, side view.

218. *Musa paradisiaca* L. var. *enosa* var. nov. Enosa, Pisang Tondok. Fruit, cross section.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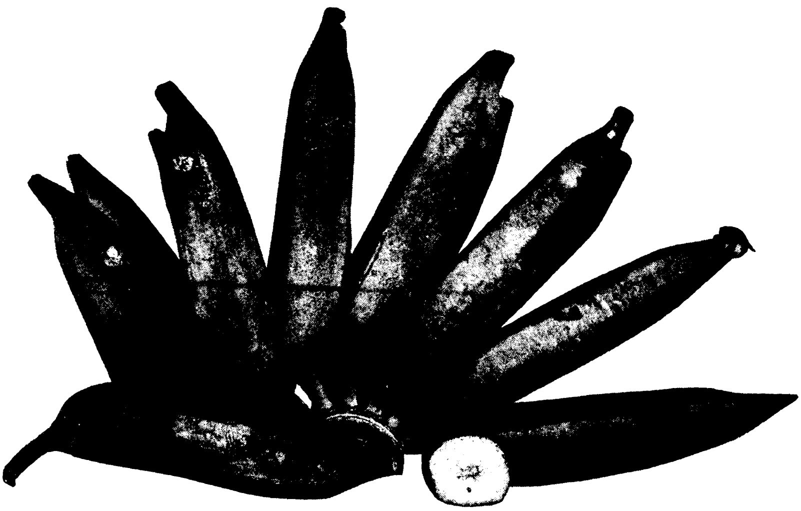
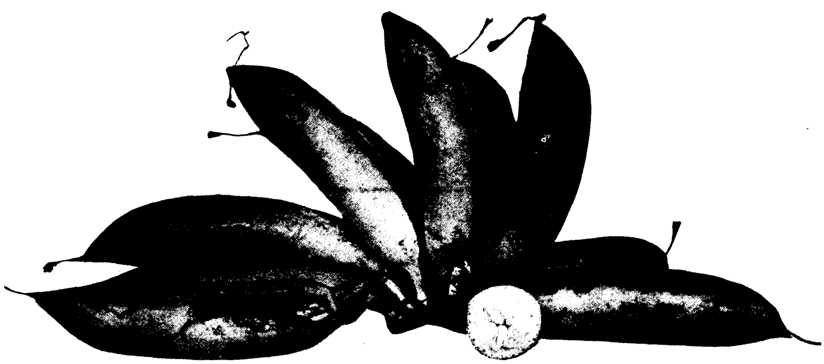
1. *Musa sapientum* L. var. *gladiata* var. nov. Kileng

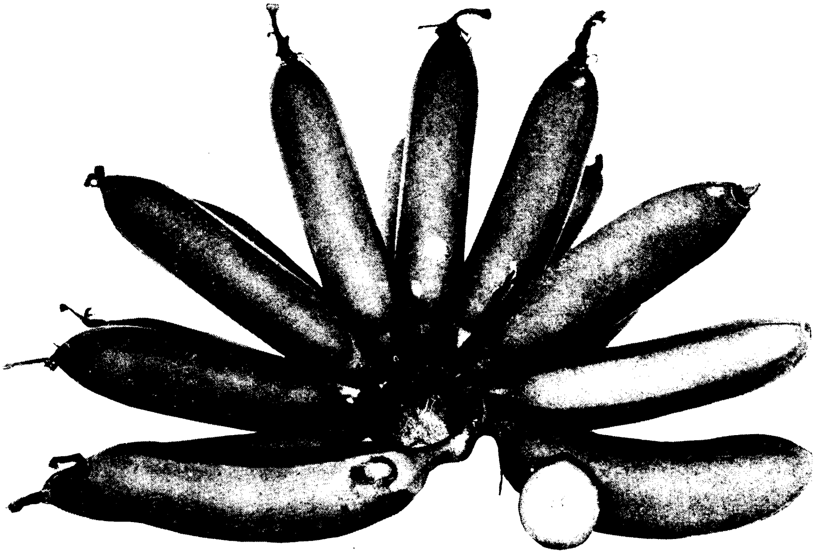


2. *Musa sapientum* L. var. *oanga* var. nov. Oanga

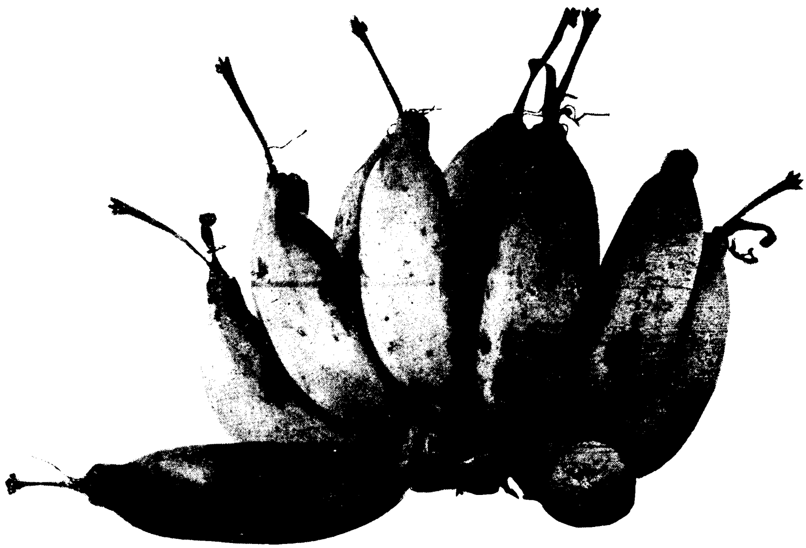
1. *Musa sapientum* L. var. *klum* var. nov. Klum



2. *Musa sapientum* L. var. *tombak* (Blanco) Tinumbaga

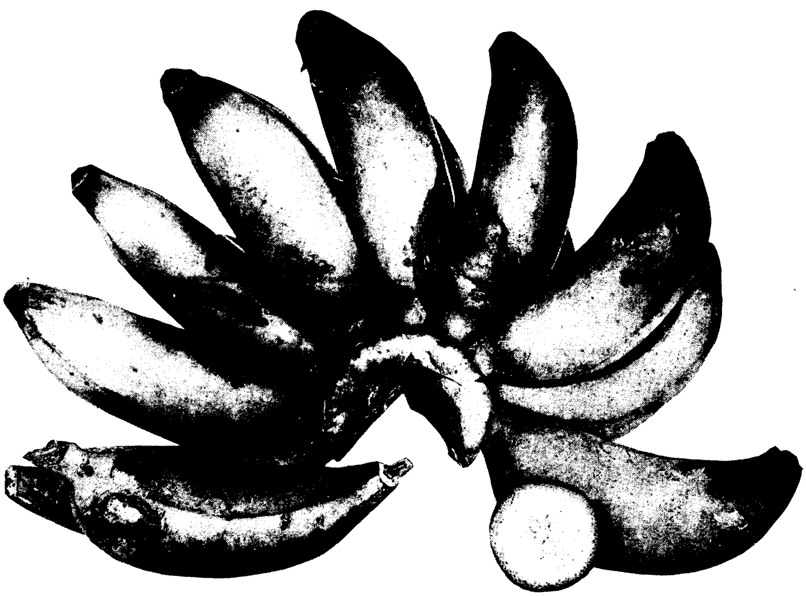


1. *Musa sapientum* L. var. *dool* var. nov. Dool

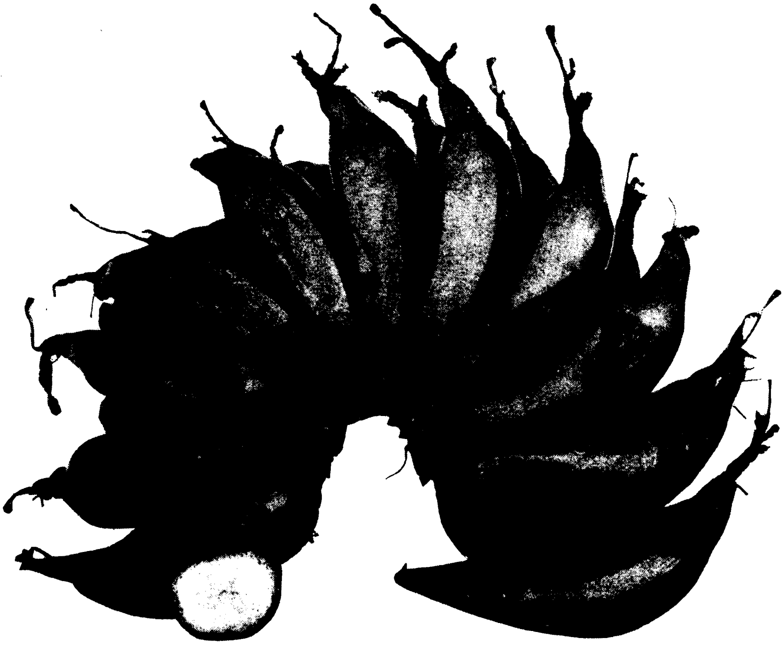


2. *Musa sapientum* L. var. *putian* var. nov. Putian

1. *Musa sapientum* L. var. *eda* var. nov. Eda an



2. *Musa sapientum* L. var. *saloor* var. nov. Saloor

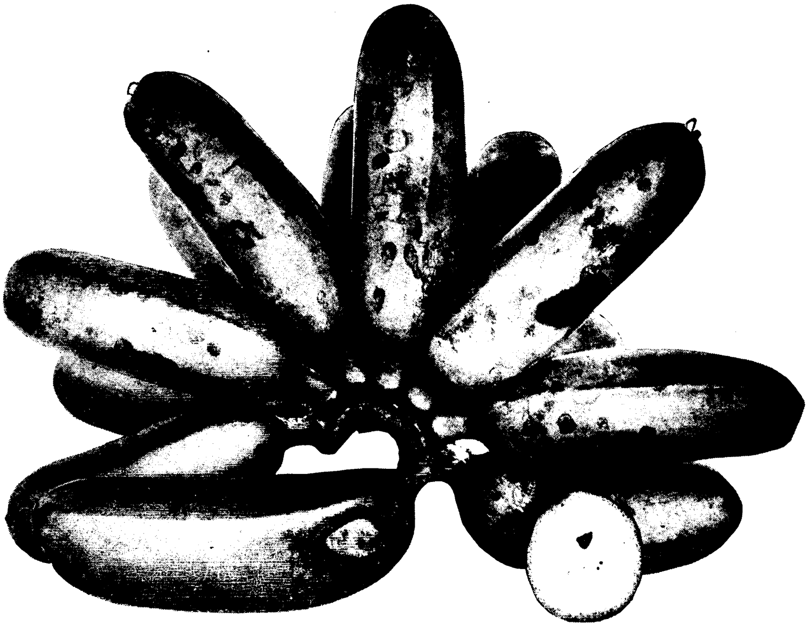


1. *Musa sapientum* L. var. *sarocsoc* var. nov. Sarocsoc

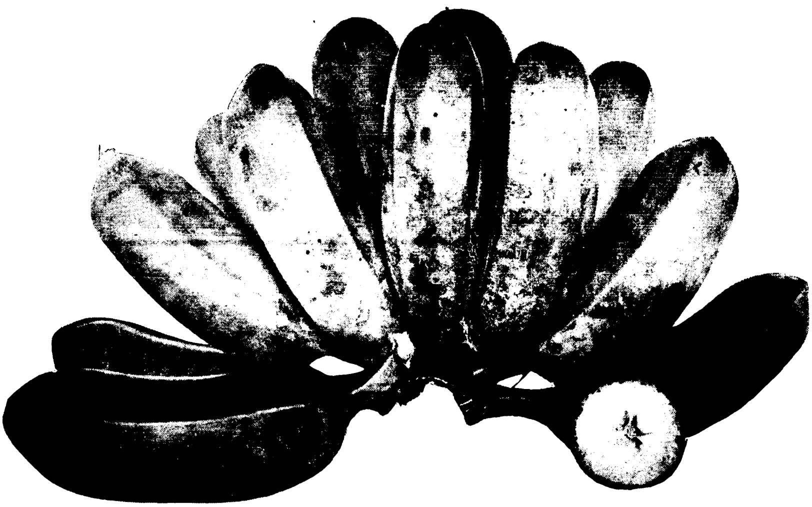
2. *Musa sapientum* L. var. *chuntara* var. nov. Hum Chuntara

1. *Musa sapientum* L. var. *galatayan* var. nov. Galatayan

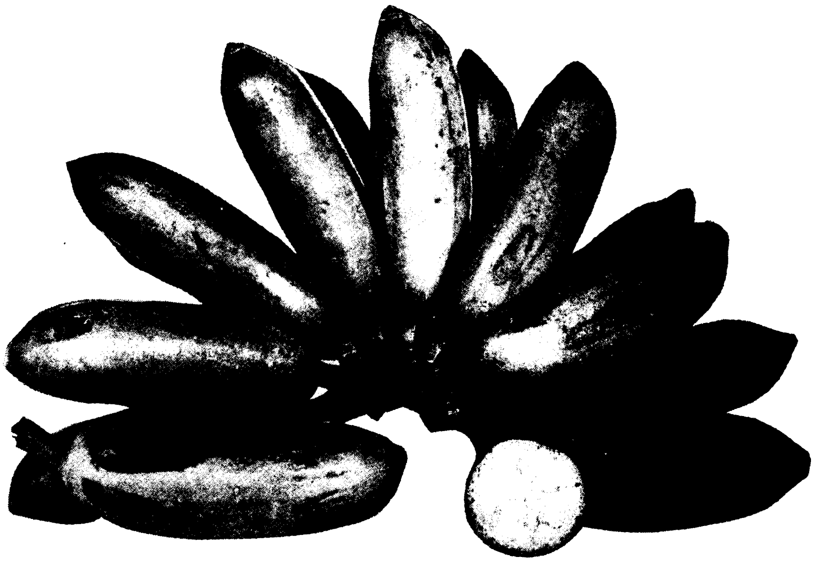
2. *Musa sapientum* L. var. *pelipia* var. nov. Pelipia



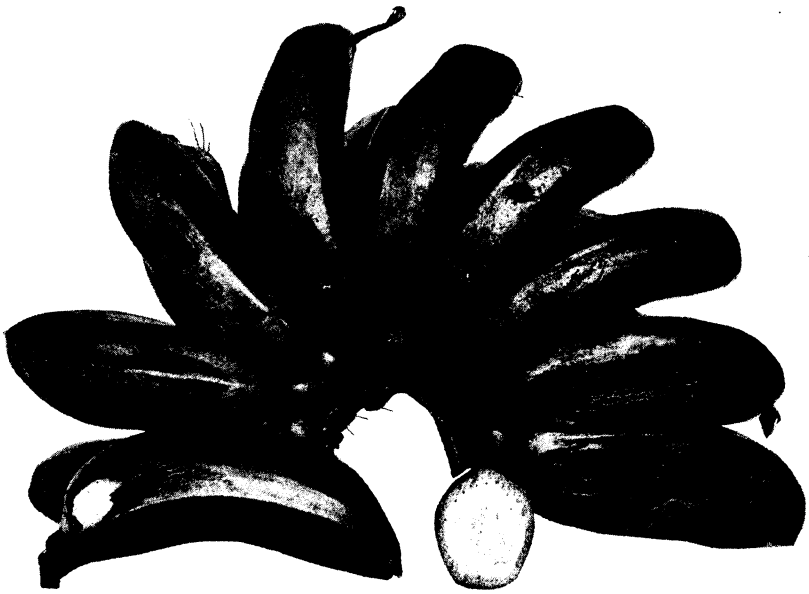
1. *Musa sapientum* L. var. *languma* var. nov. Languma.



2. *Musa sapientum* L. var. *maori* var. nov. Maori



1. *Musa sapientum* L. var. *sicsec* var. nov. Sicsec



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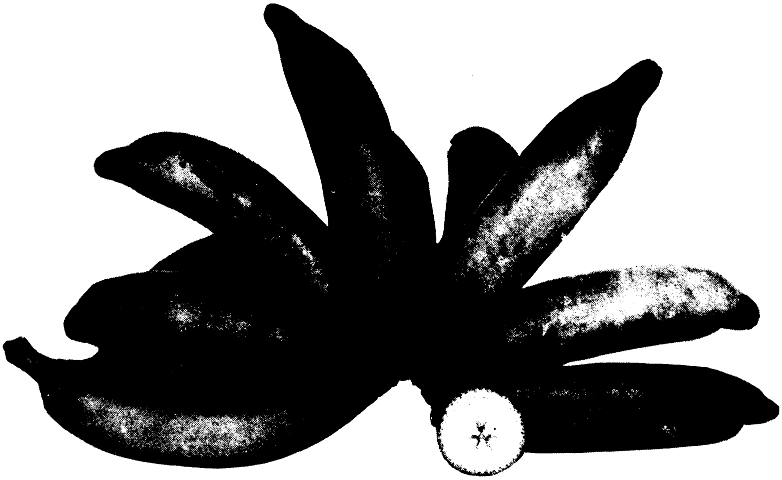
2. *Musa sapientum* L. var. *radja* var. nov. Pisang radja



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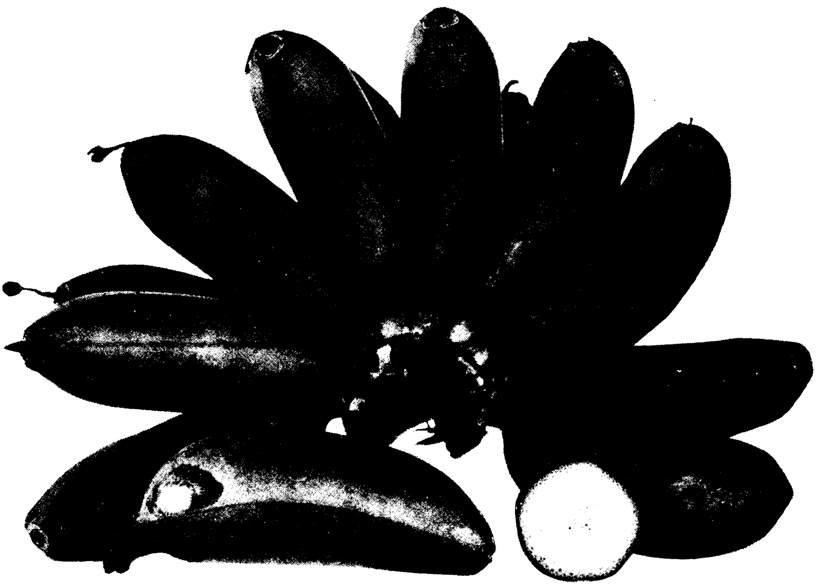

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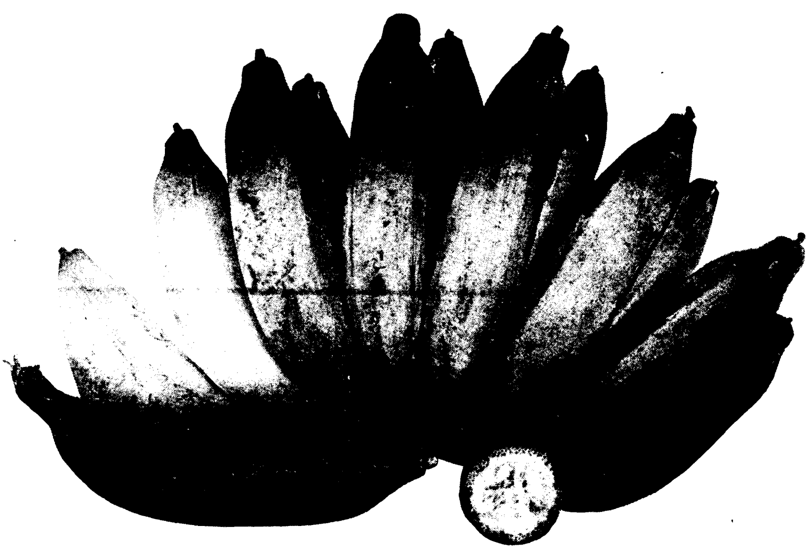
2. *Musa sapientum* L. var. *nam* var. nov. Nam Chang Rai

1. *Musa sapientum* L. var. *yanaikonban* var. nov. Yanaikonban



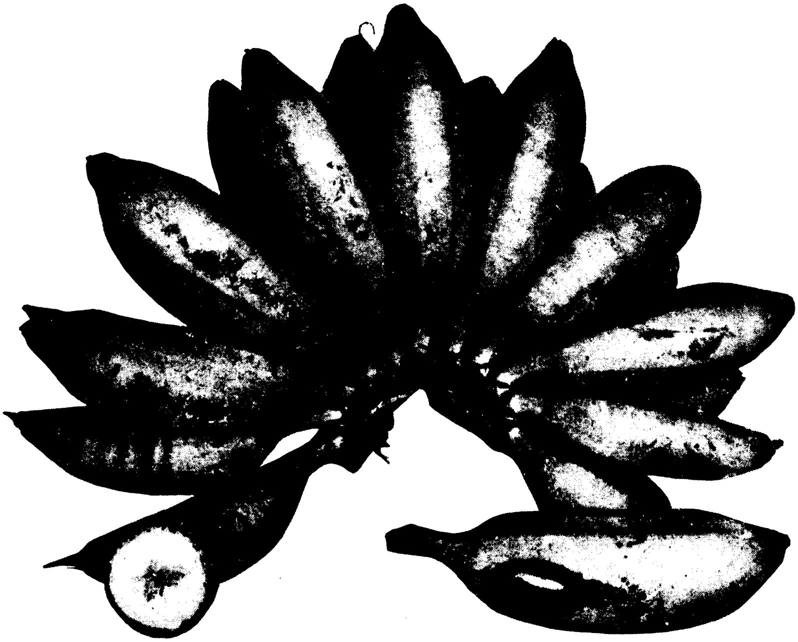
2. *Musa sapientum* L. var. *rachidis* var. nov

1. *Musa sapientum* L. var. *raines* var. nov. Raines na puti

2. *Musa sapientum* L. var. *katali* var. nov. Katali

1. *Musa sapientum* L. var. *cochinchinensis* var. nov. Chuoi Ticu Huong

2. *Musa sapientum* L. var. *angao* var. nov. Angao



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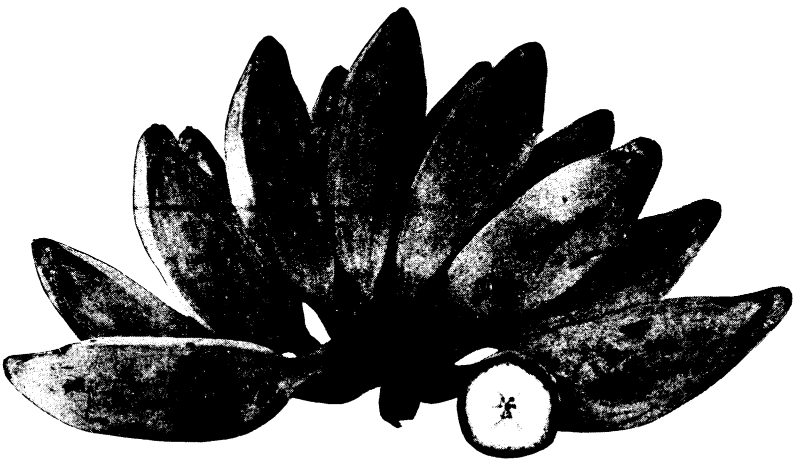
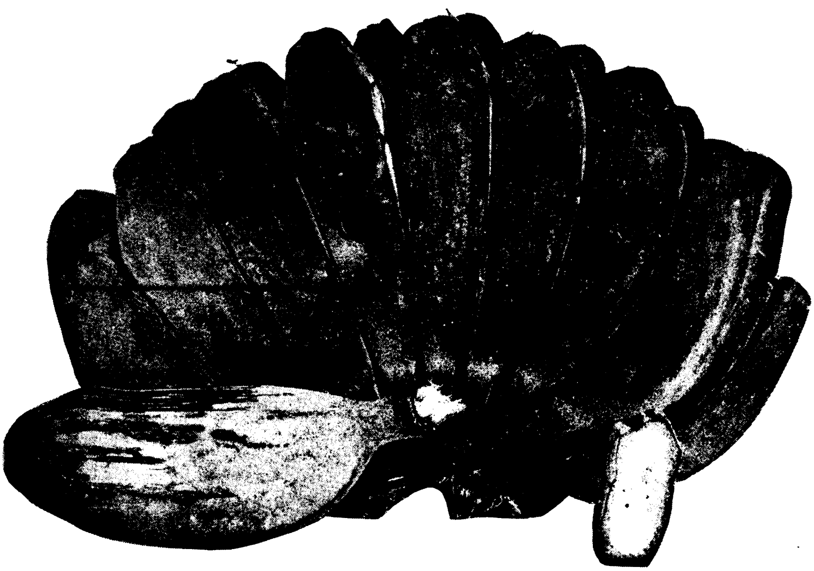


2. *Musa sapientum* L. var. *krie* var. nov. Krie

1. *Musa sapientum* L. var. *padilat* var. nov. Padilat

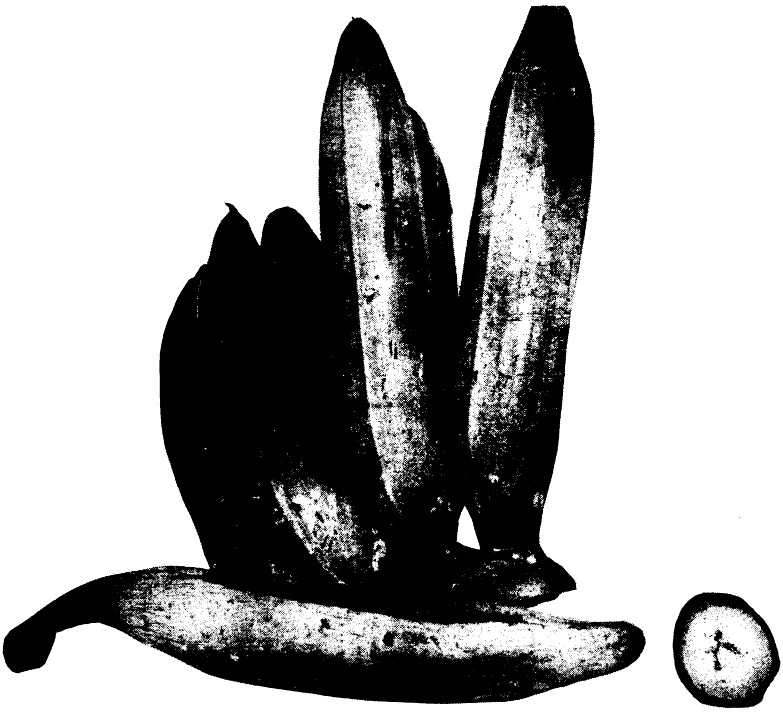
2. *Musa sapientum* L. var. *khai* var. nov. Khai Pet

1. *Musa errans* (Blanco) var. *basilisae* var. nov



2. *Musa sapientum* L. var. *flabellata* var. nov. Inabaniko

1. *Musa sapientum* L. var. *maduranga* var. nov. Maduranga



2. *Musa paradisiaca* L. var. *enosa* var. nov. Enosa

BUD-ROT

By GONZALO MERINO, *Chief, Plant Pests Control Division, Bureau of Agriculture.*

The bud-rot is considered as the most fatal disease of the coconut. Because of the fact that the disease attacks the heart and causes it to rot, there is no treatment possible that can be applied with beneficial results. The only recourse is to cut down the infected tree to prevent the disease from spreading to the healthy trees. It has been found that one diseased tree may cause fourteen others to be infected in a year's time, so the necessity for a careful inspection of the trees by each owner and the removal of the diseased palms can be readily seen.

From the recent reports of inspectors and from observations as to the frequency of cases in each particular place, it has been found that bud-rot cases are most often found in groves which are ill-kept, with the trees planted very near together and in places where there is a great deal of humidity. In fact it is especially severe in the regions around the mountains. It has been observed that there are two distinct types in the mode of infection. In one type the attack begins from outside; the young nuts begin to drop from the bunches and the leaves from below gradually fall until the youngest leaves are the only ones remaining, and finally these last leaves die because of the rotting of the heart.

A disease of this nature slowly develops for months in the tree before it kills the heart of the tree but it has been observed that this type of bud-rot contaminates the surrounding trees quicker than the other type and is most prevalent among older trees (see Plate XXXI). The other type acts in contrast to the above-described one. It begins from inside and spreads outward. The youngest leaf is first affected and then the next, and so on consecutively until there are only two or three leaves left. This type of the disease is usually found on younger trees and in moist regions, and is the most common type of bud-rot (see Plates XXXII and XXXIII).

[1] Published in the local dailies last June, 1919.

SPREAD AND LOSS

According to Johnston, "in Cuba a certain grove of 450 trees was totally destroyed in two years. Another grove of 1,200 was reduced to 300 in the same time. A planter in Jamaica who formerly obtained a revenue of ₱5,000 or ₱50,000 per year from his coconuts now gets only ₱500 or ₱5,000. On one estate in Trinidad of 5,000 trees only 15 per cent standing at present.

"Formerly many coconuts were grown on the grand Cayaman Island, but the industry has now been wiped out.

"If it continues to spread as it has done for the last ten years, it will inevitably destroy the coconut industry of the island and that too, within the next 10 or 15 years.

"Not confined to Cuba. It has caused great loss in Jamaica, British Honduras, Trinidad and British Guiana."

SYMPTOMS OF THE DISEASE

The first definite indication that a coconut tree is affected with this disease is to be found in the appearance of the spike and adjoining central fronds or branches. In nearly all cases these will be dead and dried and perhaps broken over. The rare exceptions will be when the disease is of the first type above. In this type, infection is shown by the darkened, water-soaked spots at the bases of the leaves. Sooner or later, if it is bud-rot, the central fronds will show the attack if the whole crown does not break off, entire, beforehand. If the central fronds show the symptoms described, the crown should be examined and a man sent up the tree to see. If it is a true bud-rot case, the central frond will readily pull out, exposing a whitish, rotten mass, emitting a vile, purid odor, a characteristic of the bud-rot case. This should be taken as final and definite proof that the tree is affected with bud-rot and if the tree is cut down at this stage and the heart is opened, it will be found that putrefaction has already set in over a large part of the heart and the line of infection can be readily traced as shown on Plate XXXIV. One of the unmistakable indications of infection in the early stages is the blackening of the flower spike and the dropping off of the young nuts. This last indication however, sometimes coincides with symptoms of a fungoid disease, as in case of Phytopthora of the coconut.

GENERAL DISTRIBUTION OF THE DISEASE

The disease is almost pan-tropical and according to Johnston is recorded in the following countries:

Tropical America: Cuba, Cayman Islands, British Honduras, Trinidad and British Guiana.

Eastern Tropics: Philippine Islands, Ceylon, India, German East Africa.

CAUSES OF THE BUD-ROT

Ashby, microbiologist for the Department of Agriculture of Jamaica, claims it is probably caused by a fungus (Pythium palmivorum Butler), and says that he has observed that the disease of the coconut known as leaf bite (Phytophthora) and bud-rot of the stinking rot type are due to the same fungus and that the bacterial soft rot of cases in Jamaica are being secondary. Dr. Copeland states that the organisms causing this disease are not positively known and that whether or not they cause the disease the gas producing bacteria are always present in the rotting mass and produce a vile odor. Profesor Reinking speaks of this disease of Laguna, Tayabas, and Batangas as bacterial. He says that microscopic examinations of diseased tissues taken from young cases of bud-rot demonstrated the presence of an abundance of bacteria and the absence of mycelium and even the culture of the pieces collected in the field under sterile conditions and placed in sterile vials developed no fungi.

August Busck, Entomologist, investigated it entomologically but found a fungus, *Pestalozzia palmarum.*

D. Smith, however, agreed with Busck's statement and after six weeks investigation confirmed the presence of *Pestalozzia palmarum.* However, bacteria were found only in the advancing margin of the disease and the fungi he considers second in importance.

Dr. Carlos de la Torre of the University of Havana admitted that the putrid condition in the crown is a bacterial fermentation but in his opinion the scale insects were the primary cause.

Mr. Stockdale found bacteria on the margin of the advancing rot concluded that the disease was due to bacteria.

WORK OF THE BUREAU OF AGRICULTURE

The Bureau of Agriculture, seeing the danger that the groves are confronted with by allowing this disease, alone undertook the work of controlling it about four years ago, by sending out inspectors to locate the disease and ordering the owners to destroy the trees infected with bud-rot. In order to avoid trouble between owners of coconut groves and inspectors, the Bureau issued General Order No. 38 concerning Bud-rot, which reads as follows:

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF PUBLIC INSTRUCTION
BUREAU OF AGRICULTURE

MANILA, *April 21, 1915.*

General Order No. 38.—*Concerning Bud-rot.*

Whereas there exists in certain parts of the Philippine Islands the disease commonly known as coconut bud-rot;

Whereas this disease is a menace to the agricultural interest of these Islands; and

Whereas adequate measures should be adopted to prevent the spread and to effect the control of the said disease:

Therefore, by the authority of the provisions of Act 2515, the disease commonly known as coconut bud-rot is hereby declared to be a dangerous plant pest and shall be dealt with as hereinafter prescribed.

SECTION 1. Whenever an outbreak of coconut bud-rot is known to exist in any locality of the Philippine Islands it shall be the duty of the Director of Agriculture or his authorized agent to inspect all coconut trees in that locality, to mark in a suitable manner all trees ascertained to be affected by the disease, and to issue notification in writing to the owners, lessees, or persons in charge of coconut plantations, groves, or trees advising them that disease exists among their trees and indicating to them what trees are diseased.

SEC. 2. Whenever the Director of Agriculture or his authorized agent shall have issued notification in accordance with the provisions of section 1 hereof, it shall be the duty of the owner, lessee, or person in charge of the coconut plantation, grove or trees where the disease exists to destroy every affected tree by cutting down and completely burning the crown and other infected parts thereof.

SEC. 3. Failure to destroy affected trees within a period of fourteen days from the date of receipt of written notification shall be considered prima facie evidence of an endeavor to avoid the duties imposed by virtue of this order and shall render the owner, lessee or person in charge of coconut plantations, groves, or trees liable to the full penalties herein provided.

SEC. 4. Any person who, after being duly notified in writing by the proper authority, as herein set forth fails or refuses to comply with the requirements of this order shall, upon conviction, suffer the penalties provided in section 4 of Act 2515.

SEC. 5. In order to carry out the provisions of this order the Director of Agriculture or any person acting in his behalf shall have access at all times into and upon any land occupied by any coconut tree or trees for the purposes of inspection.

W. E. COBEY,
Acting Director of Agriculture.

Approved:
H. S. MARTIN, *Secretary of Public Instruction.*

People of the coconut districts were occasionally given instructions by our inspectors on how to find out whether or not their trees were attacked by the bud-rot, and shown what trees should be destroyed. Other symptoms were explained to them and the danger of allowing an affected trees to contaminate ten or twelve other trees pointed out. The owners fully realized the value of the campaign and readily obeyed the orders and instructions issued by the Bureau. Our inspectors went over all the groves of the Province of Laguna and half of Tayabas, part of Pangasinan, Zamboanga and Basilan. During the last two years we have inspected 20,707,958 trees of the above indicated provinces of which 12,442 trees were found attacked by the budrot. These were immediately cut down and destroyed.

REMEDIAL AND PREVENTATIVE EXPERIMENTS

Johnston gives the following experiments from which no success were obtained:

1. Removal of diseased part by pruning, failed for the germ could pass through the strainer and might have been present in the tissues without showing any sign of rot. Besides, to carry the cutting of leaves too far will weaken the vitality and power to resist the wind.
2. By the use of salt, iron sulphate, Bordeaux mixture, copper sulphate and Paris green as fungicide failed to check the disease.

PREVENTION IS THE ONLY RECOURSE

To prevent the spread it is necessary that we immediately destroy the source, its means of transmission (insects or other animals) or the conditions favorable to its development (thicket, close planting and dirt). The infected tree should be absolutely destroyed. New cases should be carefully watched and should immediately be removed. This practice has demonstrated the possibility of preventing of great losses. For example, in Jamaica, where such steps are vigorously observed, the bud-rot is not so widespread as in Cuba, as per statement herewith quoted:

> The conditions of culture in Jamaica are as a rule very good, in great contrast to the conditions in Cuba. The underbrush is kept out, the fallen leaves and other debris are burned up and the planting of other crops between the trees is little practised. Thus, in every way the Jamaica planter has much better conditions under which to combat the disease.
>
> In Jamaica then, the bud-rot has been put under control by keeping the diseased trees cut down.

CONTROL MEASURES

As the coconut is a plant that does not branch and all the leaves grow from the same point, and as the bud-rot attacks this soft growing tissue, it consequently stops the formation of the leaves and of the flowering branches and finally kills the plant. The tree once affected never recovers and will at once stop bearing fruits and is of no value. With these years of actual inspection for bud-rot in the Province of Laguna, Tayabas, Pangasinan, Zamboanga, and Basilan, not a single case has been reported of a person claiming that he was ever able to restore a bud-rot tree to its normal condition. The only remedial measures that are available are to cut the tree down, split the bud upon and chop it into a number of pieces and then thoroughly burn all infected parts until they are charred. The parts of leaves and trunks that show infection should also be burned. The bolos and axes used in splitting or chopping the diseased parts should be heated in the flames. Copeland states that the close planting favors the spread of the disease. Consequently, coconuts should not be planted less than nine meters apart and the groves should be kept clean so as to admit air and sunshine.

REFERENCES

Copeland, *The Coconut*
Reinking, *Philippine Plant Diseases*
Ashby, *The Budrot of Jamaica*
Johnston, *The Budrot and Its Cause*

ERRATUM.

Paragraph 5, page 90, Second Quarter, Vol. XI of the Philippine Agricultural Review, which reads:

Recommendations.—Immunization properly applied is the surest method for the control of rinderpest, and with judicious extension will be one of the prime factors in the eradication of rinderpest in a short time and without the necessity of observing the fundamental principles of sanitation and hygiene. All the measures at our disposal must be properly and carefully applied in order to keep the disease well under control and thus give hope of ultimate success in its eradication.

should be:

Recommendations.—Immunization properly applied is the surest method for the control of rinderepest, and with judicious extension will be one of the prime factors in the eradication of this disease. Care must be taken, however, not to lead the public to believe that it will accomplish the miracle of bringing about the eradication of rinderpest in a short time and without the necessity of observing the fundamental principles of sanitation and hygiene. All the measures at our disposal must be properly and carefully applied in order to keep the disease well under control and thus give hope of ultimate success in its eradication.

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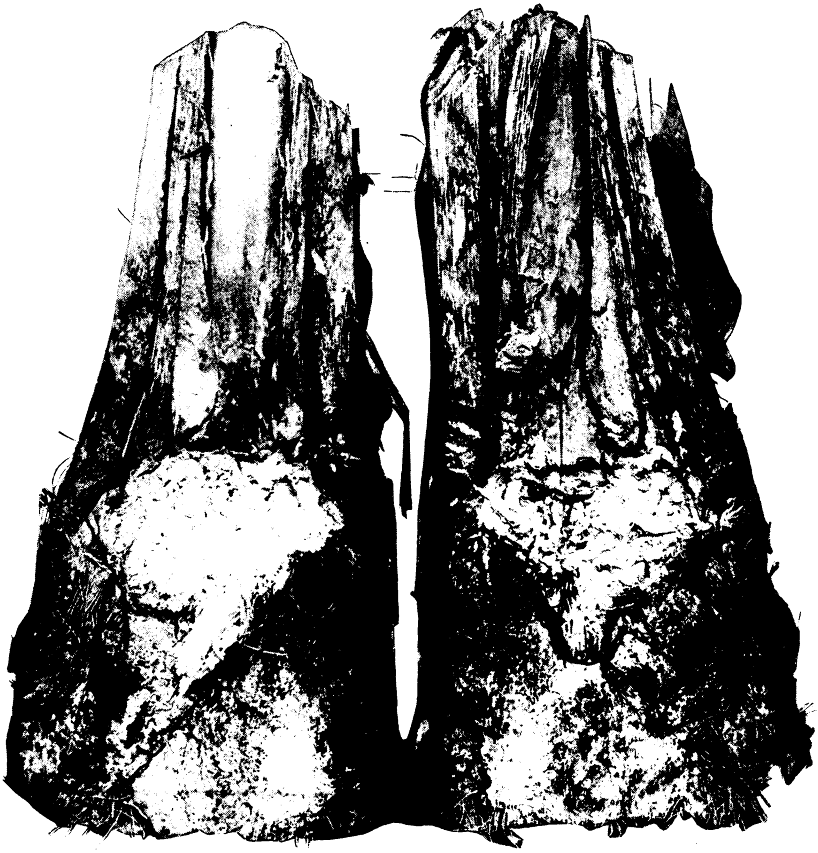
A case of budrot on old trees

NOTE.—The attack begins from outside

An inspector of the Bureau of Agriculture examining a tree for a new case of budrot

A case of budrot

NOTE.—In this case the disease began from the youngest leaf



A frond of a coconut tree attacked by the budrot showing the rotten mass

THE PHILIPPINE

Agricultural Review

VOL. XII FOURTH QUARTER, 1919 NO. 4

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EIGHTEENTH ANNUAL REPORT OF THE BUREAU OF AGRICULTURE

MANILA, *February 16, 1919.*

SIR: I have the honor to submit herewith the Annual Report of the Bureau of Agriculture for the year ended December 31, 1918.

PHILIPPINE AGRICULTURE

GENERAL SUMMARY

A comparison of statistics compiled by the Bureau of Agriculture for the past six years, shows conclusively that the year 1918 was a banner year for agriculture in the Philippines, all records being surpassed, not only in the money value of the crops produced but also as to the number of hectares in cultivation and the amount of crops produced. In round numbers, the total value of the six leading crops of the Islands, namely, rice, abaca, sugar, coconuts, corn and tobacco, jumped from the previous high record of ₱241,000,000 for 1917, to ₱350,000,000 for 1918, a net gain for the year of ₱109,000,000 and the highest total ever attained for Philippine agricultural products since the statistical division was established in the Bureau in 1913. Compared with the average annual production for the previous five-year period, the 1918 record shows an even greater gain of ₱181,000,000 in value. Compared likewise with the averages for this previous five-year period, there is an increase of 371,000 hectares planted to the six leading crops mentioned above, and an increased yield in kilos and liters of 1,434,000,000, certainly a remarkable showing and abundant cause for congratulation. Only one crop of the six fails to show an increase in hectarage, in yield and in value of the product. Corn showed a slight decrease in hectarage and in yield, but the value of the crop produced even then, showed a satisfactory gain.

RICE

First on the list of the Philippine Agricultural products for 1918, is the standard crop of rice, with an increase of 192,000 hectares in cultivation over the average of the previous five years, an increase in the yield of 1,202,000,000 liters, and an increase in value over the same period, of ₱74,000,000, the 1918 totals being: hectares in cultivation, 1,368,140, liters produced 2,684,628,000, valued at ₱135,163,375, a gain in value over the record crop of 1917 of ₱53,000,000 in round numbers. More gratifying even than the above impressive figures is the marked advanced in the average yield per hectare for 1918, which establishes a new record of 26.16 cavans. The average production for the Philippines for the previous five years was 19.41 cavans per hectare; a net gain per hectare in average production, of 6.75 cavans.

ABACA

Abaca comes next in importance, with a total area for 1918 of 512,508 hectares, which produced 166,863,644 kilos, valued at ₱92,493,223, which compared with the previous five-year period shows a gain of 62,000 hectares in area, 18,000,000 kilos in production and an increase in value of ₱54,000,000.

COCONUTS

The total area planted to coconuts in 1918 was 335,602 hectares, which yielded 346,656,535 kilos of copra, and the total value of all coconut products was ₱56,533,793. Compared in round numbers with the average for the previous five-year period, there is a gain of 73,000 hectares in area planted, 202,000,000 kilos increase in production, and ₱31,000,000 gain in the total value of all coconut products.

SUGAR

Sugar comes next on the list with an area of 205,511 hectares planted to sugar cane, a production of crude sugar of 396,242,786 kilos and a total value of all sugar cane products of ₱41,158,788. By comparison with the average of the previous five-year period sugar shows a gain of 29,000 hectares under cultivation, 54,000,000 kilos in production and ₱9,000,000 in value.

TOBACCO.

The 1918 record for tobacco shows a hectarage of 78,443, a yield of 61,555,322 kilos of leaf tobacco, worth ₱15,219,155. Compared for same period as above there is a gain of 18,000 hectares in area, 17,000,000 kilos in production and ₱7,000,000 in the value of the crop.

CORN

There were 418,386 hectares planted to corn in 1918 which produced 397,177,733 liters of shelled corn, valued together with forage at ₱21,372,123. Corn shows a decrease in area planted of 3,000 hectares over the five-year average and a decrease in yield of 59,000,000 liters, but a gain in value nevertheless of ₱6,000,000.

THE FOOD CAMPAIGN

During the year, the most important work of the field men of the Bureau of Agriculture, the Agricultural inspectors, farm advisers and their assistants, was that pertaining to the food production campaign, for which a fund of ₱500,000 was set aside by the Department of Agriculture and Natural Resources. That the efforts to increase food production have brought satisfactory results, the splendid showing for 1918 crops readily attests. The Bureau of Agriculture activities in this campaign were carried out through the field force by means of Demonstration Plots and Public Nurseries, through the coöperative agricultural societies and the rural credit associations, the purchase of seed and plant materials, instruction in seed selection, soil preparation, home gardens, improved livestock and poultry breeding, public lectures, bulletins, farm publications, etc.

BUREAU OF AGRICULTURE

PERSONNEL

Among the important changes in the personnel of the Bureau was the appointment on August 1, 1918, of Mr. José G. Sanvíctores as Assistant Director, vice Mr. Pedro Rodriguez, whose resignation was accepted July 3, 1918.

On April 11, Mr. H. H. Boyle resigned as Chief of the Fiber Division. He was succeeded by Mr. Don D. Strong who was promoted from the position of First Assistant Chief.

The Chief of the Plant Industry Division, Mr. A. M. Burton, resigned on August 8, 1918, and he was succeeded by Mr. Silverio Apostol, the Assistant Chief of the Division.

Mr. Mariano Billedo was appointed Chief of the Demonstration and Extension Division on May 16, 1918, succeeding Mr. E. F. Southwick, who resigned on March 30, 1918.

On July 27, 1918, Mr. Jose Nieva resigned as Chief of the Animal Insurance Section. Mr. Tomas V. Vargas was placed at the head of this section on September first, following. Mr. Vargas, however, resigned December 17, 1918.

Mr. W. G. Frisbie was transferred from the Pest Control Section to become acting Chief of the Publications Section on March 1, 1918.

The following table gives the changes that have taken place during the year:

	American personnel.			Filipino personnel.		
	Permanent.	Temporary.	Total.	Permanent.	Temporary.	Total.
Appointments January 1 to December 31, 1918	1	5	6	61	273	334
Separations January 1 to December 31, 1918	17	25	42	52	593	645
Promotions January 1 to December 31, 1918	7	1	8	146	63	209
On duty December 31, 1918	14	10	24	186	167	353

A large portion of the Filipino temporary staff is made up of livestock inspectors whose duties necessarily place them in the unclassified group. As may be noted from the preceding table, there were 593 separations in the temporary column of the Filipino personnel during the year. This is explained by the discharge of practically all the livestock inspectors during the last quarter of the year when the appropriation for wages was exhausted.

ORGANIZATION

There were no important changes in the Bureau organization throughout the year, its affairs being conducted under the organization plan adopted by the Efficiency Committee, under date of August 1, 1916, as follows:

ADMINISTRATIVE DIVISION.

General service section.
Accountancy section.
Records section.
Property section.
Statistics section.
Construction and repair section.
Publications section.
American colonies section.

ANIMAL HUSBANDRY DIVISION

Improved breeding section.
Animal Selection and Distribution Section.
Poultry Selection and Distribution Section.

One of the many home gardens that made the food production campaign successful

VETERINARY DIVISION

Disease control section.
Quarantine and meat inspection section.
Veterinary research section.

PLANT INDUSTRY DIVISION

Agronomy section.
Horticulture section.
Pest control section.

FIBER DIVISION

Fiber investigation section.
Fiber inspection section.

DEMONSTRATION AND EXTENSION DIVISION

Agricultural demonstration section.
Coöperative organization and marketing section.
Rural credit section.
Animal insurance section.

ADMINISTRATIVE DIVISION

GENERAL SERVICE SECTION

The work of this section involves the general supervision of the stenographic work, dictation of official correspondence, pertaining to the Administrative Division, general transportation, supervision, the preparation of the estimate for the annual appropriation and the distribution of the same, keeping the efficiency records of all Bureau employees, the supervision of property, accountancy and records sections. The Chief Clerk is in charge of the above mentioned activities and is directly resposible to the Chief of the Administrative Division, for the proper carrying on of the above mentioned work. The rental of buildings, light, water, janitor service, etc. are also under the supervision of the Chief Clerk. During the year 1918 the amount of work performed in this section has been greatly augmented due to the food production campaign, rural credit activities and the general increase of the work of the Bureau. During the year there has been created the office of the superintendent of land transportation at Singalong, the duties of which were formerly performed by the Chief of the Construction and Repairs Section. This change took effect on April 16, 1918, when a man trained in automobile engineering was placed in charge of that office.

RECORD SECTION

During the year, due to the activities of the Rural Credit Division, the Plant Industry Division, Demonstration and Extension Division and the Food Production Campaign, and the transfer of the records of the latter from the Executive Bureau to this office, the personnel of this Section has been augmented. A spirit of excellent coöperation prevailed among the employees.

In the middle part of the year, a new system of handling correspondence was introduced. This system materially aids the old one as it calls for the action on all correspondence by the chief or chiefs concerned before indexing.

Correspondence.—During the year there has been a total of 148,689 communications sent and received, of which 127,708 letters were outgoing and 20,981 incoming. Forms from our field force and letters from school children requesting seeds are not included in the average number. There were 6,852 letters delivered by messengers to different Departments and Bureaus and offices in the City. The cost for the transmission of correspondence has been ₱6,284.94 for letters, and ₱2,255.95 for telegrams, a total of ₱8,540.89.

ACCOUNTANCY SECTION

The following were the twenty-six authorized positions for this section: one chief accountant, one assistant chief accountant, one cashier and disbursing officer, one assistant colony agent, two examiners, six auditing clerks, one warrant clerk, one index clerk, two requisition clerks, two colony clerks, five bookkeeping clerks, one warrant recorder and filing clerk, one messenger, and one laborer. The position of assistant chief accountant was not filled until February 1, 1918. For the sake of economy, on December 31st, the positions in this section were reduced to nineteen, two of which were vacant. Four positions were eliminated and two clerks were transferred to the property section.

There were seventeen appointments to and twenty-one separations from this section during the year. The separations were due to offers of a higher salary by some governments and private offices. There were more appointments and separations during this year than in any of the previous years.

In addition to the functions assigned to this section in accordance with the organization of the bureau, this office is acting as sales agent of the American Colonists' produce shipped to Manila. On November 1st, the work of preparation of requisitions and personnel was transferred to the property section. In October, the mailing of all warrants was transferred to this office from the veterinary division and the record section but no provision was made for additional personnel.

This section was divided into six groups, as follows: general service, bookkeeping, auditing, American colony, requisitions, and disbursements. Each of these groups was assigned a clerk in charge. But when the work of a group was delayed and needed immediate attention, some of the clerks of the different groups were shifted from place to place.

The expenses of the Bureau were recorded by the functions of each division. Monthly statements showing the status of their allotments were submitted to the corresponding chiefs of division or section. Monthly statements showing the financial status of the Bureau were also submitted to the Director and the chief of the administrative division.

PROPERTY SECTION

The clerical force of the section during the first ten months remained unaltered. But with the incorporation of the requisition work, formerly of the Accountancy, with the Property Section on November 1, an additional two clerks were entered on its rolls. The position of assistant chief vacated by Mr. Victor Pagulayan upon his assuming the duties of the chief of the Property Section was filled by Mr. Felipe Villanueva on June 16. Of the twelve men composing the force of temporary employees at the beginning of the year eight left the service. Six new employees were appointed to fill their places leaving the temporary force two men short.

The plan of work as a whole remained practically the same. The property accounting through the medium of ledger cards, memorandum and invoice receipts as stated in the last annual report is still in vogue. The issue of supplies and materials and the handling of shipments have, however, taken an entirely different aspect.

The effect of the war on the Philippine economic conditions was greatly felt in this section. And in this connection, the most careful consideration and most zealous efforts to limit as much as possible the consumption of supplies and materials and to strictly avoid all unnecessary waste were exercised, in accordance with the general system of economy laid out by the Insular Government. To this end the recording of supplies consumed by each individual employee was established to serve as a sort of check valve to any apparent overdrawing of supplies. The result was so very encouraging that it was also applied to both provincial stations and fieldmen. With the change in the method of issue of supplies and materials was also felt the need of a new system in the important matters of handling shipments and the management of our transportation facilities to efficiently meet the needs of the situation.

The increased activities of the Bureau as a whole have had their proportionate effect upon the Property Section. And this holds true as regards the purchase and shipment of materials. During the first nine months of the year a considerable volume of shipment of vegetable seeds, plants and plant materials was made. This together with the demand for supplies, equipment and animals for the different bureau and food campaign provincial stations, field men and private parties throughout the islands strained our transportation facilities to the very limit.

CONSTRUCTION AND REPAIR SECTION

This section has charge of the upkeep and repair of all Bureau transportation and machinery, repair and manufacture of office furniture and equipment, and the construction and repair of buildings belonging to the Bureau of Agriculture.

This station received and filled during the year 1918 serial and work orders for repairs and manufacture of office furniture, etc. There were 54 repair orders and 53 furnish orders for bicycles, 27 repair orders and 1 furnish order for automobile, 62 repair orders and 77 furnish orders for motorcycle. The cost of operation and maintenance of 8 passenger cars and 2 White trucks, 3 wagons, 5 carromatas, 3 calesas, 3 carretelas, and 17 native ponies and 6 mules and for the consumption of gasoline, oil, greese, lubricants and auto accessories amounted to ₱21,357.05. The increase in the cost of maintenance of this station over that of last year was due to the fact that new automobiles, motorcycles and several bicycles were purchased during the year.

PUBLICATIONS SECTION

Library.—Much work was done during the year in sorting out for storage old periodicals and pamphlets occupying space greatly needed for publications of every day interest and use.

The proper classification of scientific bulletins was also given considerable attention.

The library of the Bureau of Agriculture is far from complete. Efforts are being made to increase the number of standard books on agriculture, especially on tropical agricultural subjects, as rapidly as funds will permit. Books ordered are selected from bibliographies on agriculture and after consultation with the chiefs of the different divisions and other members of the technical staff of the Bureau.

The Philippine Agricultural Review.—This is a quarterly publication issued by the Bureau of Agriculture and serves as a record of the scientific experiments performed by the Bureau and of the contributions of other scientific workers in the Philippines.

There are 143 paid subscriptions for the Philippine Agricultural Review, distributed as follows: Manila, 30; provinces, 78; United States and foreign countries, 35.

The number of free and exchange copies sent out during the year was 3,764, of which nearly 72 per cent went to the United States and foreign countries.

The Philippine Farmer.—The Philippine Farmer is a monthly publication issued in both English and Spanish, principally for distribution in the Philippines. It carries no regular subscription price, being sent free to all members of agricultural societies and subscribers to the Philippine Agricultural Review and such others as may apply for copies. Believing, however, that the Philippine Farmer does not reach in all cases the farmers that really take interest in it, a revision of the mailing list is being made. It would seem, though, that a mere revision of the mailing list will not be sufficient and that a nominal subscription should be charged for the farmer, to make sure that it goes to interested readers. The price of ₱1 a year is being considered because of the convenience of mailing a peso bill, facilities of mailing a subscription price being extremely important, especially for those places where there are no money order offices established.

Bulletins, Circulars and Miscellaneous Publications.—During the year, 5,000 Spanish copies of Bulletin No. 32, on Plant Propagation in the Tropics, by P. J. Wester, were printed, the English edition having been issued earlier, and 2,000 copies (English) of Bulletin No. 33, on Cane Production and Sugar Manufacture in the Philippines, by C. W. Hines, were ordered printed. Circulars No. 36, The Vegetable Garden, by A. M. Burton, and No. 37, Some Observations on Rats, by D. B. Mackie were printed, 10,000 of the former and 5,000 of the latter. Several thousand copies of reprint circulars were printed during the year. A grand total of 19,662 copies of publications were distributed.

Translation Work.—During the period from January 1 to December 31, 1918, inclusive, delivery was made on a total of 218 work orders, aggregating 2,244 manuscript pages of an average of 200 words each page.

ANIMAL HUSBANDRY DIVISION

INTEREST IN IMPROVED LIVESTOCK

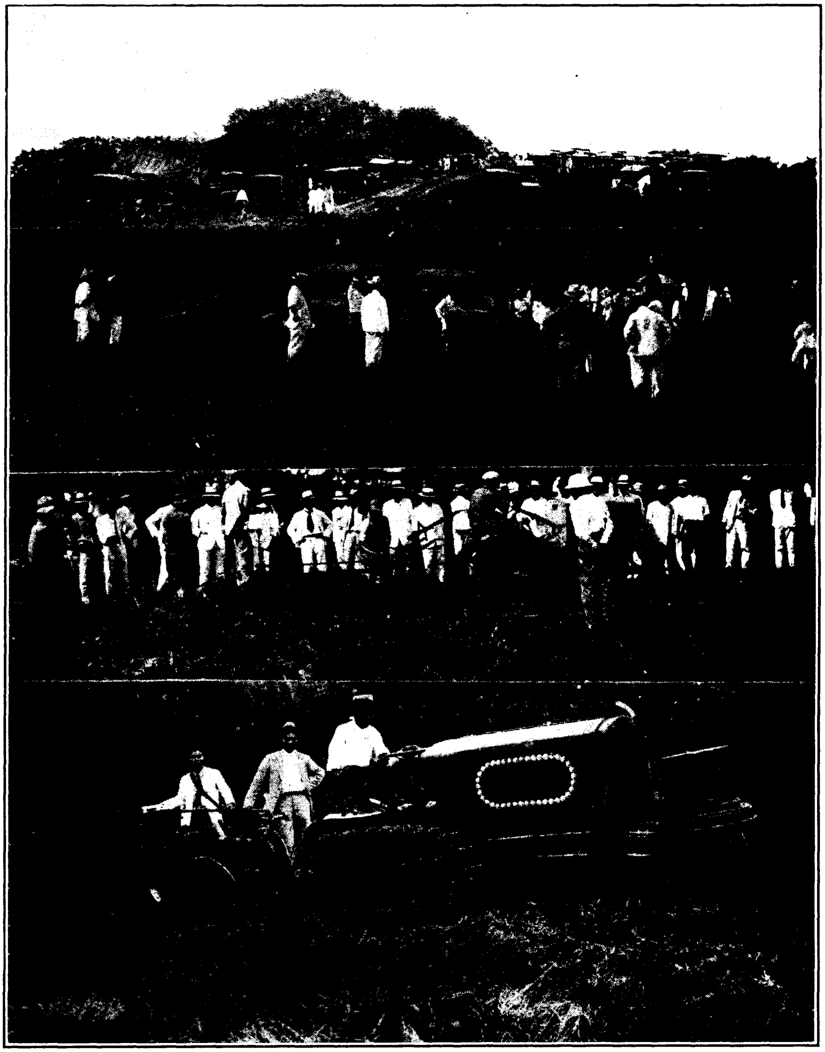
The requests upon the Bureau for animals of different kinds for breeding purposes, especially for chickens and pigs, have been greatly in excess of the available supply, and the demand for improved stock is constantly increasing. It is worth noting in this connection that the great majority of these requests came from Filipino stockmen and farmers, indicating a genuine interest among the general farming population for improved livestock.

The people of Batangas, especially of the central and southern parts of the province, are displaying keen interest in the Berkshire and Duroc-Jersey types of pigs, the only types, it might be said, of American pigs that the Bureau has had for distribution.

FEEDS

Guinea grass, Para grass and Paspalum were grown successfully and found to be of great value at Alabang, La Carlota and Trinidad. In addition, Japanese cane and Sorghum were grown at Alabang, the Sorghum seeds being fed mostly to chickens. Paspalum was the main forage crop raised in Trinidad, while Paspalum and Guinea grass constituted the principal green feed stuffs for the animals at Batangas.

As soon as the technical staff of the Bureau can be sufficiently increased to permit of a better division of the work pertaining to livestock breeding and management, further investigations will be made in connection with different feed materials locally procurable, probably in coöperation with the College of Agriculture at Los Baños.



Different views of the tractor demonstration held at Alabang under the auspices of the Bureau of Agriculture

INBREEDING

Owing to the extreme difficulty experienced by the Bureau in securing chickens and pigs for breeding purposes either from the United States or Australia, it has not been possible to introduce new blood into the flocks and herds of the Bureau of Agriculture, and, consequently, there is danger of inbreeding among the chickens and pigs of the Bureau unless new blood can be imported in the near future. There are bright hopes, however, that this situation may be remedied soon by the importation of chickens and pigs from California. If animals suitable for breeding can be imported, not only shall we be able to increase the vigor of our present animals, but at the same time, appreciably increase the supply of livestock for sale to the public.

INDIAN CATTLE

For the purpose of purchasing cattle from India for the cattle farms provided for by Act No. 2758, the Chief of the Animal Husbandry Division of this Bureau was commissioned by the Secretary of Agriculture and Natural Resources to proceed to India July 3, 1918, and attend personally to the selection of animals for shipment to the Philipipnes, under the contract with Mr. Gardner, a cattle importer. On this trip, a total number of 627 head of cattle and buffaloes were bought and shipped to the Philippines. The Nellore breed was the predominant type secured. A few head of the Multani breed, which are reputed to be good milk animals and some Indian water buffaloes were also imported. Four hundred fifteen of the total number bought in India were delivered at the Pandacan Quarantine Station the latter part of August, for the Department of Agriculture and Natural Resources, and 212 were left at Zamboanga, for the Department of Mindanao and Sulu.

PURCHASE OF ANIMALS

In accordance with the provisions of Executive Order No. 84, series of 1913, "purchases within the Philippine Islands of large cattle for all branches of the Insular Government, the provincial governments and the cities of Manila and Baguio, other than such as may be bought locally by the provinces or the city of Baguio, shall be consummated by the Bureau of Agriculture, to which Bureau, requisitions for all such cattle should be addressed, through proper channels." The principal reasons for this requirement are to insure that large cattle purchased by the Government conform to a high standard for the purposes for which they will be used; that the animals so purchased posses no serious defects; and that the price paid is reasonable. Upon the Animal Husbandry Division naturally falls the duty of passing upon all large cattle requisitioned by the different branches of the Government. During the year, the purchases for the Bureau alone were as follows:

Horses and mules	₱2,640.00
Cattle	2,730.00
Carabaos	6,277.04
Swine	419.78
Goats	680.00
Sheep	350.00
Poultry	943.08
Total	14,039.90

ALABANG STOCK FARM

The Alabang Stock Farm has been in charge of Mr. Carlos X. Burgos, as acting superintendent since January 15, 1918. Besides livestock, sugar cane and agave are grown at Alabang for seed. The preparation of feed mixtures for the different kinds of livestock supplied to other stations of the Bureau as well as to stations established by the Department of Agriculture and Natural Resources, and the training of men for the poultry-swine stations under the said Department, is additional work performed by the Superintendent of the Alabang Stock Farm.

Stock Feeds Locally Grown.—Although the weather conditions prevailing during a considerable portion of the year were not entirely favorable for the growing of green feed, a sufficient quantity of such feed was grown at the farm for the livestock there. Corn, cowpeas, sweet potatoes, peanuts, sorghum, rice, and Guinea grass were the principal forage crops grown at the farm and these provided that variety of succulent feed so essential for the health of animals, especially sick ones. Special mention is here made of the value of sorghum as a forage, not only as to its quality, but quantity as well, and the seeds make execellent chicken feed. The Shek Shealy grass introduced from India and planted on a small plot in October promises to give as good results as Guinea grass. The Japanese cane produced a large quantity of forage. Fifty-nine thousand three hundred sixteen kilos of cane were shipped to other stations, principally to the Pandacan Research Laboratory and 90,000 kilos were consumed at the farm. In addition to the different kinds of forage named, 128 sacks of acacia pods were fed to cattle, goats and pigs.

Public breeding.—The work on public breeding of swine and horses has been satisfactory, especially if it is considered the disadvantageous conditions of this stock farm which is distant from the places where there are plenty of animals to be bred. At the beginning of the year only a few services were performed specially by the stallions. But upon the arrival of the grade stallion "Moscow" there was a marked improvement in the attitude of the people of the vecinity and of others quite distant from the place. This can easily be seen in the quarterly breeding records which show that some of the animals bred in this farm come from Sta. Rosa, and Biñan, Laguna, and Malolos, Bulacan. Horses of the type of "Moscow" are very attractive on account of their fine carriage and intelligent Arabian heads. The following tables show the services rendered at this farm:

Horses.	Number of services.	Number of offspring.	Remarks.
Hanover No. 516	1	2	Trans Jan. 18.
Moscow No. B-102	42	----------	Received Mar. 22.
No. 599	2	----------	Young: transferred July 23.
No. 486	17	----------	Received April 6 and transferred Dec. 23.

Swine.	Number of services.	Number of offspring.	Remarks.
Property No. 93	2	6	Old Berk. boar.
Property No. 488	9	19	Trans. July 29.
Property No. 452	11	21	Duroc-Jersey.
Property No. 498	5	----------	Young Berkshire.
Property No. 384	1	----------	"Wickham," rec'd Nov. 18.
Litter No. 337	10	----------	Young Berkshire.
Total	38	46	Reports of births irregular.

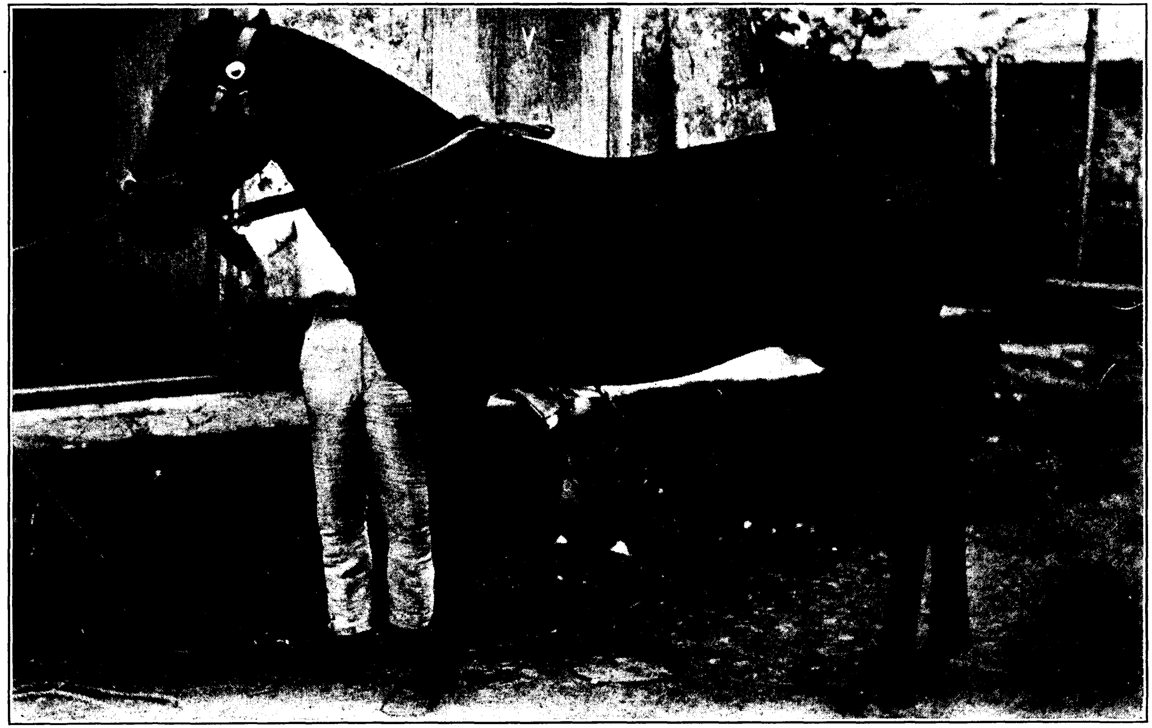
Horse Breeding.—In former years this was one of the most important activities of the Alabang Stock Farm. Owing to shortage of funds, however, it has not been possible to replace the stallions shipped from Alabang to the different provincial public breeding stations. As a result, there were only a native colt, two mares and a one-year old filly, the stallions for public breeding and several geldings used in herding cattle at the station at the end of the year.

Cattle.—In accordance with the change of policy, practically all the large cattle at Alabang were shipped to Bongabong and a few were shipped to Nueva Vizcaya, it being the policy now to concentrate the work at Alabang on small animals like pigs, goats and chickens. The farm, however, is capable of supporting quite a number of cattle and because of its nearness to Manila and the execellent facilities of transportation there, it will remain as a sort of stop-over station for large cattle received in Manila for other points of the Philippines, as any attempt to keep cattle in Manila for any length of period will involve enormous expense.

The large cattle retained at Alabang or brought to the station during the year continue in good health. From the number of births recorded, it will be seen that they were not only able to maintain themselves, but to reproduce quite satisfactorily as well. Out of 34 grade cows, 25 offspring were dropped from January first to July thirty-first, inclusive, or, an increase of 73.5 per cent; out of the 64 Indian cows, 25 offspring were dropped from January first to May twenty-sixth, inclusive, or an increase of 39 per cent; out of 7 multani cows, 5 offspring were dropped from January first to August eleventh, inclusive, or an increase of 71.4 per cent, and the only Chinese cow gave birth, thus representing a natural increase of 100 per cent. The record of the Indian carabaos was even more satisfactory—10 cows all gave birth from January first to August eleventh, inclusive, though unfortunately there was a case of abortion, so that the natural increase was only 90 per cent. Only one of the 8 native carabaos gave birth and the other aborted from the period of January first to August eleventh, inclusive.

The Nellore (or Indian) cattle at Alabang are all newly imported from India and it will thus be premature to make any comment regarding them. According to the past experience at Alabang, however, Nellore cattle will thrive well there, provided, that the pastures are not crowded. Alabang is very rocky and, consequently, can not provide pasturage for as many animals per hectare as in localities where the soil is deep, but this does not mean that cattle will not thirve at Alabang. As a matter of fact, the cattle at that station, awaiting shipment to other parts of the Philippines, are doing well.

Indian Carabaos.—The water buffaloes imported from India, which differ considerably from the native water buffaloes in several respects and have a reputation of being good milkers, have done well so far at Alabang. As stated in one of the preceding paragraphs, every one of the female buffaloes dropped a calf, although there was a case of abortion. There has been no success met with as yet in the crossing of Indian water buffaloes with the native water buffaloes. Having arrived at the place but recently, it is perhaps natural that they should not



Product of Public Breeding at Lipa, Batangas—Arabian—Native Stallion $3\frac{1}{2}$ years old

take to each other well. It is hoped, however, that if young buffaloes can be raised together with native carabaos, in time, they will mate and produce a cross.

Swine.—The growing of pigs at Alabang gave highly satisfactory results which in part may be attributed to sanitary management and to systematic feeding. In all cases, sheds were provided for the pigs under which they could find shelter from the hot sun. The yards were cleaned by burning the trash and were plowed whenever soil conditions permitted. No standing water was allowed to stay in the yard; the pigs were bathed often and nutritious feed given in plentiful quantities. The fresh charcoal manufactured at the station proved better than the charcoal formerly purchased outside.

A trio of white pigs consisting of one Mid-York boar and sow and one Yorkshire sow were sent to Alabang during the fourth quarter. Both sows have been bred and are expected to farrow during the early part of 1919. But white pigs in the Philippines will probably not do well in the low regions. As regards the Berkshire and the Duroc-Jersey, however, the experiences with these types of American hogs, both at the Government stations and at private farms, entirely justify their importation in large numbers. These breeds of animals have shown themselves entirely suitable to Philippine conditions and they produce excellent results by crossing with the native pigs. Their early maturing qualities and generally handsome appearance are the reasons for the great enthusiasm expressed by every one having any knowledge of these breeds and for the truly remarkable interest being shown by the people of Batangas, as referred to already in the early part of this report. One other breed of American hog that would probably find ready acceptance in the Philippines, considering that the trade requirements here are for lean pork, is the Tamworth, which is a breed that belongs to the bacon type. Efforts will be made to secure at least a trio of Tamworth pigs for trial here.

Goats.—An unknown disease killed many of the goats at the farm. It gained in virulence during October and November, causing a great number of deaths among these animals. The symptoms of the disease are distressful appearance, bending of the head to one side and paralysis of the hind quarters, causing the animals to loss control of their legs when walking. On postmortem examination, the lungs were found to have dark patches of coagulated blood and a few small yellowish patches. The spinal cord was covered on the outer membrane, irregularly placed, by short streaks of dark color. The brain was found to be shrunken and floating in a large amount of liquid of the sinovial fluid consistency. This disease might be caused by a cestode or a miscroscopical parasite. So far, experiments in raising sheep and goats at the Alabang station has been unsuccessful, owing perhaps to the wet climate prevailing in this district, which is not agreeable to this class of animals.

Poultry.—The poultry at Alabang were visited with many kinds of disease, the most common being diphtheria, roup, favus, dysentery, chicken pox and intestinal worms. These diseases caused a considerable number of deaths and naturally affected egg production. The grounds and utensils were thoroughly disinfected, but as the infection was pretty general throughout the place, it took considerable patience and a long time to check the diseases. With the use of shotguns, the loss from hawks and other birds of prey was greatly reduced. This unfavorable condition existed during the first half of the year. Conditions greatly improved, beginning with the second half, although the American chickens from two to four months of age suffered quite a setback, owing to change of location.

LA CARLOTA EXPERIMENT STATION

Livestock receives considerable attention at La Carlota, though this station is probably better known for its work on rice, corn and sugar cane. There has been at the station at all times at least one technical man in charge of the livestock, as assistant to the superintendent of the station.

Horses.—At the beginning of the year, there were 8 horses at the station. Four of these died of surra and two were shipped to Manila. During the year, a grade stallion (Prop. No. 426) was shipped to La Carlota from Manila, Australian stallion No. 446 was transferred there from La Paz, Iloilo. The native stallion "El chico" was the only one available for breeding in January. When the Australian stallion No. 446 was first transferred to La Carlota from La Paz, Iloilo, it was found to be unsuitable for breeding, owing to its poor condition. Stallion No. 77 at La Carlota rendered 47 services during the year, while stallion No. 446, 12.

Indian Cattle.—There were 65 head of Indian cattle when the year commenced. As the pasture within the corral for Indian cattle was found insufficient to maintain the number of animals quartered there, the cattle were taken outside and transferred from one place to another to prevent killing the pasture grass. The suckling calves suffered from intestinal parasites for which

White Leghorns Raised at Alabang

turpentine mixed with linseed oil in the proportion of 1 to 6 and administered in one pint doses per head daily was prescribed. This treatment proved successful and was followed by giving all cattle salt saturated with turpentine twice a week. Three cattle died during the year. On October seventeenth, the cattle were affected with foot-and-mouth-disease which, however, did not cause a single death. At the end of the year, there were 70 head of Indian cattle.

Chinese and Grade Cattle.—The year began with 174 head of Chinese and grade cattle including calves, among which were 3 Indian bulls which were used as sires. As was the case with the Indian cattle, the Chinese and grade were affected with intestinal diseases. The same treatment was followed with satisfactory results. On the same date that foot-and-mouth-disease affected the Indian cattle, the Chinese and grade cattle also were affected, as a result of which, 6 calves died. Although the other animals got thin, as a result of confinement, they are now fast recovering. During the year, there were 58 births as against 18 deaths, or a net gain of 40. Twenty-four head were sold.

Carabaos.—There were 41 carabaos at the beginning of the year, and these also suffered from foot-and-mouth-disease when it broke out at the station on October seventeenth. All the carabaos recovered from this attack. During the year, four births and one death were recorded. The death was due to internal parasites. At present there are 45 carabaos at the station.

Sheep and Goats.—At the beginning of the year, there were 38 sheep and 35 goats at the station. As experienced in other stations, these animals suffered from foot-rot and later from parasites, especially tapeworm and pinworm, despite the good care taken of them. The animals which were affected by intestinal parasites were drenched with one per cent solution of bluestone (copper sulphate) and salt saturated with turpentine was given them twice a week. During the year 25 lambs and 16 kids were born while 11 sheep and 20 goats died. Eleven sheep and seven goats were sold during the same period. At the end of the year, there were 41 sheep and 24 goats at the station.

Swine.—The Berkshire and the Duroc-Jersey breeds made up the herd of pigs at this station. There were at the commencement of the year, 8 Berkshire and 4 Duroc-Jersey pigs. The pigs were fed twice a day with corn, rice, camotes, and other feeding materials. The corrals were planted with peanuts and camote which supplied part of the green forage. Cowpeas and velvet beans were also planted during the early part of the year.

Male pigs other than those needed at the station were sold whenever available. Very few sows were brought to the station for breeding, owing doubtless to the distance of the station from the centers of population.

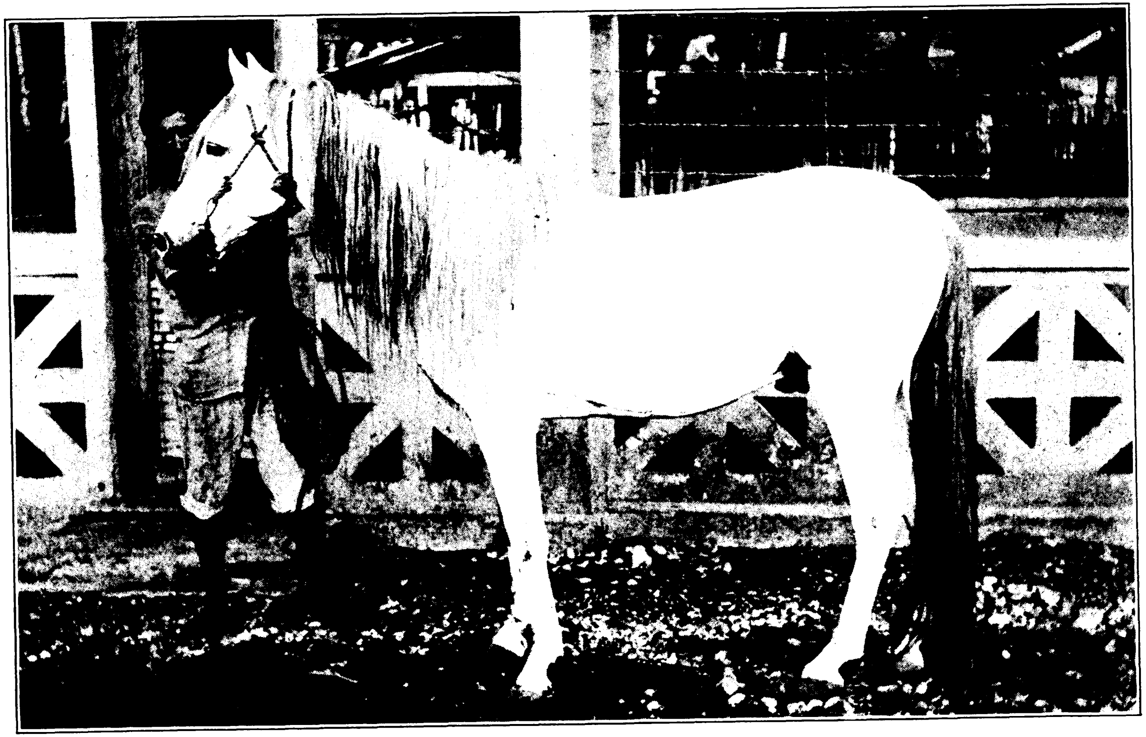
Poultry.—The feed for chickens consisted principally of corn and palay. To furnish the chickens with protein, meats and snails were given. The small chicks receive the same kind of food but ground before feeding. The chickens became infested with lice and were individually treated with powdered sulphur and dust. This treatment proved unsuccessful and instead, the leaves of "alagao" *Premna odorata* L. were placed in the nests and as a result, the hens are now free from lice.

TRINIDAD STOCK FARM

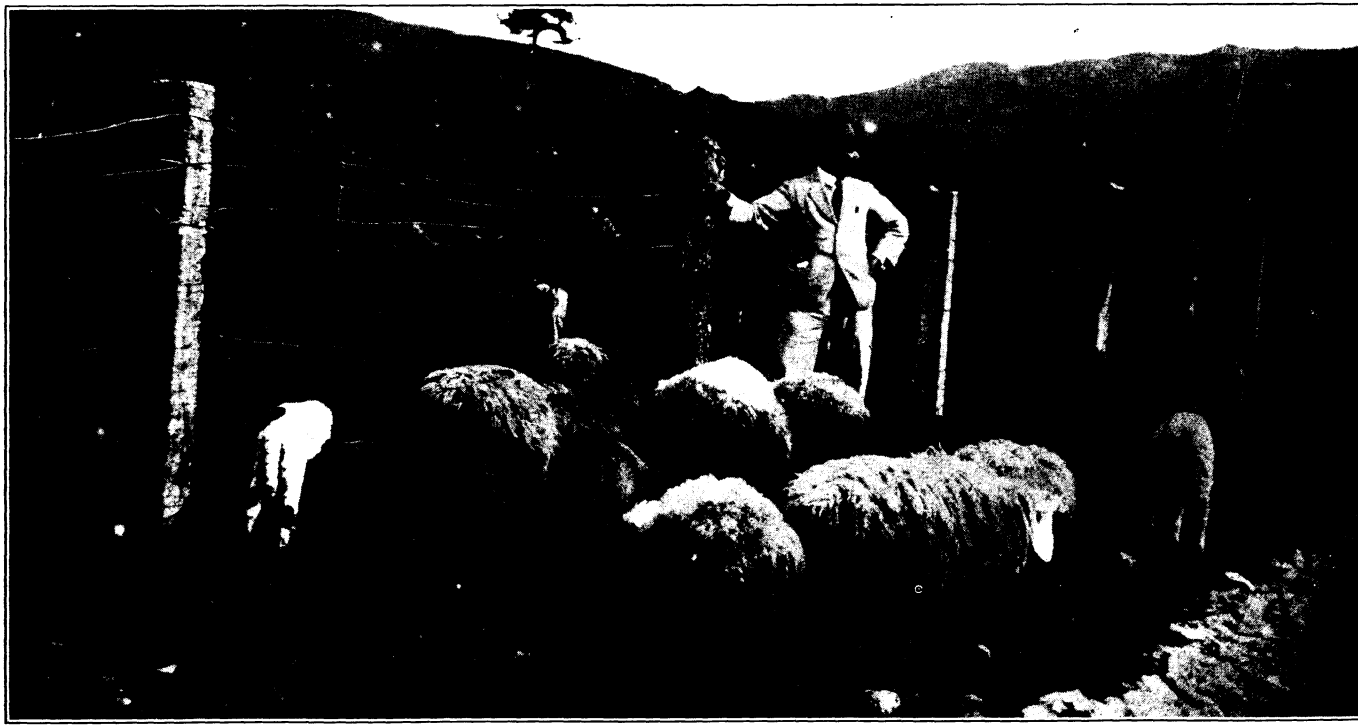
Mr. Bert Duckworth is in charge of this farm as superintendent. The horse project is not important at this station, there having only one stallion kept there during the year in use for public breeding purposes. At the beginning of the year, there were 159 head of cattle, of which 59 were females of the breeding age. The number of animals born during the year was 34. Twenty-one head of cattle were sold during the year, including young bulls and heifers suitable for breeding. Six bulls were loaned to the Mountain Province for breeding purposes. There were 4 sows at the station of breeding age and from these sows, 22 pigs were born. There are 8 sheep and 71 chickens at this station.

PUBLIC BREEDING STATIONS

Besides the livestock farms like Alabang, La Carlota, and Trinidad maintained by the Bureau of Agriculture, there are small stations called public breeding stations kept up in different provinees, with the primary object of upgrading the important livestock in the provinces where they are established. Swine and poultry predominate at these public breeding stations, as it is in the improvement of these animals that the people show the greatest interest now. The demand for public breeding stations of inexpensive equipment has been too great for the Bureau with its appropriation and available number of animals, to meet. This fact, added to the success that has uniformly marked the establishment and operation of these public breeding stations, amply justifies the extension of this phase of the work of the Bureau. That more has not been done along this line is due to the inability of the Bureau to secure poultry and swine suitable for breeding.



Mestizo Stallion (American-Native), No. 442, Oriental Negros



Indian Sheep at the Trinidad Stock Farm, Baguio, Benguet

Berkshire pigs grazing at Trinidad Stock Farm, Baguio, Benguet

Products of Stallion (American—Native) 442—in one year, at Guihulñgan, Oriental Negros

VETERINARY DIVISION

Chief Veterinarian, STANTON YOUNGBERG, D. V. M.

RINDERPEST

Extent of Infection.—The generalized epizoötic of this disease which began to assume serious proportions in 1916, appears to be gradually abating in virulence. The recorded number of cases and deaths in 1918—21,586 new cases and 15,747 deaths—cannot however be properly compared with the 33,971 cases and 26,951 deaths reported during the preceding year, because the data for the last quarter of 1918 is exceedingly incomplete owing to the fact that the greater part of the field force was dismissed at the close of the third quarter on account of the exhaustion of funds. Figures for the first three quarters show 19,677 new cases as against 26,819 in 1917, and 14,253 deaths in place of 21,660. The actual losses, it is safe to say, were in each of the last three years much larger than those which came to the knowledge of the veterinary division; in fact they would appear to have been sufficient to nearly offset the normal excess of births over deaths, leaving the numbers of cattle and carabaos practically stationary.

From the beginning of the year it was apparent that the funds appropriated for the veterinary division were inadequate for the maintenance of a sufficient field force. After consultation with the Honorable, the Secretary of Agriculture and Natural Resources, representations were made to the Emergency Board which alloted us ₱125,000 on May 27. As this sum proved insufficient a further appeal for funds was made; but owing to the practical exhaustion of the fund at the disposal of the Emergency Board the only additional amount granted was ₱42,000, alloted on October first, for traveling expenses of all divisions of the Bureau. This made the immediate discharge of all temporary field personnel absolutely necessary.

The following table shows the incidence of rinderpest cases and deaths during 1918 by three month periods:

Rinderpest cases and deaths by quarters

	New cases.	Deaths.
First quarter	5,416	3,916
Second quarter	7,281	5,185
Third quarter	6,980	5,152
Fourth quarter	1,909	1,494
Total	21,586	15,747

Our records show that during the year, 334 new outbreaks occurred, counting each municipality declared or reinfected during the year as a separate outbreak. This number has been surpassed only in 1917 when 448 towns became infected with this diseases.

The year opened with 22 provinces and 116 municipalities infected; and ended with 18 provinces and 65 municipalities, some of which had furnished no data for a number of weeks, though carried on our records as infected. The total number of provinces infected during the year was 32, an increase of two over 1917.

These infected provinces were Albay, Ambos Camarines, Bataan, Batangas, Bulacan, Capiz, Cagayan, Cavite, Cebu, Davao, Ilocos Norte, Iloilo, Laguna, La Union, Leyte, Mindoro, Misamis, Nueva Ecija, Nueva Vizcaya, Occidental Negros, Oriental Negros, Pampanga, Pangasinan, Rizal, Samar, Sorsogon, (including the Subprovince of Masbate), Surigao, Tarlac, Tayabas, Zambales, Zamboanga, and the city of Manila. The Provinces of Albay, Ambos Camarines, Davao, Ilocos Norte, and Tayabas had not been reported as infected during 1917; while Ilocos Sur, Isabela, and Mountain Province which had rinderpest during that year reported none for 1918. The province recording the greatest amount of infection for the year was Batangas with 4,580 cases and 3,593 deaths. It was followed by Leyte with 2,442 cases and 1,733 deaths, Bulacan with 2,048 and 1,454, Laguna 1,814 and 1,370, Oriental Negros 1,643 and 969, Rizal 1,603 and 1,328, Mindoro 997 and 931, Cebu, 989 and 580, and Sorsogon with 814 and 553.

Of the five provinces newly infected during the year, Davao had reported no rinderpest since its great epizoötic of 1915, the other four had been several times infected within more recent years.

Masbate Infection.—The Island of Masbate (a Subprovince of Sorsogon) also became infected for the first time since the very disastrous epizoötic which swept off the majority of its livestock about 15 years ago. This visitation was very unfortunate, indeed, as the island was again becoming pretty well re-stocked. The infection was first discovered in a small coast barrio of the municipality of Dimasalang. Up to the present time it has not been possible to obtain absolutely conclusive proof as to the exact manner in which the disease was introduced; suspicion is, however, directed against a certain Chinaman who is said to have taken a few head of cattle in a

Type of virulent blood animal employed in rinderpest inoculations

small sailing vessel to the Island of Leyte with the intention of selling them there. Rumor has it that upon being unable to obtain the price he desired he returned with them to Dimasalang, Masbate. The Island of Leyte was at the time badly infected with rinderpest. This is supposed to have occurred during the month of May; the first report of infection reached this office on the 9th of July.

One of our most experienced veterinarians was rushed down to investigate. He found that the disease had already spread over a considerable portion of the municipality and that unless immediate and drastic action were taken a disastrous epizoötic was imminent. Three additional veterinarians and thirty livestock inspectors were sent to assist him as quickly as they could be mobilized and transportation secured. The Bureau of Constabulary was appealed to for quarantine guards, and quickly responded with fifty soldiers. Our veterinarian was given complete control of the campaign and the local officials were directed by the Chief of the Executive Bureau to render all assistance within their power. The people for the most part cheerfully complied with the necessarily strict quarantine measures as they realized that the livestock industry of the island—which is their principal source of revenue—depended upon it. After the campaign was well organized and under way, the infection was also discovered in some barrios of the neighboring municipality of Cataingan, and the quarantine operations were accordingly extended to include that town. Dimasalang was reported free from rinderpest on September 16, while Cataingan was first reported free September 30. New infection was, however, discovered in the southwestern part of the latter municipality on November 15th. Up to the end of the year the disease had not spread beyond that section, where it was running a course rather mild in virulence. The cattle industry of the island will of course be menaced until the last vestige of infection shall have been stamped out. Strict quarantine and careful inspection must be carried on until this is accomplished.

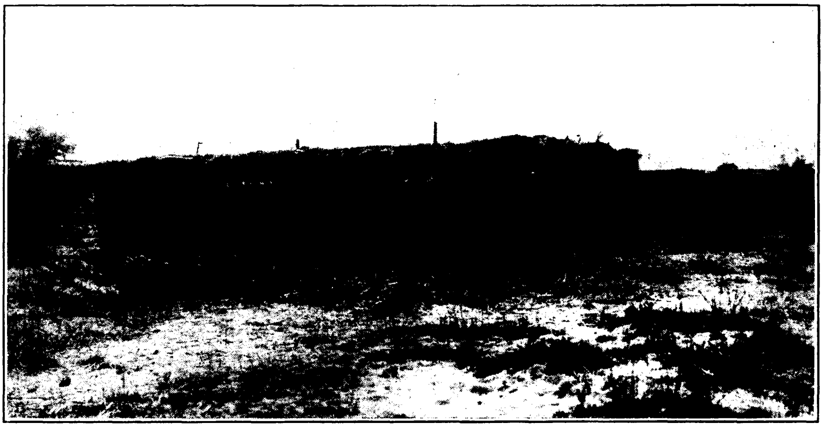
This control of the rinderpest outbreak in Masbate is a good example of what can be accomplished when the campaign is placed in proper hands and willing coöperation of both people and local officials is forthcoming.

Department of Mindanao and Sulu.—Davao was reported as infected with rinderpest on September 30th. The manner in which the infection gained entrance has not been determined, though it is presumed that it was carried down from Surigao by either tame or wild animals, probably the latter. This outbreak has been handled by the veterinarian of the Department of Mindanao and Sulu, assisted by one veterinarian and four livestock inspectors of this Bureau. At the end of the year the infection appeared to have been brought under control, no new cases having been discovered for more than twenty days. There had been a total of 373 cases followed by 281 deaths or a mortality of seventy five per cent.

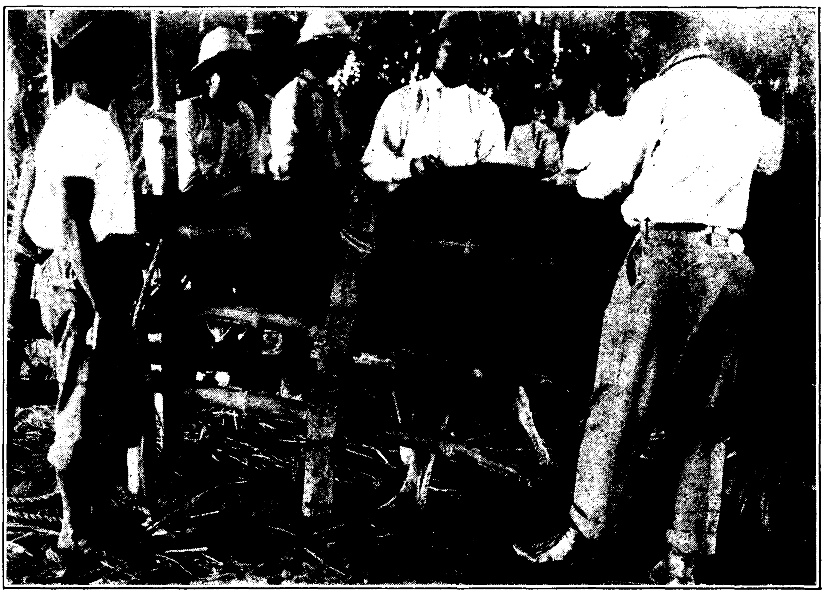
The Province of Zamboanga became reinfected in March but the disease had been entirely brought under control on the 8th of August. The veterinarian of the Department of Mindanao and Sulu has been in direct control of the animal quarantines in the provinces appertaining to that Department. The local officials have given him full coöperation, and as a result the disease outbreaks have speedily been brought under control.

The local quarantines throughout the rest of the infected provinces have varied considerably in point of effectiveness. In reality, in a great many cases, our inspectors served only to keep us informed of the extent of infection in the various provinces. So far as being able to enforce even a moderate quarantine they were frequently almost helpless. This state of affairs was due in part, aside from the indifference of the people and disinclination of the local authorities toward enforcing compulsory measures, to the amendment made in our regulations relative to the use of serum.

Use of Serum.—Many people insisted on having serum, whether they belived in it or not, just to avoid having their animals subjected to quarantine. The amendment was intended to alleviate to some extent the inconveniences of quarantines so that the farmers would not have their agricultural work interferred with too greatly. It provided that the animals injected with serum should be kept within the limits of the quarantined barrio. It was, however, gradually weakened by the broad interpretation which many municipal presidents insisted on giving to it. They frequently permitted these injected animals to go from an infected barrio to non-infected ones, and at times even to other muncipalities. This frequently resulted in the further spread of rinderpest; for such animals might either have been in the period of incubation at the time of injection with serum or would contract the disease after the serum had been eliminated, and in either case would not show noticeable symptoms until after having left the infected barrio. The amendment above referred to has, therefore, been eliminated from the quarantine rules and regulations as experience has demonstrated that it had but very little real influence in the control of rin-



(*a*) Shed in which animals are injected with anti-rinderpest serum



(*b*) Injecting anti-rinderpest serum

derpest and at times was even the cause of its spread. Our veterinarians are now being instructed to employ serum only in cases where they can be reasonably sure that it will prove of some benefit.

Enforcement of Quarantine.—After the proper regulation of cattle importation from disease-infected countries, the next step of importance in the control of rinderpest is the adequate enforcement of quarantines and other measures necessary for its suppression within the country. Walley, in considering the experiences had in England during the outbreaks of 1866 and 1877, makes the following comment:

Into whatever country Cattle Plague is introduced, the most rigorous suppressive measures should be adopted; and from our experience of the last visitation it is plain that the execution of these measures should not be entrusted to any other power than the Privy Council. Many local authorities have, in the past, been extremely lax in their efforts to suppress not only this but other and less important zymotic affections, and in a matter of such moment the Privy Council has done well to ensure for itself *absolute and unrestricted power to deal with Cattle Plague in the future as it sees best, and not to trust to less responsible and feebler bodies.*

In all the principal countries of the world the enforcement of measures for the suppression of contagious animal diseases is not left in the hand of local authorities; also, the people having direct charge of the measures are appointive and not elective officials.

In October, 1907, the Philippine Commission passed Act No. 1760 which placed the direction of the measures for the control of dangerous and communicable animal diseases in the hands of Director of Agriculture. It was not until 1910 that the Bureau of Agriculture began to have enough veterinarians so that enforcement of the provisions of this act could be properly commenced. In 1911 a well-organized campaign was started which had for its object the control of rinderpest in the provinces of Central Luzon. As the work was extended some of the farmers and local officials convinced themselves that the Bureau of Agriculture was too stringent in the enforcement of the quarantine measures. This idea gradually gained ground and finally culminated in the passage of Act 2303 by the Philippine Legislature on December 13, 1913. This Act provided that the Director of Agriculture prescribe the necessary measures, but that the provincial governor of the province concerned should have the direction of and be responsible for the measures so prescribed.

In the annual report for the year 1914, after this act had been in force for a year, the undersigned made the following statement in regard to the results obtained:

"It may be said, in general, that while Act 2303 has eliminated conflicts between the Bureau and local officials and owners, and has greatly decreased the expenses of the veterinary work of the Bureau, it has made it difficult to secure prompt, complete and reliable reports of local outbreaks and has resulted in almost complete cessation of work outside the immediate vicinity of known infection." This statement still holds good today.

Prior to 1914 there may have been some justification for the opinion that the measures adopted by the Bureau were too stringent owing to the fact that at that time the majority of the veterinarians were Americans, a great many of whom were ignorant of local dialects and customs. It was, therefore, natural that misunderstandings should occur. This cannot be true today when more than 90 per cent of the field force is composed of Filipinos.

The only logical conclusion that can be drawn from the results obtained in the last five years is that the direction of measures for the control of dangerous and communicable animal diseases should be vested in the Director of Agriculture.

Cattle Importation and Rinderpest.—The course of rinderpest outbreaks in these Islands during the last four years and the discoveries that have been made during this period demonstrate the effect that the importation of animals from rinderpest-infected countries has on the local situation. To properly understand this relation one must take into consideration the peculiar features of rinderpest.

The English Veterinarian Walley in his work entitled "The Four Bovine Scourges" written in 1879 makes the following statement in regard to Cattle Plague (Rinderpest):

> Cattle plague in those countries in which it is enzoötic is usually of a very benignant type, and not only do many animals run the gauntlet of infection quite scathless, but the majority of those which are attacked recover, and the symptoms are comparatively but slightly developed. This is probably one of the worst and most deceptive features of the malady, and not only so, but in addition, an animal which does not show the slightest sign of the existence of the infection in its own system, frequently becomes the means of propagating it in its most virulent form to every animal with which it is brought in contact.

The work of all the authorities on rinderpest since Walley's time have constantly confirmed his conclusions. The celebrated veterinarians Hutyra and Marek in their recent work (1916) make the following observations in regard to this diseases:

> Natural infection results either by direct contact with affected animals or is transmitted through the raw products of such animals, *such as parts of carcasses*, as well as by persons contaminated by such carcasses or by infected secretions and excretions. Food, drinking water, stable utensils,

cloths, etc., may also transmit the infection. In most instances, however, the infection is disseminated by affected animals in the ordinary traffic with cattle, which mode of infection is the more important as some animals may be only very slightly affected and yet retain the virus in the body for 14 days, in chronic cases probably even somewhat longer.

According to the observation of Russian authors and Eggebrecht the disease among these breeds (range cattle) of cattle may be manifested only by a febrile condition lasting for a few days, and by a mild catarrh of the mucous membranes of the respiratory organs, as well as of the digestive tract. As a result of these the disease may sometimes even pass unnoticed in the larger herds.

The above paragraph applies exactly to the cattle of French Indo-China, or at least those imported into these Islands which come from the vicinity of Pnom Penh. All the shipments of cattle that have arrived from that country during the past four years, with the possible exception of a few of the very small lots which were killed off within a few days after arrival, have been infected with rinderpest. The number of atypical cases has been very large; that is, animals which have been apparently normal upon ante-mortem examination and have shown lesions of rinderpest on post-mortem examination. It is a hopeless task to try to eliminate these cases during the ordinary periods of quarantine. This is very well brought out in the report of the then Chief Veterinarian for the fiscal year 1911–12. In regard to the imported animals he makes the following statement:

These animals had been passed by a veterinarian of the Bureau of Agriculture in Indo-China, by a French veterinarian there, and besides had undergone ten days quarantine in the Philippines. In spite of these precautions rinderpest was introduced and nothing remained but to put in effect a ninety day quarantine on shipments of cattle from this territory.

The experiments conducted by Dr. Boynton during the past two years show that the virus of rinderpest in the visceral organs is very tenacious. It has been proven that extracts of liver and spleen kept in one per cent carbolic acid for 21 days are still virulent. It must also be born in mind that these extracts were made from animals which were bled to death on the second or third day of temperature at a time when in all other respects the animals were apparently normal. It thus becomes easy to understand how rinderpest can be spread by the liver, spleen, or other viscera of an animal which was in the first stages of the disease at the time of slaughter and upon post-mortem examination showed no evidence of being infected.

Walley in 1879 wrote as follows in regard to importation of animals from rinderpest infected countries:

It has been suggested that if importation is allowed at all from scheduled countries, inspectors of our own appointing should be stationed at the ports of embarkation. Doubtless such a system would still further minimize the danger of invasion, especially if the British Consuls and inspectors were instructed to keep themselves thoroughly posted up as to the existence of Cattle Plague in neighboring states; but, on the whole, *if the slightest suspicion or doubt exists, the wiser course is to prohibit the importation, not only of live stock, but every thing which is likely to become a medium of introducing the infection.*

Veterinary experience since that time has caused no decided modification of these opinions, except to strengthen them. It, therefore, becomes increasingly apparent that the first step in the proper control of rinderpest in the Philippine Islands lies in the regulation of cattle importation from rinderpest-infected countries. Importation of cattle on the hoof from these countries should be discontinued; the frozen meat, exclusive of the visceral organs, may be allowed to enter. If it should not be advisable to take this step at once, then all imported cattle as well as carabaos should be admitted only after having been immunized against rinderpest by simultaneous inoculation at the port of origin.

The demand for fresh meat can be supplied by native cattle and those imported from Australia, which it will still be permissible to import on the hoof. Australian cattle were the main source of Manila's fresh meat supply from 1912 to 1916. Australia is absolutely free from rinderpest and foot-and-mouth disease. It is true that contagious pleuro-pneumonia is prevalent in some sections of that country, but this is a disease of an entirely different nature from the other two. During the period above mentioned more than 30,000 head of Australian cattle were slaughtered at the Sisiman Matadero without causing any dissemination of pleuro-pneumonia. In 1916 importations from Australia were suspended owing to the fact that tonnage was no longer available for that purpose. At that time some native carabaos that had been used at Sisiman for work purposes in connection with the matadero and had been constantly in contact with the Australian cattle were slaughtered, owing to the fact that it was not considered advisable to remove them alive from that place. Special care was exercised in the post mortem examination of their carcasses and not the slightest evidence of contagious pleuro-pneumonia could be found. It seems probable that carabaos do not readily contract this disease. Be that as it may, experience has demonstrated that Australian cattle when received at Sisiman and properly handled can be imported for slaughter purposes without any great danger of disseminating contagious pleuro-pneumonia.

Carabao preparatory to being placed on a table for bleeding

Partial view of one shed of the Immunizing Station at San Fernando, Pampanga

Immunization.—The total number of carabaos and cattle immunized during the year, 6,232, compares very favorably with the 7,191 immunized in 1917, when it is considered that during November and December, two good immunizing months, the stations had to be closed on account of the prevalence of foot-and-mouth disease. Of this number, 148 died from all causes in the stations during the immunizing period. This is a mortality of 2.4 per cent. It must also be taken into account that several of these animals died from other causes than immunization; but we carry them on the mortality lists, as all animals that die in a station are paid for.

In the Province of Pampanga there were four stations in operation, viz: Angeles, Lubao, Macabebe (with a substation at Apalit), and San Fernando (with a substation at Santa Rita and also at San Luis for a few months). Work at these places went on pretty steadily till the month of June when it became necessary to suspend operations on account of the rice planting season, with the exception of Angeles which is in the sugar cane belt. Work was resumed in September, but in October it became necessary to close all stations on account of the virulent epizootic of foot-and-mouth disease which was rapidly spreading throughout Pampanga Province. This disease by itself produces a mortality that is negligible, but combined with rinderpest the results are liable to prove highly disastrous. It had not been found possible to reopen any of these stations by the end of the year. There were 5,313 carabaos and cattle immunized in Pampanga during the year, with a total mortality of 133 or 2.5 per cent. In this regard it is interesting to note that the highest death rate occurred at the Lubao and Macabebe sations, and the lowest at Angeles. The country around the two first-mentioned places is low lying, with large swampy areas, while that around Angeles is higher, drier, and sandy. The animals of the former places are pretty heavily infested with parasites while those at the latter place are comparatively free from such infestations.

The immunizing station at San Miguel, Bulacan, was opened on the 6th of March, at which time 6 animals were presented for immunization. The succeeding lots have been small and scattered and a total of only 95 animals have been immunized during the year. No animals have been received since the middle of October, due first to the influenza among the people and later to the foot-and-mouth disease affecting the livestock. To have received only 95 animals over a seven-months period (March to October) is very discouraging to say the least. The underlying cause can probably be found in conflicting political situations and it is evident that the provincial board made an error in locating a station at that place. As far as the results of immunization are concerned, the people can have no complaint. Only one animal having been lost, or a mortality a trifle over one per cent. Unless there is a speedy change in conditions at this place it might become necessary to withdraw the men from there and use them where something can be accomplished, for continuing as at present is only a waste of money.

At Iloilo only 178 animals were immunized, the mortality being 1 or about 0.5 per cent. The small number received at that station is due to the fact that the importation of work animals during the year was practically at a stand-still. This also affected our work at Pandacan, where only 646 were immunized. The death rate here was 13 or 2 per cent. Of the animals received there were 364 cattle and 57 buffaloes imported from India, for breeding purposes, by the Department of Agriculture.

The animals that are already in the period of incubation upon arriving at the station still constitute somewhat of a problem, and one which will probably never be solved to our absolute satisfaction. As stated before, these animals are apparently normal at the time of injection and from one to three days afterwards come down with rinderpest. Whenever possible we try to keep new lots under observation for about two days, during which time temperatures are taken, before making the simultaneous inoculations. In this way we have been able to eliminate quite a few, as animals carrying a high temperature are not inoculated but are held pending further developments. A great deal of course depends upon the skill and judgment of the individual veterinarians, but taking it all in all the number of already infected animals that get past them is not large.

Since 1913 more than 36,000 animals have been immunized against rinderpest by simultaneous inoculations. These animals are in districts that are fairly constantly infected with rinderpest, and hence have good opportunity to contract the disease not being subjected to the quarantine regulations applied to non-immunized animals. To the best of our knowledge less than one per cent of these animals have afterwards contracted rinderpest. These figures are pretty accurate as owners of immunized animals are as a general rule very quick to report any ailments with which these animals may suffer.

During the past year this office has continued to be seriously handicaped by the shortage of veterinarians. This has neces-

Anti-rinderpest serum; drawing blood

Autoclave used in field serum laboratory

sarily reflected on the work of immunization and has not made it possible to extend our activities in this direction as rapidly as might have been desired. Six new veterinarians joined our forces, but we also lost the services of five others, which left us with only a net gain of one. The new men were young and inexperienced, while those who left were of considerable experience. From now on, however, it should be possible to hope for a gradual increase in the number of the veterinary personnel, for the new men entering the service are mostly graduates of the College of Veterinary Medicine of the University of the Philippines and are permanent residents of the islands.

A new and rapid method of immunization is being worked out, which up to date has shown very promising results and is likely to effect a change in the present methods of immunizing against rinderpest. This will be taken up again in connection with the work of the Veterinary Research Laboratory.

Changes in the Immunization Law.—With regard to the work of immunization, the experience of the past two years has demonstrated some of the weak points of Act No. 2548. Before further extensions are made in this work it would be well to have these defects remedied by the proper amendments being made to the Act.

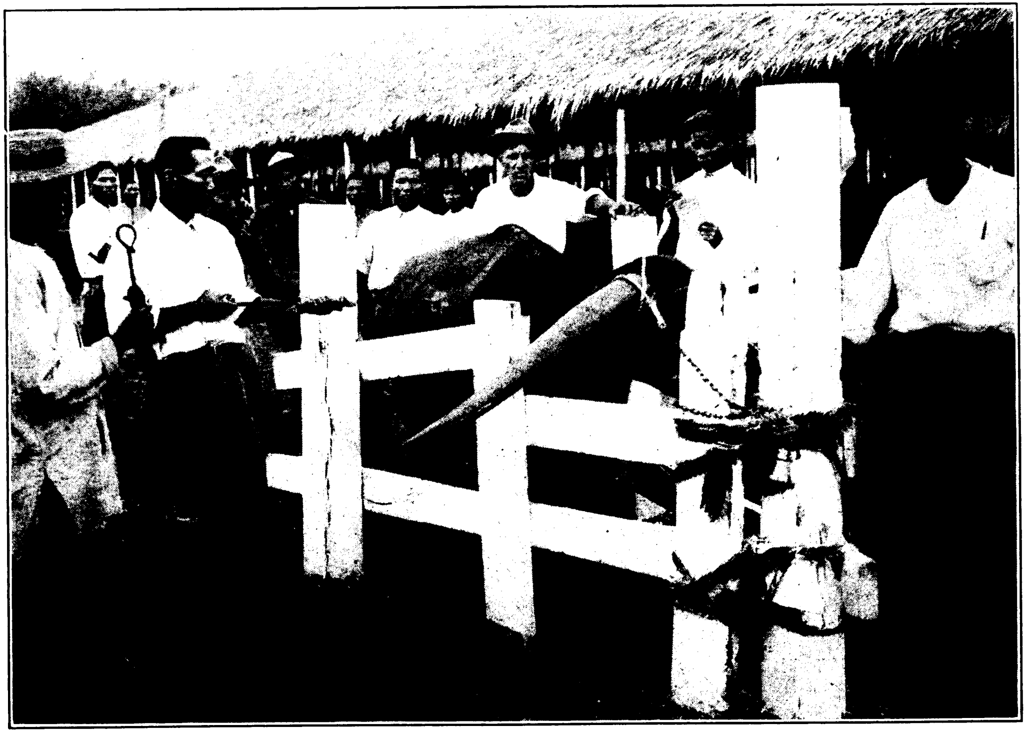
Immunizing stations must be run to their capacity in order to be adequately compensated for the cost of the personnel. This must be kept at a pretty constant figure as the men are all skilled in their particular duties and it requires some time to train them. They can not therefore be hired and discharged from week to week. There are but very few stations that have been run to their full capacity of animals, and these only for a few weeks at a time. The way it is now the veterinarian in charge may request 100 animals for a certain day and he cannot be certain whether he will get that many, or half that many, or even less. He usually gets the latter. When it comes time for the animals to come in there are too many owners who present excuses for not bringing them. It often happens that a man having say 6 carabaos may have work for a couple of them; on this account he gets an excuse for all six when he could just as well send in two each week.

When a station first opens up it is usually not very difficult to obtain animals, but as the rinderpest decreases as a result of the immunization the people become less worried and it is a harder job to get the carabaos. It often happens that when rinderpest assumes serious proportions in a locality that the people there want immunization immediately. Of course then it is already too late; the proper time to immunize is before the enemy arrives. When any provincial board decides to have the animals of any locality immunized, they should be prepared to have the work pushed to completion within the shortest possible time. By the exercise of good common sense combined with a little diplomacy that can be accomplished without seriously injuring any agricultural operations.

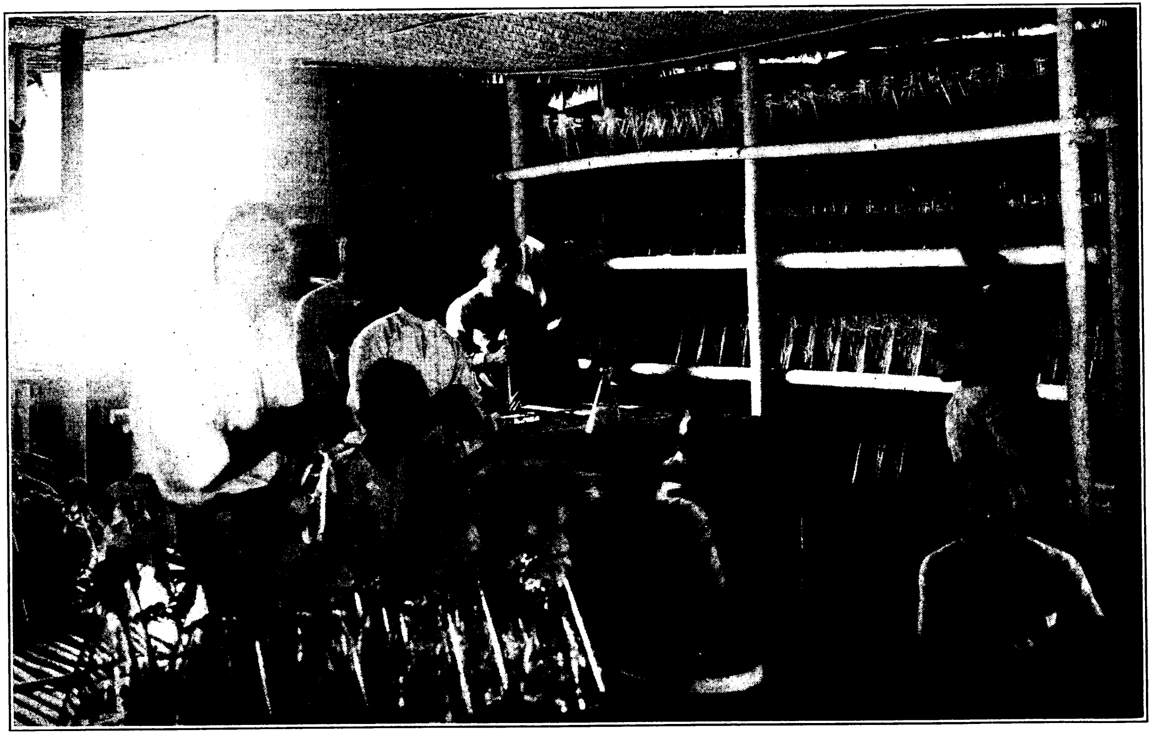
The present method of appraising and paying for the dead animals as provided for by section 3 of the Act has not proved to be entirely satisfactory. In the first place the payment of 75 per cent of its value is not a fair proposition. This leads to erroneous statements in appraising so that the owner may really be reimbursed the actual value of the animal. The first thing to do is to see that the animal is appraised at a fair value and then if it dies pay exactly that sum, not a cent more nor less no matter to whom it belongs. The law now authorizes the provincial board to make the appraisals. This does not work out in practice, as the board cannot visit each station for this purpose every time animals are brought in. So it resolves itself into one member of the board making the appraisals, which in the majority of cases are not made till the dead animals have already been buried. It would be a much better arrangement to have a board of appraisers consisting of the following members: (1) a representative of the Director of Agriculture, (2) the provincial treasurer or his representative (which would very likely be the municipal treasurer), and (3) a reputable property holder residing in the municipality where the immunizing station is situated, to be appointed by the Director of Agriculture, upon recommendation of the provincial board. In any case where the board of appraisers fails to reach a unanimous decision the matter shall be referred to the Director of Agriculture whose decision if approved by the Secretary of Agriculture and Natural Resources, shall be final. This method will give justice to every party concerned and will also fix a better standard of prices to be paid for the animals.

FOOT-AND-MOUTH DISEASE

On August 12, 1918, a shipment of 105 head of cattle arrived from Saigon, French Indo-China consigned to Lichauco and Co. They were found to be badly infected with foot-and-mouth disease of a virulent type. Everything possible was done to prevent the escape of the infection; the animals were sent on lighters to the Pandacan Quarantine Station where they were



Branding immunized carabaos, Immunizing Station, San Fernando, Pampanga



Preparing flasks for bleeding at Immunizing Station, San Fernando, Pampanga

slaughtered off as rapidly as possible, being in the meantime kept in strict isolation, and everything with which they came in contract was saturated with disinfectants. But in spite of all these precautions the disease in some manner was carried to animals in the city of Manila and from there to the adjoining provinces. This particular strain being of a virulent type the spread of the contagion was very rapid. The Provinces of Rizal, Bulacan, Pampanga and Tarlac have become infected. In Pampanga it is causing considerable financial loss owing to its interference with the harvesting of the present sugar crop and the planting of the next crop. This can be readily understood when it is known that a farmer's entire lot of work animals will become affected within a few days and he is therefore forced to stop all work. The quickest that any animal again begins to be serviceable is two weeks and in most cases it is closer to a month owing to the debilitated condition in which the disease leaves its victims. This epizoötic has been the cause of deaths among aged and debilitated animals and among suckling calves. The latter class of course die from starvation on account of the mothers going dry. The effect upon dairy cows is disastrous. The La Loma Dairy Farm, which has all Australian cows, became infected and as a result received a very serious setback; fourteen of their best cows died and the milk supply of the remainder was practically nil. It will be several months before these cows get back to somewhere near their former production and some of them very likely never will.

"Foot-and-mouth disease is one of the most infectious and contagious maladies which affect domestic animals, and is the easiest of transmission. No disease with which we are acquainted is capable of propagation in such a variety of ways as the one under consideration. One attack does not give immunity from others; and not only may an individual animal suffer several times from it in the course of its life, but even twice or thrice in a season, though in the great majority of cases each successive attack becomes milder in its character." (Walley, The Four Bovine Scourges.)

Subsequent lots of infected animals arrived from Indo China on August 23, September 1, 12, and 21, 1918. These were as carefully handled as the first shipment even though the disease had already escaped to the native animals. The idea was to try to prevent any fresh strain of virus from escaping. As a result of these infected shipments our general orders governing the importation of animals from French Indo China have been amended. If in the future any shipment upon arrival proves to be infected with foot-and-mouth disease the animals shall be unloaded into lighters and there held until the death or recovery of the last case of this disease. The idea is to make the importers exercise greater precautions to obtain animals from disease-free areas. Of course it must be understood that even the best of precautions will not always prevent the entrance of disease with animals coming from infected countries. Shipments have already arrived which did not show the infection till some days after landing, and the same thing can easily happen again. The only really safe way is not to import live animals from these countries. Dr. John R. Mohler, Chief of the Bureau of Animal Industry, U. S. Department of Agriculture, has recently issued a warning to public officials, veterinarians, and stock owners in the United States to be on their guard as an outbreak of foot-and-mouth disease has appeared in England. In this warning he makes this pertinent statement: "So long as communication is maintained with other countries the danger of reintroduction of the disease must be acknowledged."

ANTHRAX

This disease is known to be enzoötic along the shores of Laguna de Bay and in certain sections of Northern Mindanao, particularly Agusan. It takes its annual toll of victims, though so far these have not been numerous enough to constitute a very serious problem. However, as the cattle industry in those sections increases, the death rate will naturally assume larger proportions, and it will then very likely become necessary to undertake the preparation of Anthrax vaccine.

HEMORRHAGIC SEPTICAEMIA

This disease is more widespread in these islands than was previously thought to be the case; in fact it is doubtful if there is any province that is absolutely free from it. It usually makes its appearance at the beginning of the rainy season. On account of its rapid course medicinal treatment is out of the question. Prevention consists in the removal of the well animals from the infected pastures and keeping them away until the later, heavier rains have commenced. A preventive vaccine is being used in the United States which from all reports appears to be giving very satisfactory results.

CONTAGIOUS PLEURO PNEUMONIA

During the year no cases of this disease have been found either among native or imported animals. The quarantine order issued some years since by the Honorable, the Secretary of Public Instruction, placing the barrio of Sisiman in quarantine to prevent the possibility of this being conveyed from Australian animals imported for slaughter to other points in the Philippine Islands, is still in effect.

SURRA

The heavy demands of the rinderpest campaign upon the personnel of the division have again rendered it impracticable to wage any systematic campaign against surra. The disease is known to be widely disseminated in the Islands and numerous reports of the death of animals from this cause have been received by this office.

GLANDERS

During the year a considerable number of cases of glanders among horses were found in the city of Manila and ordered destroyed. As this disease is readily communicated to man, and invariably with fatal result, a thorough campaign should be undertaken to eradicate it from the city. This, however, is impracticable until adequate personnel is available. It must be noted, in this connection, that no cure for glanders is known and the destruction of the infected horses, often much against the will of the owners, is the only practicable course.

HOG CHOLERA.

This disease is known to be present in the principal swine raising districts of the archipelago and, while no reliable statistics exist as to the number of cases and deaths, undoubtedly causes serious losses every year. The custom of allowing hogs to run at large and forage for themselves keeps the infection constantly present and, as is the case with rinderpest, handicaps any attempts to bring it under control.

Owing to the large outlay of money which would be required and the difficulty of sparing any of the personnel of the division from their present duties, the undersigned cannot recommend undertaking the manufacture of anti-hog-cholera serum at the present time.

LIVESTOCK IMPORTATIONS

The year witnessed a still further decline in the importation of live animals from foreign ports, due rather to the scarcity of tonnage and excessive freight rates than to any lack of demand in the local market. The number of native cattle arriving at Manila was 178 less than those that were brought here in 1917.

During 1918 of the 1,856 cattle arriving at Manila from foreign ports 1,016 were from French Indo-China, 403 from Hongkong, 395 from India, 39 from Australia, 2 from the United States, and 1 from Spain. Of the 181 carabaos that arrived, 104 were from Pnom Penh and 77 from India. There arrived during the year at the port of Cebu 152 cattle from Pnom Penh, which were transshipped to Manila. The same steamer which brought the large shipment of Indian cattle and carabaos to Manila also unloaded 204 cattle and 8 carabaos at Zamboanga.

General Order No. 63 regulating the importation of animals from French Indo-China was amended during the year by General Orders Nos. 65 and 66, which, respectively, apply to carabaos and cattle. These orders provide that if any shipment arrives infected with foot-and-mouth disease the animals shall be unloaded into lighters and held there until the death or recovery of the last case.

ILOILO QUARANTINE STATION

During the year only 94 cattle and 95 carabaos arrived from Pnom Penh, French Indo-China. As stated above this was in the main due to lack of tonnage. Besides these animals a few native carabaos were also immunized against rinderpest by simultaneous inoculation before being shipped to Occidental Negros. In the month of April the Superintendent of the Station, Dr. W. A. Curtis, having been granted accrued leave to visit the United States, Dr. Ambrosio Gison was detailed to take his place. He is also the veterinarian for the Provinces of Iloilo, Capiz, Antique, and Occidental Negros.

SISIMAN MATADERO

Owing to the suspension of importations from Australia, this station, which is used exclusively for the slaughter of cattle from that country, was closed throughout the entire year. Mr. G. J. Wilson has been stationed there during the entire period to care for the Bureau property located there.

SAN LAZARO IMMUNIZING STATION

During the entire year this station has been loaned to and used by the College of Veterinary Science, University of the Philippines.

VETERINARY RESEARCH LABORATORY

During the year work was continued on locating the various seats of rinderpest virus in the animal body. It was found that water extracts of liver spleen and lymph glands three days old were highly infectious to susceptible animals. That a 0.5 per cent phenol extract of liver, spleen and lymph glands five days old was highly infectious. That 0.5 per cent phenol extract of heart muscle five days old was highly infectious. That an extract from skeletal muscle was not infectious. That a 0.5 per cent phenol extract of liver, spleen and lymph glands could hold the virus of rinderpest in a virulent form as long as 55 days. That a 0.5 per cent phenol extract of caecum and colon five days old was highly infectious. That the larynx, pharynx and base of tongue were not suitable tissues to hold the infection. That the pancreas was not a suitable tissue to hold the infection. That a 1 per cent phenol extract of lymph glands seventeen days old is infectious. That a 1 per cent phenol extract of liver, spleen, caecum and lymph glands seventeen days old is highly infectious. That a 1 per cent phenol extract of liver and spleen twenty days old are highly infectious. That a 2 per cent phenol extract of spleen five days old is infectious. That in a 2 per cent phenol extract of lymph glands eight days old the virus is destroyed. The organs in which the virus of rinderpest is well seated are the liver, spleen, lymph glands, heart, fourth stomach, caecum and colon. The real place where the virus multiplies is evidently inside the tissue cells, and the virus in the blood stream is merely a surplus which is thrown off from these tissue cells.

These organ extracts can be used in place of virulent blood in simultaneous inoculation against rinderpest and also in hyperimmunization. It was found that quantities as large as 2,000 cc. could be injected into small Fuga bulls without any ill effects providing the extract had been kept at a temperature around 15°C. If it had been exposed to air temperature bad results were liable to follow due apparently to protein decomposition. By the use of organ extracts the virulent material obtainable from an animal can be greatly increased.

The principal work of the year has been the continuation of perfecting a vaccine which has been developed for rinderpest. Plans have been drawn up for the remodeling of the Veterinary Research Laboratory so that the vaccine may be still further perfected and produced in larger quantities for use in the field. The results obtained up to date are very encouraging. It is possible that this method may supplant immunization by simultaneous inoculation, as it can be more quickly applied and will not necessitate withdrawing the animals from work as has to be done at present.

Work on the pneumonia of swine caused by a pseudomonas is being carried forward. There are good possibilities of developing a vaccine against this disease. Undoubtedly many of the deaths hitherto ascribed to Swine plague have in reality been due to this malady.

Experiments are also being conducted on the cultivation in vitro of Trypanosoma Evansi, the causative agent of surra.

A condition in sheep and goats which appears to be an infectious enteritis is under investigation.

Practically all the microscopic diagnostic work on babies for the Bureau of Health is performed at our research laboratory.

Manufacture of Serum.—The two laboratories for the preparation of antirinderpest serum, established by private individuals in 1917, were both closed in the past year due to the fact that the demand for serum was not constant enough to make it a paying proposition. This Bureau purchased the equipment of both plants at a very reasonable figure. As there will continue to be some slight demand for antirinderpest serum this office will undertake its preparation and will endeavor to keep a reasonable supply of the fresh product constantly on hand.

MOVEMENT OF LARGE CATTLE

Importation from Foreign Ports.—During the year a very few cattle were received from Australia, Spain, and the United States for dairy or breeding purposes while 599 cattle and 85 carabaos of Indian breeds arrived.

Small numbers of cattle and carabaos for work purposes or slaughter were imported from Pnom Penh and Hongkong.

Inter-Island Shipments.—During the year 20,016 cattle and 2,971 carabaos arrived at Manila from interisland ports, a slight decrease from the record figures of the preceding year.

REDUCTION OF FIELD PERSONNEL

When our field force of livestock inspectors had to be dismissed on account of the shortage of funds, the enforcement or rinderpest quarantine became in many cases nothing but a farce. Municipalities were forthwith reported free of disease, and cases and deaths in those towns that remained infected dropped suddenly to a ridiculous minimum. Throughout the year the local officials of Bulacan, Leyte and Oriental Negros were rather indifferent in regard to the enforcement of quarantine regulations and in several instances were somewhat impatient of suggestions from this office or from our veterinarians in their respective provinces.

CHANGES IN VETERINARY FORCE

Another factor of weakness in the situation was the fact that most of the veterinarians sent to the field were just out of college, young and inexperienced, who never before had handled men nor dealt with conflicting political interests.

They were by force of necessity, on account of the shortage of our veterinary personnel, given large districts which even for an experienced veterinarian would have been quite a proposition. Thus, they were often at a loss as how best to handle complicated situations. This condition is not serious, however, for these young veterinarians as they grow older and gain experience, will learn how to better handle men and complex and changing conditions. Also, as more veterinarians become available it will be possible to reduce the districts in size.

DEMONSTRATION AND EXTENSION DIVISION

THE FOOD CAMPAIGN

During the year, the most important work of the field agents of the Bureau of Agriculture, or the agricultural inspectors and their assistants, was that pertaining to the food production campaign, for which an appropriation of ₱500,000 was set aside for the Department of Agriculture and Natural Resources. As this work properly pertains to the Department let it suffice for the purpose of this report, to make mention of it and of the part taken in it by the field employees of the Bureau in this brief manner.

DEMONSTRATION PLOTS AND PUBLIC NURSERIES

Much attention was given to enlisting farmers to set aside suitable pieces of land for coöperative demonstration plots. Coöperative demonstration plots are an excellent means of disseminating knowledge of progressive farming among the people, as it is through practical demonstration in the last analysis that we can hope to convince farmers of the advantages of scientific cultural practices. The establishment of provincial and municipal nurseries was encouraged whenever local appropriations provided for the maintenance were adequate to insure success.

AGRICULTURAL SOCIETIES

For the purpose of banding the farmers together and promoting closer relationship among them for a better understanding of their needs and to point the way to meet those needs, agricultural societies are organized in the different municipalities of the Philippines. At the end of the year there were 286 municipal agricultural societies organized in 29 provinces.

All members of the agricultural societies receive copies of the Philippine Farmer free of charge and copies of the weekly reports of Manila market prices on staple farm products.

For the benefit of the sugar growers, weekly telegraphic reports were sent to Occidental Negros, Oriental Negros, Iloilo, Pampanga, and Batangas, of the sugar prices as reported from New York every Saturday. This telegraph service was greatly appreciated by the sugar growers.

SUMMARY OF THE WORK IN PROVINCES

Abra.—Except for the storms which visited the province in June and July, weather conditions throughout the year were favorable.

A provincial and a municipal nursery for growing seedlings of local and exotic plants for distribution among the people of the province were established in Bangued and Laañgitang respectively. All told, the employees in Abra kept in touch with 24 coöperators. The rice coöperators were very succesful, producing an average of 78 cavans per hectare as against an average of 61 cavans in the adjoining plots. Second generation seeds were used by Bureau coöperators. Seventy-two lectures on agricultural topic were delivered by the inspectors in fifteen municipalities and rancherias.

Albay.—A drought during the planting season delayed the rice planting and the flood and typhoon later damaged the crops considerably. Of the 50 coöperators, only one, who planted early and produced about 80 cavans to the hectare, had a good crop.

A provincial nursery was established in September with an appropriation of ₱2,500 at Camp Doraga.

Ambos Camarines.—The upland rice crop was fairly good but the lowland rice and rice seed selection work suffered from the Christmas typhoon. Weather and other conditions were unfavorable in general. The corn campaign, however, produced good results and the provincial governor bought 20,000 ears for distribution through the inspectors he appointed. The provincial nursery at Naga had an appropriation of only ₱270

A portion of the Provincial Demonstration Farm at Calapan, Mindoro, devoted to vegetable garden

and no work animal; so only corn, vegetables and forage crops were raised.

Antique.—The early rice did well but the late varieties were affected by the drought. Rice seed selection was carried on according to the Department instructions.

About three hectares of the provincial demonstration station at San Jose (appropriation ₱1,200), was planted to rice and vegetables to the value of ₱339 sold therefrom.

Bataan.—The province suffered no great harm from the typhoon and floods, the rice crop being about 25 per cent higher than that of the previous year. The area planted to rice was much extended coffee and cacao seedlings and vegetable seeds were distributed to the farmers from the small provincial nursery at Balanga, and there are some 3,000 coffee seedlings remaining on hand.

Batangas.—A flood in June damaged the early rice, corn, sugar and vegetable crops and the September drought caught the late rice. At the end of the year, though, these crops and the coffee, mangoes and vegetables are doing well.

There is a demonstration station at Lipa, and municipal nurseries at Batangas and Balayan, respecitively.

At Lipa 205 gantas of coffee seed of the Abeocuta, Congo, Iui Uno, Uganda, Robusta, Excelsa and Liberian varieties were planted. All but the first two germinated well, and 30,000 seedlings were distributed.

Two lots of Irish potatoes were shipped to the station for planting and distribution, but the first lot were planted too late, the second lot are in good condition, however. Large crops of vegetables, cattle feed and castor oil beans were harvested and sold.

At the Batangas nursery 1,200 mango mandarin and vegetable seedlings were raised and seven gantas of Liberian and one of Robusta coffee planted.

The newly established station at Balayan produced corn, cowpeas, sitao, upo and a few coffee seedlings. The corn was injured by the storm in October.

Bohol.—Heavy rains injured only a part of the rice crop, which in general was good at the end of the year. Six coöperative plots of native and Moro were harvested with an average of 35 cavans per hectare. At the provincial demonstration station at Carmen there are planted abaca, bananas, jack fruit, coconuts and kapok and five acres were cultivated to rice, corn, beans, peanuts and sweet potatoes.

Bulacan.—The early corn crop was light, due to the drought, but secondary crops were abundant until November. The Malolos Demonstration Station was planted to rice, corn, vegetables, and other food crops and raised castor oil beans, sweet potato cuttings, papaya, coffee, cacao and mongo seedlings for distribution. There were twenty-three coöperators on rice and corn. The soil is not good at the station and the attention of the governor has been called to the advisability of changing the location.

Cagayan.—Rice suffered a little damage from drought and so did the tobacco in Cagayan, but the high price obtained for the latter encouraged the planting of new land thereto. This work was much delayed by drought and the influenza epidemic. The heaviest corn crop the province ever had helped to bring down the excessive cost of rice.

At the small newly started provincial nursery at Ballesteros, the work of propagating fruit and vegetable seedlings was got under way.

Cavite.—Neither rice nor corn did well because of the drought, the rice crop falling a third below normal. The upland rice did fairly well, though, and rice seed selection work was carried on. Some interest is being taken in the planting of maguey and bulbils have been sent the farmers from this Bureau.

Capiz.—The first corn crop was much damaged by rains but the second was good. Dry weather interfered with the rice crop but it is to be noted that the plots planted by the 25 coöperators did better than those adjoining. An inspector was assigned to Romblon to see to a second planting of rice there. A provincial demonstration station was established at Capiz in August with an appropriation of ₱1,049. It has an acreage of 1.83 hectares, nearly all of which was planted to corn. Vegetables were sold to the value of ₱42.07 from this new station and seeds and seedlings distributed free, besides those saved for next season.

Cebu.—More acreage was planted to corn than previously and the second crop was normal. Many farmers were instructed in seed selection and induced to interplant with cowpeas.

Twenty-nine coöperative plots were set out to corn, rice, tobacco and peanuts respectively, with the object of demonstrating to the farmers the value of crop rotation and proper cultural methods. Twenty-four conferences were held on agricutural topics.

(*a*) Maize, variety test No. 6, Singalong

(*b*) Moro Maize, variety test No. 7, Singalong

The one acre provincial station at Tabonoc was run on an appropriation of ₱580. It was planted mostly to corn, sisal, vegetables, peanuts and cowpeas. Coconut, coffee, and lumbang seedlings were raised, with some ornamental plants for public parks in the province.

The weather was in general too dry for tobacco.

Ilocos Norte.—Rice seed selection was carried on in the province in conformity with the department outline. A graduate from Los Baños was detailed to take charge after the province was reorganized as a separate district. It was originally a part of the district embracing Ambos Ilocos, Abra, La Union and Amburayan for that work.

Vegetable seeds and a total of 16,719 fruit seedlings were distributed from the provincial nursery at Laoag and from the municipal nurseries at Laoag, Pasuquen, Bacarra, Paoay, Badoc and Sarrat.

Favorable weather prevailed, except for a typhoon in July which damaged the early planted rice.

Coöperating with the Compañía Tabacalera our inspectors distributed 16 demijohns of tobacco seed together with cultural instructions.

Maguey, the third crop in importance, did not bring very good prices, nevertheless, the acreage planted to this staple was increased.

Ilocos Sur.—Weather conditions were on the whole favorable, so there was a fair rice crop. Secondary crops of corn, sugar cane, maguey, tobacco and indigo were also planted but prices were low, the Manila market demand being small.

There were 21 rice demonstration plots, one of sugar cane, four of corn and one of peanuts. At the 84 conferences held there was a total attendance of 8,336 people.

The municipal nurseries at Vigan, Sinait, Lapog, Cabugao, Magsingal, Santa, Narvacan, Santiago, Santa Lucia, Candon, and Santa Cruz distributed a total of 1,825 fruit seedlings, and 766 packages of vegetable seeds during the year.

Iloilo.—As in Capiz, there was considerable drought at the end of the year and much rain in the first quarter, which somewhat lessened the rice and the tobacco crops.

In the 1917 rice seed selection campaign, which ended January 26, 1918, 43,638 gantas of rice were selected for Iloilo and Capiz. Of the 36 coöperative plots six were planted to Moro corn and the rest to rice. All were doing well at the end of the year.

At the Insular Demonstration Station at Iloilo there were raised corn and tobacco, castor oil beans, legumes and banana suckers and coffee, cashew, papaya and mango seedlings for distribution and for planting at the station.

Isabela.—This province until July was in the district under the superintendent from the Dammao Tobacco Station, when the department was able to send a provincial agricultural inspector and an assistant.

There were 118 corn and 68 corn and rice coöperators. With corn the showing was 70 cavans per hectare as against 65 from adjoining plots. There was no seed selection.

Heavy rains caused a shortage in the tobacco crop, as many young plants were flooded out.

There is a provincial nursery at Ilagan and eight municipal nurseries at Añgadanan, Cabagan, Echagüe, Gamu, Reina Mercedes, Naguilian, Santiago, Tumauini, respectively, the latter with appropriations ranging from ₱100 to ₱300 each. These were established late in the year and so served principally as distribution centers for vegetable seedlings.

Laguna.—Dry weather injured both upland and lowland rice in Laguna and the influenza interfered with rice seed selection and coöperative work considerably the latter half of the year. However, the areas sown to rice and corn were extended. Corn and vegetables were raised at the Demonstration Station at Santa Cruz and seeds and sweet potato cuttings distributed to the public and the surplus crops sold, the money going to the province. The avocados raised were sent to the Bureau for propagation purposes.

La Union.—Planting rice from selected seed was supervised and because of the good results many farmers were encouraged to practice it. Seed selection was begun too late to include the early varieties.

More than an average crop of tobacco was produced due to proper methods as well as increased acreages. Nine coöperators were supervised by the two tobacco inspectors.

Besides the provincial nursery there are three municipal nurseries.

Leyte.—In general the weather was unfavorable to the principal crops; there was too much rain for the corn and tobacco. Seed selection with rice and corn was encouraged by the inspectors and demonstrated in the fields. Conferences were held with the farmers as to cultural methods, crop rotation, etc.

In September the provincial demonstration station was established at Jaro with an appropriation of ₱4,500. Half of its four and a half hectare acreage was planted to corn and vegetables which were all damaged by the December typhoon. Vegetable seedlings were distributed from the station.

Mindoro.—A demonstration station was established at Calapan in April, with an appropriation of ₱3,000. It contains two hectares.

There were seven rice coöperators supervised. Of the five varieties of rice raised, Inantipolo, Macan, Inasimang, Roxas and Calivo, the last named produced 28 cavans per hectare and the other from 6 to 12 only, because of drought and rats, but adjoining plots yielded less.

Misamis.—Misamis had no agricultural assistant until the last part of the year and so nothing was undertaken but coöperative work with the various agencies engaged in the food campaign.

Mountain Province.—Good weather favored the crops all through the year. Demonstration plots of rice, sweet potatoes, beans, coffee and tobacco were established throughout the subprovinces as this work seems the most effective that is possible to undertake among the Igorots. Vegetable seed—17,389 packages—and 16,315 plant seedlings were distributed from the Demonstration Station at Bontoc, and the nine municipial nurseries.

A potato campaign was carried on and it has been found that the Burbank variety does well, especially in the subprovince of Lepanto. The seed potatoes arrived too late for the planting season in many localities, however.

A continuous campaign was conducted for reviving of the coffee industry, 13,544 Arabian and Robusta coffee seedlings having been distributed; and there was an equally strenous campaign for increasing the tobacco yield. Due to this and the distribution of improved seeds, more tobacco was planted than ever before in the history of the province.

Nueva Ecija.—Corn, rice seed selection and tobacco campaign were undertaken. It is estimated that 5,000 acres were put into corn in the province and the heaviest crop ever produced in the province was gathered. The July flood and the drought later did serious damage in some places to the rice harvest. Due to increased area planted, though, it probably exceeded that of 1917. The production of tobacco was greatly increased but there was delay in the transplanting of the new crops because of the drought and the difficulty in obtaining regular laborers, during the influenza epidemic. There were 24 conferences held, which were mostly well attended. Only two tobacco inspectors were available for assignment to this province.

Nueva Vizcaya.—Irrigation canals have been dug recently in many parts of the province because so much damage was done to rice by the drought where there have been no means of irrigation. Of the 12 plots of the coöperators 115 cavans per hectare was the everage crop from the selected seed. The five cavans of Binicol rice obtained from the Bureau did not do well because of strong winds and the depredations of birds.

New lands were planted to tobacco and the estimated crop is 7,000 fardos. These sold at from ₱9 to ₱10 per fardo. Fifty crates of Burbank potatoes were distributed as seed to farmers who had had previous experience in raising potatoes. The sugar cane promises an average, and in some places an excellent crop.

Occidental Negros.—Both upland and lowland rice crops were poor, due to the drought and the tobacco crop also suffered.

In San Carlos, Ilog and Kabankalan, the sugar crop is very promising and it will be up to the average in other localities.

A provincial nursery was established at Dumaguete and the provincial board appropriated ₱800 por its upkeep.

Oriental Negros.—Hot weather in October damaged the entire rice crop, which was extra calamitous in view of the fact that the rice acreage had been increased 50 per cent. Corn thus remaining as the principal food staple took up most of the attention of the agricultural inspectors. Seed ears were distributed free and the crop in December was most promising, as were the secondary food crops.

A provincial nursery with an area of one hectare and an appropriation of ₱800 was established at Dumaguete.

Pampanga.—Increased acreage in rice produced enough of that crop to make up for the loss caused by the drought. The inspectors superintended 30 rice coöperators and 362 planters who had selected their seed, also 20 coöperators in corn, 21 in tobacco, 8 in mongo, and 1 in tangan-tangan. From the demonstration at Mexico sugar cane points to the value of ₱450 were sold. A municipal nursery was established at Floridablanca and one at Mabalacat.

Pangasinan.—More tobacco than was ever produced before was harvested and it brought a better price. The drought and influenza prevented the planting of next season's crop in many districts, however. The rice crop, because of increased area planted in uplands, was normal.

Members of the Agricultural Congress of the Fieldmen of the Mountain Province, held at Cervantes

Of the three municipal nurseries, each of which has a fair appropriation, only the one at Malasiqui was in operation. Coffee, cacao and vegetable seedlings were distributed from there.

Rizal.—The weather was too dry for rice, corn and vegetables at the end of the year. Rice seed selection was not particularly successful as the rice was poor and laborers scarce.

The provincial nursery at Pasig is planted mostly to vegetables including Irish potatoes. Though in need of rain it is doing fairly well.

Samar.—Hemp and coconuts are the main crops of Samar but corn, vegetables, etc., were also raised in abundance. The means of communication being poor the work of the two agricultural inspectors was limited to the area from Catbalogan to Calbayog. There were thirty-one rice, thirty-eight corn, sixty-one camote, and one coconut coöperators supervised during the year. The plots suffered somewhat from rats but did better than those adjoining.

The demonstration station at Catbalogan has an appropriation of ₱2,000 and an area of about two hectares under cultivation. Buildings were erected this year and vegetables and other secondary crops raised, distributed and sold.

Sorsogon.—The Christmas typhoon damaged the hemp and banana plantations and rice considerably.

There was at first only one inspector appointed and he did not speak the local dialect. Later there were two others. All three were engaged principally on food campaign work.

Surigao.—There was only one provincial inspector to handle both the provincial nursery at Surigao and the food campaign.

Several hundred seedlings of fruit, coffee, citrus trees, etc. were distributed from the station. One-third of the total area was planted to upland and lowland rice of local varieties.

Tarlac.—The supervision of the planting and harvesting of the rice raised from seed selected last season and the securing of 284 coöperators was the most important work carried on by the inspectors. Twice the usual amount of corn was produced this year. There is a very small nursery—only $\frac{1}{5}$ hectare—at Victoria. Some thousands of fruits and vegetable seedlings were distributed from this and some sales made.

Tayabas.—The crops in general, due to unfavorable weather condition were not very good. Much corn was planted therefore to make for the rice shortage. Coconuts, the main crop, were planted on a large scale. Proper cultural directions were given to planters.

A provincial demonstration station was established late in the year at Lucena and fruit and vegetable seedlings distributed therefrom.

Zambales.—The rice did quite well but as there was so much influenza much of the harvest was lost. Vegetable and secondary crops were good.

A provincial nursery was established at Zambales in May and municipal nurseries at San Antonio and San Narciso in September, the latter, because of the lateness of the season being planted to mongo and vegetables only.

RURAL CREDIT SECTION

Progress of the Work.—The year 1918 proved to be a successful one for the agricultural credit coöperative associations, or what are more commonly known as rural credit associations. On December 31, 1917, there were 82 incorporated associations while on December 31, 1918, this number had increased to 242. If the fact is taken into account that greater attention was paid to developing the associations already organized than to organizing new associations, the increase from 82 to 242 is indeed remarkable and indicative of the desire of the people to organize themselves into coöperative societies.

The work of organizing rural credit associations and guiding those already organized must necessarily be slow, as great patience is required in explaining the fundamental rules of coöperation. It should be borne in mind that we have to deal with small farmers who, in the majority of cases, are borrowers rather than capitalists, and that much tact has to be used and a great amount of painstaking efforts exerted to organize these into a solid group for mutual help. In no other kind of Bureau work is there a greater need for able organizers and patient promoters than in the work of rural credit associations. Much depends however, upon the rural credit agent whether the cause of rural credit shall progress or fail.

As already stated, though, great progress was recorded in the life of rural credit associations during the year. Starting with as small a capital as ₱250, in many cases, most of them now count with one to three thousand pesos of their own capital, and a few control larger amounts. Being made up of small farmers who are borrowers rather than capitalists, rural credit associations must necessarily look to outside sources for capital for

Mr. A. W. Prautch, Chief of the Rural Credit Section of the Bureau of Agriculture

expansion of the scope of their work. Unless they can count upon the patronage of citizens who have reserve funds to deposit or upon the assistance of banks, it becomes readily apparent that with the small capital these associations can hope to gather in the way of subscriptions of their own members very little can be accomplished to supply the need of ready money at planting and harvest time which is now borrowed at ruinous rates because there is no other source of money available.

It is gratifying to acknowledge the loans which the Philippine National Bank has made to rural credit associations. The rules of the bank were made before these associations were organized and prohibit the acceptance as security of the titles and property generally possessed by the small farmers. Fifteen associations have been granted loans equal to their paid in capital on the security of their capital and the joint and several notes of the five directors. All such loans were made at eight per cent per annum, the associations in turn charging ten per cent per annum to borrowers.

The Naic System.—The municipality of Naic in the Province of Cavite had been borrowing money to harvest and mill its sugar at the rate of about forty per cent of interest for five months. The members of the rural credit association of that municipality thought of the possibility of securing the money they need during the harvest and milling season and forthwith applied to the Director of Agriculture for assistance to secure this money from the National Bank. The bank required a joint and several note of the borrowers secured by a mortgage made by the members to their association on the standing sugar crop (valued at ₱120 per hectare), on work animals and on their sugar mills. By this process ₱12,000 at four per cent for six months, or 8 per cent per annum, was secured. The association in turn loaned this money out at 5 per cent, the profit of 1 per cent going into the general fund. As the next step to simplify the process of effecting this loan, the members guaranteeing the same executed a power of attorney to enable the president of the association to act for them. It might be well to note in this connection that the people of Naic have no real estate to mortgage, as they have not yet completed paying the installments on their holdings, which form part of the Friar Estates administered by the Bureau of Lands.

The amount of ₱12,000 borrowed, plus interest, was paid as soon as the sugar was harvested and before the debt became due. There is one incident that occurred during the life of this loan which is worth mentioning. One borrower of ₱300 had the misfortune of having his entire output of sugar and mill burned down. The other signers of the obligation prorated this loss among themselves and paid it. This illustrates how much safer it is for the bank to take joint and several notes than to make individual loan. Naic has since secured another loan for ₱16,000 under the same terms and conditions. Maragondon, also in the Province of Cavite, secured ₱6,700 from the National Bank under the "Naic system."

The Rosales System.—The association in Rosales, Province of Pangasinan, secured a loan of ₱9,000 on a different plan, which may be briefly described as follows: A number of public spirited citizens who do not need to borrow money offered their real property as security for this loan. The members of the association unitedly signed an obligation to repay this amount and the interest thereon to the bank.

Progress by Provinces.—The following table shows the progress made by provinces:

Provinces.	Capital at incorporation.	Total receipts December 31, 1918.	Total number of sharehold.	Total number of borrowers.	Total sum borrowed.
Abra	₱1,612	2,465.23	217	27	₱1,500.00
Albay	5,126	5,222.25	799	17	925.00
Ambos Camarines	4,092	7,875.60	758	138	3,918.00
Antique	3,614	24,050.51	1,358	542	18,050.18
Bataan	1,402	16,875.74	687	439	15,908.00
Batangas	810	5,954.79	277	104	5,425.00
Bohol	9,632	11,527.46	1,373	177	7,075.80
Bulacan	2,334	6,261.55	516	69	4,075.60
Cagayan	600	2,356.00	139	30	2,185.00
Capiz	2,170	2,668.87	141	19	1,249 00
Cavite	2,912	31,929.05	375	147	30,540.00
Cebu	2,358	4,438.50	125	44	4,100.00
Ilocos Norte	7,044	13,154.22	2,897	314	10,104.05
Ilocos Sur	3,896	10,081.14	1,184	203	9,502.46
Iloilo	3,825	10,555.83	834	259	8,625.00
Isabela	3,554	6,532.00	248	67	3,080.00
Laguna	5,624	9,877.36	666	128	8,461.84
Lanao	1,128	1,498.50	90	10	1,442.00
La Union	3,314	7,522.81	942	104	5,462.90
Leyte	1,632	2,158.00	313	12	876.66
Misamis	9,640	18,531.82	1,166	168	15,255.00
Mountain	600	888.01	30	10	716.00
Nueva Ecija	976	4,959.89	296	79	4,259.00
Nueva Vizcaya	816	1,362.00	108	7	330.00
Occidental Negros	560	2,541.50	68	31	2,460.00
Palawan	1,448	1,694.00	111	7	750.00
Pampanga	5,643	16,790.10	451	208	13,056.00
Pangasinan	22,738	54,948.38	6,287	973	43,375.00
Rizal	3,146	9,575.83	629	117	6,679.00
Samar	894	935.50	98	----------	----------
Sorsogon	1,320	2,852.80	89	----------	2,130.00
Surigao	500	573.50	17	3	250.00
Tarlac	4,933	18,837.16	1,228	228	14,276.00
Tayabas	285	367.00	14	----------	----------
Zambales	2,668	3,012.30	292	12	330.00
Total	122,846	320,875.70	24,822	4,693	245,362.49

ANIMAL INSURANCE

An Insurance Division was created by Act No. 2573 to take charge of insuring work animals and provision was made by the same Act for the organization of what is known as "Work Animals Insurance Society." The immediate supervision over the insurance of work animals falls upon the board composed of three members, of which the Director of Agriculture is chairman. The other members of the Board, as at present constituted, are Honorable Matias Gonzalez, Senator from the Second Senatorial District, and Mr. Ramon Soriano.

As under the provisions of Act No. 2573, as amended, the same "shall not take effect or be in force until at least ten thousand work animals have been listed for insurance," the animal insurance agents, of whom there were ten employed by the end of the fiscal year, devoted most of their time to listing animals in the different provinces for insurance, in accordance with a plan laid down by the Insurance Board. The work of organizing the central office to direct the insurance agents in the provinces and of preparing the necessary forms for the insurance of work animals was also completed. Ten provinces comprising 139 municipalities have been canvassed and 8,256 work animals listed for insurance by the end of the fiscal year.

PLANT INDUSTRY DIVISION

RICE

The work with the upland rice was conducted at the La Carlota Experiment Station and the work with the lowland rice at the Alabang Stock Farm. At La Carlota, the work consisted of variety tests and the production of seed for distribution. The amount of land devoted to variety tests is one-third hectare and is under the direct charge of the station superintendent, while the production of seed for distribution was taken care of by tenants on a "share basis." At Alabang, rice work was conducted along two lines; namely, experimental or investigational and the production of seed for general distribution. Owing, however, to the limited area of land available at Alabang, only a small quantity of improved seed is being produced there. The area devoted to rice at this station is scarcely 7 hectares, fully 2 hectares of which are set aside for experiment purposes. At La Carlota there were 50 hectares of land planted to rice by tenants.

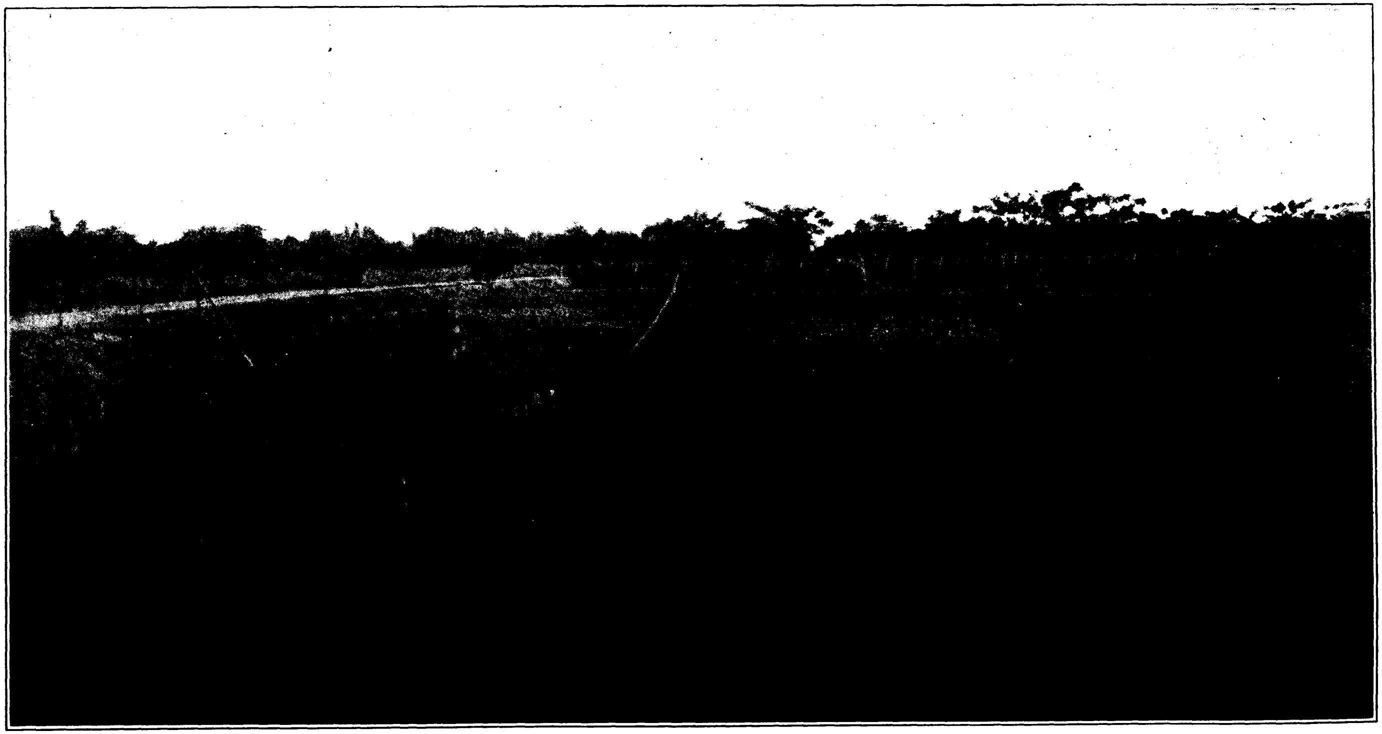
General Variety Test.—In carrying on a general variety test, the different varieties used for the trial are planted side by side in small duplicate plots so located that soil conditions will be as nearly the same as possible, and given the same treatment. This is done in order that a fair basis for comparison as to the individual merits, physical characteristics, yield, adaptability, resistance to disease and period of growth of the varieties under trial may be afforded. The variety test conducted at Alabang during the past year embraced 187 varieties consisting of 85 nonglutinous, nonbearded; 87 nonglutinous, bearded; 7 glutinous, nonbearded; and 4 glutinous, bearded. Of the total number of varieties tried, 150 were varieties continued from the 1917 experiments and the remainder entirely new varieties.

Most of these varieties are continuation from last year's test. There were a few new acquisitions and transfers from Alabang.

Head-to-the-Row Test.—This work is conducted at Alabang only. It has for its object the improvement of a variety by selecting the most meritorious individual plant of a variety of acknowledged superiority. As stated elsewhere, by this means, the purifying of a variety can be carried to the highest degree. Once the strain desired is secured, the matter of producing a sufficient quantity of seed from the selected plants for extensive trials is one of time only.

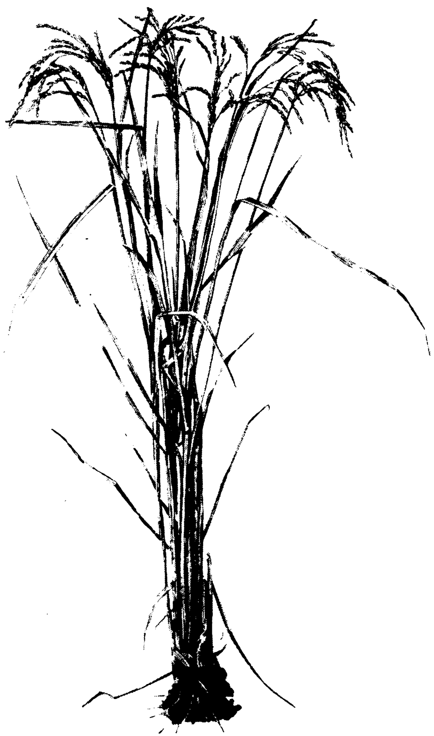
Seed Propagation.—The next step after the head-to-the-row test is the multiplication of the desirable varieties obtained. As much land therefore as is available at Alabang is devoted to the propagation or multiplication of the selected varieties to produce seed for general distribution.

Pruning the Leaves.—The object of this experiment is to determine the effect of cutting the foliage of rice as some farmers do when the plants tend to run to tops. Two paddies of the variety "señora" located in an open field were selected for this experiment. Each of these paddies was pruned back to 56 cm. and one section of the other paddy to 63 cm., the portion of the blades thus cut off being about 43 cm. The other sections of each paddy were left intact. Pruning was done on July 19th. The yield was in favor of the unpruned section. Similar results had previously been obtained from pruning shaded plants. It would appear therefore that the practice of reducing the foliage of rice tends to reduce the yield. This conclusion, however, should not be accepted as final, as it might be that the pruning in these cases was not done at the proper time nor to the proper proportion.

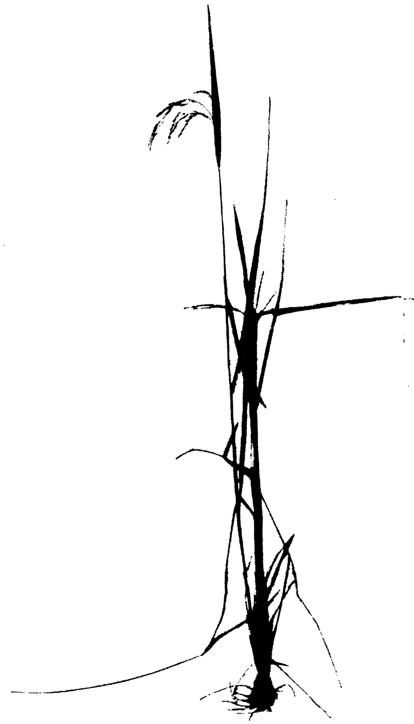


Seedbed for varieties of rice, Alabang, Rizal

PLATE XXII



(*a*) An ideal type of rice plant



(*b*) An undesirable rice plant

Rice; head-to-the-row test, Alabang Stock Farm

Seedling Experiment.—The object of this is to find out the difference in yields from well developed seedlings as compared with ordinary sized seedlings and from entire seedlings as compared with pruned seedlings.

It would seem to be reasonable to conclude that the difference in yield in favor of the well-developed seedlings was due to ability to grow rather than to heavier yield. A lesson that may be derived from this experiment is that one must either spread the seed more thinly in the seedbed to produce vigorous seedlings, or in transplanting ordinary sized seedlings, put 2 or more seedlings in a hill, to insure a good and even stand.

Entire vs. Pruned Seedlings.—Plat I in duplicate was planted to seedlings with the top cut off as ordinarily. Plat II, also in duplicate, was planted to entire seedlings with the tops on. Fertilized Pauni seedlings averaging 57.5 cm. in height and 57 grams in weight were used in both cases, except that those planted to Plat I were cut back to 26 cm. and reduced by about 16.8 per cent in weight.

The uncut seedlings in Plat II were either blown down or bent over or broken down by the wind almost immediately after they were planted and the damaged portions soon began to wilt. This, more than anything else, accounts for the low percentage of the surviving plants and the consequent reduced yield. The pruned seedlings (Plat I), on the other hand, remained upright and kept on producing new leaves, practically without any interruption.

Pruning of rice seedlings before transplanting is a good practice.

Distribution of Seeds.—The amount of seed distributed in 1918 was much greater than in the previous year. In addition to seeds produced and purchased by the Bureau, 870 cavans of seed of different varieties were bought from the Central Luzon Agricultural School in Nueva Ecija by the Department of Agricultural and Natural Resources and turned over to the Bureau of Agriculture.

The Bureau produced for the year 331 cavans of seed rice, of which 148 was upland rice grown at La Carlota and 183 lowland rice grown at Alabang.

SUGAR CANE

The La Carlota Station was used to grow cane for experimental purposes as well as for producing points for distribution to planters. The cane grown at Alabang was for distribution only. The plot at the Singalong Station was set aside for growing imported canes under observation for diseases. The work at Lamao Station was confined to the propagation of cane from seeds.

Propagation from Seed.—This work was started in 1914 for the purpose of producing new varieties of cane that will be especially suited to Philippine conditions instead of importing new varieties from abroad. By this manner, the danger of introducing new cane diseases into the country will be largely eliminated.

Native Varieties.—The common varieties of cane found in the different sugar districts of the archipelago have been collected and are being carefully studied for the purpose of obtaining comparative data on yield of cane, yield of sugar resistance to drought and excessive water, resistance to insect pests and other cane diseases.

Foreign Varieties.—Alongside the experiments on native cane, imported varieties are being tried to determine their relative merits as explained under the preceding subhead.

Distribution of Cane.—There should have been more than a hundred thousand points of various varieties available for distribution to planters, if the cane could be cut early enough to permit 3 or 4 points to be taken from each stalk. Unfortunately, due to lack of funds, the employment of the necessary labor was prevented so that a reduction of more than 30 per cent of what would have been available for distribution was experienced.

Education and Demonstration Work.—Arrangements were made with the owners of modern sugar factory to employ a limited number of selected men at a nominal salary and permit them to acquire experience in factory and plantation management under the supervision of the sugar technologist of this Bureau. Six Muñoz graduates and one named Vicente Pascual of Pangasinan who has had considerable experience in sugar making were selected for this purpose. The Muñoz men were paid ₱50 per month each, while Vicente Pascual was paid ₱75, plus quarters. These men were given instruction in laboratory and analytical work, the handling of the various pumps and machines, about the factory in sugar boiling, the handling of locomotives in transporting the cane, the handling of steam and oil burning internal combustion tractors in preparing and

Sugar cane, yellow caledonia

cultivating cane lands under modern conditions. It is hoped that with preliminary training of one year, they will be ready to fill various positions of a supervisory character at the large centrals and on plantations.

LAMAO HORTICULTURAL STATION

More perhaps than ever before has the work at the station been hampered by shortage of farm labor. The higher rate of wages offered by the saw mill at Limay and the exceptionally high price paid for firewood have taken away from the station even some of its old laborers. To overcome the shortage of farm hands, women and young boys were employed during the latter part of the year at an average daily wage of fifty-five centavos each. It was found that for light work; such as, hand weeding, sprinkling or watering vegetables and nursery plants, harvesting and shelling beans, etc., the women and young boys could do as good work as the regular laborers, if not better.

About 1.4 hectares of land was cleared up and nearly all of it planted to citrus hybrids for use in a coöperative experiment being conducted by Mr. W. T. Swingle, of the U. S. Department of Agriculture.

Mr. H. A. Lee, also of the U. S. Department of Agriculture, is also carrying on experiments at the Lamao Station, in connection with the citrus canker and other pathological microorganisms affecting citrus. The final results of this experiment can not help but be of immense value to the station and the Philippines in general.

The U. S. Department of Agriculture bears all the expenses incident to the work under the supervision of Messrs. Swingle and Lee.

Generally speaking, the same outline as has been followed in previous years was followed during 1918, with the addition of vegetable growing for seed which was initiated last year. In view of the great demand for vegetable seeds, as a result of the food production campaign, the station paid greater attention to seed production for general distribution than usual.

Exchanges with the U. S. Department of Agriculture and with Mr. P. J. Wester, Agricultural Advisor to the Governor of the Department of Mindanao and Sulu, were maintained and as a result, appreciable quantities of seedlings, seeds and other plant materials were received.

It is the aim of the station to establish a permanent orchard that will serve as a complete collection of the different kinds of fruit trees found in the Islands, as well as those which are introduced from time to time; to select and breed those varieties that have already been established; to propagate vegetatively all species planted; and finally to carry on hybridization work as materials become available.

Many imported trees blossomed and fruited during the year, the fruits of which were carefully studied to determine their commercial value here. Among those that showed sufficient merits to justify a more extensive propagation are: the rambutan, alpay, caynito, biriba, cherimoya, hevi, avocado, breadfruit and serali.

Shield budding was tried with Chico-mamey, Tiessa, Chico, Macopa, Corica, Lauriva, Caimitillo, Pitanga, Mastic, Camanchili, and Cinnamon; the Rambutan on the Longan and the Alpay and vice versa; the Longan on the Alpay and the Alpay on the Longan. The Lauriva and the Camanchili were budded successfully. The budding inserted in the Corica took but further trials are necessary before any conclusions can be made. It was also demonstrated that the Soncoya can be budded on the Maron. Trials in propagation by means of cutting to determine the relative ability of different species of fruit trees to reproduce by this method were initiated during the year. This work will be continued next year under a more systematic plan. It is planned to try to propagate by means of cutting the different kinds of tropical fruit trees in order to find out which varieties can be grown in this manner and what part or parts of the growing zones are the best for any purpose.

The work on the citrus consists largely of the selection of Philippine species for propagation and stock purposes and the acclimatization and propagation of introduced species and varieties. In the work of propagation considerable attention was given to the selection of such species and varieties as are highly resistant to diseases and which at the same time might prove of commercial value.

Different native species are being tried for stock purposes to determine their relative merits as stocks for use in budding the species and varieties of citrus of commercial importance.

One hundred and twenty-six plants were set out during the year in orchards A, B, C and N, including the citrus hybrids and other miscellaneous species which are being experimented

PLATE XXV

A year old budded carambola (*averrhoa carambola*), Lamao Horticultural Station, Lamao, Bataan

Three years old grafted chico, *Achras sapota*, fruiting for the second time, Lamao Horticultural Station, Lamao, Bataan

Four years old budded mango fruiting for the first time, Lamao Horticultural Station, Lamao, Bataan

upon by Mr. W. T. Swingle, of the U. S. Department of Agriculture.

A large number of budded citrus hybrids and other miscellaneous species recently received from Mr. P. J. Wester and other coöperators are still being cared for in the nursery prior to their transfer to the permanent fields. Some of these new acquisitions were received in the form of budsticks which were successfully budded on native citrus plants.

The object in planting coffee at Lamao is to demonstrate the modern methods of growing coffee, to keep records of the yield and expense of cultivation, and finally to provide seeds for distribution.

The ipil-ipil trees used for shade in field E were thinned out, more than half having been removed so as to admit more light for the coffee plants.

The mesquite did not prove to be a good shade plant for coffee due to its tendency to branch out, thus making cultivation difficult.

LA CARLOTA EXPERIMENT STATION

Although the La Carlota Experiment Station comes under the Plant Industry Division, the Animal Husbandry and the Fiber Divisions, as stated elsewhere in this report, are carrying on experimental work at the La Carlota Station.

Forage Crops.—The forage crops being tried at the station are the Sudan grass, Guinea grass, Paspalum Dilatatum, Para grass and Uba cane. Of these different kinds of forage crops, the Guinea grass, the Uba cane, the Para grass and the Paspalum gave the most satisfactory results. The Guinea grass produced 26 metric tons on .594 hectare and the Para grass 17.7 tons on .106 hectare.

Cover Crops.—The following crops have been tested for cover crop purposes: Tahore bean, large hybrid bean, Atab black bean, Palawan bean, cowpeas, patani, Centrosema plumieri bean and Burgers Pole bean. These tests show that the Atab black bean is probably the best for cover crop, with the large hybrid bean coming close second for this purpose. The Centrosema plumieri is also very good, while the other kinds made a very poor showing as cover crops.

Miscellaneous Agronomy Work.—Under these are included such activities as pertain to the acclimatization test, cultural method experiments and the growing of vegetable and field seeds and plant materials received from time to time.

Root Crops.—The American large white, New Jersey Red and Momungan Sweet Potatoes were the varieties grown. The American large white and the large New Jersey Red are doing better than the Momungan variety.

A variety test of yams is being carried on at the station.

Legumes.—The different kinds of legumes tried are the Florida beggar weed, Guar, Palawan bean, Atab black bean, soy bean (Japanese yellow), Lamao lima bean, seguidillas, Celebes bean, Tahore bean, peanuts, soy bean, Japanese mongo, Burger's pole bean, Panubigan bean, green mongo, yellow mongo, New Era cowpeas, brown patani, Indian lima bean, white round patani, white batao and Lyon bean.

Vegetables.—Twelve square meters of land was planted in November, 1917 to each of these kinds of vegetables: pechay, mustard, radish, endive, carrot, Canadian Wonder bean, Kentucky Wonder bean and Davis white wax bean. With the exception of the beans which suffered greatly on account of excessive rain and of insect pests, all the vegetables tried did well, but the carrot and endive failed to produce seeds, while the pechay yielded but 0.3 kilo of seed, the mustard .25 kilo and the radish 0.2 kilo. The vegetables were harvested during February, March and April. In April, 16 square meters was planted to each of the following: pechay, mustard, and radish. Begining July, 1918, the growing of vegetable seeds was carried on a larger scale at the station. Since then, monthly planting of different kinds of vegetables to show what are the best months for growing vegetables, have been made.

Other Crops.—A plot of ground measuring 0.42 hectare was planted to castor oil bean in October and 10 hills of 40 square meters were planted to Curuba (*Sicania odorifera*). The curuba, which was planted in the latter part of December, 1917, is now bearing flowers but no fruits yet.

SINGALONG PROPAGATION STATION

The growing of seedlings for general distribution, the sorting, packing and preservation of seeds of all kinds and the seasonal test of vegetables constituted the principal activities of the Singalong Station during the past year.

Seasonal Test of Vegetables.—About 1,440 square meters of field A at Singalong was devoted to vegetable growing for the purpose of determining the kinds of vegetables best suited for planting during each month of the year. As this test was not

A field planted to Excelsa coffee

Robusta coffee, showing shield budding

begun until the latter part of the year, it will be necessary to carry it on longer before reporting any results.

Plant and Seed Distribution.—The propagation for distribution of seedlings of both foreign and native economic plants constitutes one of the important activities of the station, as already stated. Seedlings were supplied from this station to other stations of the Bureau and to the demonstration stations in the provinces. About 27,147 seedlings were grown in the propagating shed and 6,632 in the nursery. There are now about 15 varieties of seeds and plants germinating in 56 boxes. The plant shed at present contains 33,930 plants of 33 varieties.

Sweet potatoes are grown to furnish cuttings for distribution. Five varieties of bananas; namely, the lacatan, saba, latundan, gloria and bungulan, are being maintained to furnish suckers also for distribution. The other kinds of plants grown for distribution purposes are pineapple, Guinea grass, cassava, cannas and papaya.

From August to September, 1918, 912 cuttings of rimas were planted in the plant shed, of which 765 were paid for.

Considerable trouble was experienced with insects and plant diseases. The mongo, the cucurbits, the eggplant, the tomato, the beans, pepper and cabbage were among those badly attacked.

DAMMAO (ISABELA) TOBACCO STATION

This station was established with the coöperation of the Bureau of Internal Revenue which yearly allots the necessary appropriation from the tobacco inspection funds for its maintenance. The management of the station, however, is in the hands of the Bureau of Agriculture.

Progress of Work.—Owing to the damage suffered from the flood, only a few thousand plants of the foreign varieties were raised. Of the foreign varieties saved 1,800 plants were of the Connecticut Havana; 230 Vuelta Abajo (Cuban) and about 60 Texas Cuban. These 2,090 plants of the Connecticut Havana, Vuelta Abajo and Texas Cuban varieties produced over 2 *quintals* of wrapper leaves which may be compared favorably with the Sumatra wrapper after some experimenting. The seeds obtained from the mother plants will be sufficient to insure 20,000 seedlings, 2,000 of which had already been set out. Three more foreign varieties were received from the United States; namely, the Vuelta Abajo (Cuban), Havana and Sumatra which are now ready for transplanting. Another variety received is the Blumenstiel, presumably from Cuba, which is now being tried.

Very little selection was done during the past season, owing to the scarcity of mother plants, relatively few of the foreign varieties having been acclimatized. Another reason for this is the long dry spell during February and March.

Another serious drawback to the work on seed selection which was begun in May of 1918 was the poor quality of paper bags available to inclose the flowers with. The paper was thickly coated with paraffine and after a rain followed by wind, they were easily torn to pieces; hence it was necessary in some cases to change bags as often as three times before the seed pods closed.

Selected Seed.—The plants obtained from planting selected seed were uniform and could easily be distinguished. One field of Romero of more than 4,000 plants had only 17 which could be considered a variation from that type. The Vuelta Abajo (Cuban) variety did not prove very satisfactory as the plants of this variety began to flower when only about a meter high. The leaves were short and broad, resembling the native Pampano.

Harvesting and Curing.—The harvest season covered from May to June, inclusive. Just about the time the plants were ready to be primed, the laborrers asked for more pay and refused to harvest the crop. It was therefore necessary to call laborers from other places. The largest number of these new laborers were obtained in Gamu, a town about three kilometers from the station. The new laborers returned to their homes after each day's work, so that the harvesting proceeded rather slowly. Some of the lower leaves were primed too green while other too ripe. This fact explains the reduced quantity of wrapper leaves secured.

In fermenting, the leaves were stacked up in a pile of approximately 1,600 kilos of leaves. The temperature was allowed to reach 38° C. then the pile was broken up and remade, allowing the temperature afterwards to reach 44° C. later 48° C. and finally, 52° C.

The fine wrapper tobacco produced under partial shade was only allowed to reach a temperature of 48° C. for fear that the leaves which are of a silky texture might be overheated.

Seed Beds.—A high location above flood level was selected in the woods for seedbeds. After the place had been cleared and about 60 beds with an area of 20 square meters each prepared and the seedbeds sown, the laborers with one exception went on a strike. The seedlings on these seedbeds were all lost. It became necessary to get day laborers to prepare the seedbeds. It

PLATE XXX

Tobacco seed plant, Tobacco Station, Ilagan, Isabela Province

was calculated that more than 100,000 plants would be available for planting. It is doubted though it more than 30,000 of these could be planted, in view of the difficulties being experienced in maintaining at that place.

PEST CONTROL SECTION

Plant Qurantine.—The Bureau maintains two quarantine stations: one in Manila, and one in Zamboanga. Owing to the fact, however, that steamers unload directly at the ports of Iloilo and Cebu, quarantine stations should be established at those places as well. It will thus be the aim of the Bureau to increase the number of plant inspectors and as soon as possible establish quarantine stations at the last two ports named.

The importance of preventing the introduction into the Philippines of plant diseases, especially those affecting our economic plants, is obvious.

There are many species of fruit fly that are still unknown in the Philippines but are widely distributed in the surrounding countries, principally Hawaii, Australia and British India. As it is, our economic plants have enough insect and other kinds of enemies without bringing in any more and we can not be too careful in guarding against the introduction of new pests or diseases of whatever nature.

Coconut Budrot.—The work of eradicating coconut budrot was given preferential attention this year. This was possible because there were no locusts to speak of. The campaign was confined to the provinces of Laguna, Tayabas and to the Department of Mindanao and Sulu. A greater extent of territory could not be covered for lack both of trained inspectors and funds to finance a wider campaign.

It is gratifying to report that the work of the inspectors was greatly facilitated by the willing coöperation generally extended by the coconut growers. Much credit is also due to the municipal and barrio officials who, like the people themselves, fully realize what a great evil coconut budrot could be to our prosperous coconut industry if not checked in time.

In the Provinces of Tayabas, Laguna, Zamboanga, including Basilan, 14,017,741 trees were inspected. Of these, 6,689 were found infected with budrot, 3,923 and 7,897 were attacked by the black beetle and the red battle, respectively, and 5,356 by other diseases. All coconut trees with budrot were destroyed by cutting the crowns into four or six parts and burning them with the aid of powerful torches of petroleum during the wet season. When the day was dry, the use of dry leaves for kindling was resorted to instead of this more expensive method. In all cases, the trunks of trees affected were either destroyed or used for firewood or buried, as they constitute breeding places for beetles.

In order that the spread of budrot may be checked, it will be necessary not only to send inspectors to all the coconut provinces but to make a periodical reinspection of all such provinces, to insure that any reappearance of the disease is promptly checked.

Locust Extermination.—During the fiscal year, locust infestation was at a very low point, having been reported from a relatively few provinces and then only in a mild form.

Of the municipalities infested, Buluan and Cotabato was the most difficult to free from the infestation, owing to the inaccessibility of the infested places and the scarcity of men available to fight the pest. Locusts here were found in places far from Moro rancherias, where cogon and talahib abound.

The archipelago might be said to be free practically from locust infestation during the year, for as will be noted, although locusts were present in several municipalities, the extent of infestation was limited.

Abaca Pests and Diseases.—The first work undertaken with abaca pests and diseases was in the province of Cavite in the latter part of 1917. Inspectors were first sent to the town of Silang but they gradually extended their work of inspection and eradication to cover Amadeo, Mendez-Nuñez, Alfonso and Indang, finishing that part of the province early in September of 1918, when the province of Cavite was declared free from heart-rot and root-rot. Altogether, 5,085,191 abaca plants were inspected during the fiscal year. The amount of money allotted for this work was ₱2,600, of which there is still a balance in the Provincial Treasury of Cavite of ₱37.79. The cost of inspecting an abaca plant at this rate was 0.0005 centavo.

The method of inspection followed was similar to that employed in inspecting coconut trees for budrot. In other words, as soon as either the heart-rot or the root-rot was discovered in one place, the owner thereof was notified in writing. As a rule, orders for the destruction of diseased plants were carried out without protest. In some cases, however, the imposition of fines was resorted to which, being nominal, the owners of badly diseased plantations preferred to pay to carrying out the orders, as the latter involved a greater expense. It was therefore necessary to use much tact in dealing with the people, to get them to destroy the plants thus affected or at least help the inspectors in destroying them, as otherwise it would have been a difficult undertaking for the inspectors to make any headway with the work. The inspection of abaca plants was extended to the province of Laguna in the municipalities of Pangil, Longos and Paete, where abaca plants were reported to be suffering seriously from diseases. An allotment of ₱2,000 for the work in Laguna was made and nine inspectors provided to carry it on.

To the end that suckers from the diseased abaca plants of this part of Laguna might be stopped for planting elsewhere, General Order No. 64 prohibiting the transporting of abaca plants from these districts to other districts not infected, was issued.

Rat Extermination.—Rats were reported to be doing especially heavy damage in the northern part of Camarines in the rice regions which have lain fallow for many years. Other parts of the Philippines reported the presence of rats but no great damage to crops was done. As far as funds and facilities at the disposal of this Bureau permitted, poison (white arsenic) with instruction for its use was given free and rat traps were loaned to farmers. With the limited number of inspectors in the employ of this Bureau—and these needing to be completely occupied with the more imported work on bud-rot and abaca-rot eradication—it was not possible to give steady attention to the work of exterminating the rats.

The work of extermination was also handicapped by the following difficulties: (1) Failure of a great number of farmers to report the presence of rats in time; (2) unavailability of poison in many of the local drug stores; and (3) impossibility of supplying farmers with poison due to limited appropriation.

With additional men, however, and a larger sum of money for the purchase of poison and traps, a more systematic campaign against the rats can be inaugurated. It is hoped that the Bureau may be able to do this during the coming fiscal year.

Pink Disease.—About August, 1918, the attention of the Bureau was called to the pink disease, which at the time was already widely distributed among the trees of the city of Manila and vicinity, by Mr. H. A. Lee, of the United States Department of Agriculture. Inspectors were at once sent out to investigate and report upon the spread of the disease in the city parks, cemeteries, public nurseries, at the Singalong Propagation and Distribution Station at Lamao Horticultural Station, as well as in the cemeteries around the city of Manila. All the diseased branches found were cut and burned and where the infection covered the main trunk, the infected parts were chiseled out and the resulting wounds disinfected with formaline and then painted over with white lead mixed with linseed oil or coal tar. Vigorous action was taken whenever the pink disease was discovered, as this is one of the most dangerous plant diseases known. Inasmuch as it attacks many varieties of trees, its complete eradication would be almost impossible. The work, therefore, for the year was confined principally to inspection and sanitation of the Bureau stations and public nurseries, as these are the sources of a great percentage of plant materials distributed throughout the Philippines. At first, it was thought that the disease had been introduced only very recently, but indications point to its introduction into the Philippines many years ago.

Other Insect Pests.—During the year, numerous requests were received for advice on how to control different kinds of pests and diseases which affected small areas or individual groups of plants and, were, therefore, of no great consequence. In most cases, the advice sought could be given without there being any need of a preliminary investigation; in others, a study of the diseases had to be made and the means of combating them devised. The chemicals needed to kill the insects were invariably given to the farmers free of charge.

FIBER DIVISION

FIBER GRADING AND INVESTIGATION

The most important work performed during the year in connection with commercial fibers was the enforcement of the Fiber Grading and Inspection Law (Act No. 2389). The experiments on Manila hemp; agave and allied fibers; kapok; cotton; and miscellaneous tropical fibers of commercial possibilities were continued during the year. The distribution of fiber plants and seeds was handled by the Division of Plant Industry, of this Bureau, in coöperation with the Fiber Division.

Abaca, Kinisol variety

PLATE XXXII

The Abaca (Manila Hemp) must conform to the Government standards before it is exported from the Philippine Islands

FIBER GRADING AND INSPECTION

With the greater familiarity acquired by commercial houses dealing in fibers with the Government standards and the regulations regarding baling, it was possible to carry on the work of grading and inspection with much less friction than in previous years. The number of bales rejected after inspection was smaller, although the grading was kept up to high standard and proper compliance with the rules and regulations obtained. The towy and streaky fiber of the previous year coming mostly from Sorsogon and the northwestern part of Samar was not so abundant as before. The colored fiber coming from Jolo, and the coarse streaky and highly colored fiber from north Mindanao is now being received in the Manila market in a much better condition. This may be attributed to the educational campaign carried on by the two Moro Assistant Inspectors detailed especially to work among the fiber producers of Mindanao. One of the bad practices these Moro Assistants were instructed especially to correct was the one prevailing before of wetting the fiber before sending to market, in the belief that as wet fiber weighs more than dry fiber it would bring a higher price.

GRADING STATIONS AND ESTABLISHMENTS

During the year, there were designated 36 grading stations and 113 grading establishments, an increase of two stations and four grading establishments over the number recorded for the preceding year.

The total production of hemp since 1915 has been steadily increasing. The increase in the number of bales of grades I, J, G and K is explained by the corresponding decrease in the production of the lower grades, L, DL, M and DM. The principal reasons for the decrease in the production of grades L, DL, M and DM are lack of bottoms and other related causes, and the higher prices paid for fibers of I, J, G and K grades. Another reason for the increase in the production of I, J, G and K fibers is the exorbitant price demanded for the higher grades which resulted in the United States Navy being the only one buyer of the higher grades. The Navy bought grades ranging from C to F, for rope purposes.

It will also be noted that the production for 1918 of L, DL, M and DM decreased, these being the grades shipped to England, with the exception of grade I, which, though it is ranked among the U. K. grades, was bought by the United States Navy in large quantities owing to the high prices asked for the better grades.

MARKET FOR MAGUEY

In 1918 we lost our market in the United States for maguey, owing to the action of the United States Government in taking over the control of the binder twine industry and purchasing large quantities of Mexican sisal which were distributed among the binder twine manufacturers.

DEMONSTRATION AND COÖPERATION

With a view to improving the fiber producing plants, plant materials are distributed to fiber growers all over the Philippines. This is supplemented by pracitical talks to farmers whenever opportunity is offered. Coöperative experiments are also conducted with the farmers, the personnel of this Bureau giving talks on planting, cultivating, etc. The results being obtained are quite gratifying.

Owing to the slump in our maguey market, greater attention was given to the distribution of sisal bulbils and suckers, sisal being better suited for stripping by machine. The Bureau distributed sisal bulbils and suckers from the La Carlota Experiment Station and from a supply obtained from Hawaii through the courtesy of Mr. H. T. Edwards, formerly Director of the Bureau of Agriculture, and now of the U. S. Department of Agriculture. Free distribution was limited to 1,000 plants, ₱3 being charged for every additional thousand.

FIBER EXPERIMENTS

Experiments with abaca, agave, kapok, cotton bast fibers, and miscellaneous fiber plants are being carried on by the Bureau at the La Carlota Experiment Station in Occidental Negros. These experiments cover methods of cultivation, planting, harvesting and extracting the fibers. The work at La Carlota has been going on for several years now and the plan is to publish the results of these experiments as soon as they are properly confirmed.

ABACA INVESTIGATIONS

There are planted in adjoining experimental plots at the La Carlota Experiment Station the most common varieties of abaca cultivated in Southern Mindanao (Davao), Eastern Leyte,

PLATE XXXIII

Maguey stripping machine in operation, Sinait, Ilocos Sur

The native method is responsible for stripping abaca valued at ₱92,493,223 for the year 1918

Native apparatus for stripping abaca showing how to place the leaf sheath under the knife

Southern Luzon (Lagonoy, Camarines) and Occidental Negros. In addition to the four fields that were planted in previous years another field was started last year.

Considering the total number of plants and the number of stalks produced in a given time, the Southren Luzon varieties give the highest stooling capacity, the Negros varieties ranking second; the Mindanao varieties, third; and the Leyte varieties, last.

Acclimatization of Introduced Varieties.—Owing to the fact that the varieties imported from Southern Mindanao and Eastern Leyte did not develop as well at La Carlota as they do in their respective localities, it was deemed necessary to continue the variety test by planting rootstocks from plants growing at La Carlota in another field. In this way, it is hoped that healthier individual plants can be developed as they will have become accustomed to conditions at La Carlota.

Propagating Abaca from Seed.—The experiments on the propagation of abaca from seed were repeated at La Carlota to determine the merits of this method of propagating the abaca plant, and as a result it was found that the conclusion drawn from the experiments of previous years still holds good; namely, that this method is not desirable for many reasons.

Kapok.—There are two fields of kapok at present at La Carlota. Eight rows were planted from seedlings planted in the nursery August, 1912, and transplanted in September, 1913. Four rows were planted with cuttings set out in the field August, 1912. Those grown from seeds flowered in December of last year and those from cuttings, in January, 1919.

Cotton.—The American upland varieties were planted in separate plots one hundred meters apart and separated by corn to prevent cross-pollination. The percentage of germination was very low for the reason that when the seeds were received they had deteriorated, but all the seedlings that sprouted developed well. On account of the heavy rains, however, most of them died. The remaining plants blossomed but the yield of cotton was very poor. All the mature seeds were collected and preserved for further trial planting.

Panama Hat Palm (Carlodovica Palmata).—This was first planted in 1913 at La Carlota from suckers obtained from the Lamao Horticultural Station. The object in endeavoring to grow Panama palm is to be ready to supply the materials for making Panama hats should the manufacture of these hats be found successful and profitable in the Philippines, on a large scale.

COLLEGE COÖPERATION

The most cordial relations have existed during the year between the College of Agriculture and the Bureau of Agriculture. So notable has been the willingness of the College authorities to do everything possible in coöperation with the Bureau to further the cause of agriculture in this country, that it is felt only just to mention it in this report. The Bureau has done all it could to reciprocate the good will of the College of Agriculture, realizing that it is only through intelligent coöperation that the different agencies of the Government can be made to render efficient service.

RECOMMENDATIONS

In concluding this report, I have the honor to submit the following recommendations:

1. That the Department of Agriculture and Natural Resources establish, through coöperation of the Bureau of Science, Agriculture, Lands, and the Weather Bureau, a comprehensive farm survey of the Archipelago, to compile information concerning farm areas, soil analysis, rainfall and climatic conditions, etc., in connection with the Division of Farm Statistics of the Bureau of Agriculture. There are many calls for information of this character and the need of the coöperation above outlined is urgent.

2. That for the best interests of the public service, the matter of the location and administration of irrigation projects be placed in charge of the Bureau of Agriculture, leaving the construction work only, to the supervision of the Bureau of Public Works.

3. That the amendments to the Immunization Act, as explained at length in the Annual Report of the Director of Agriculture, be enacted, in order that the immunization of cattle may be carried on more expeditiously and economically.

Very respectfully,

ADRIANO HERNANDEZ,
Director of Agriculture.

To the Honorable,
the SECRETARY OF AGRICULTURE AND
NATURAL RESOURCES,
Manila, P. I.

"Kinachila" cotton plant six months old, La Carlota Experiment Station, Occidental Negros

PLATE I

Rice terraces in Ifugao, Mountain Province

THE PHILIPPINE

Agricultural Review

VOL. XIII FIRST QUARTER, 1920 No. 1

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EDITORIAL

By ADRIANO HERNANDEZ, *Director of Agriculture*

When we consider the enormous destruction of property, the stagnation of trade and the arrest in the normal development of great industries in so many foreign countries during the great world war, the steady growth of all the principal industries in the Philippines—which in some instances has been almost phenomenal—during this trying period is a source of profound gratification to the student of world economics who is also interested in the welfare and in the economic development of the Philippine Archipelago.

While we are still importing rice in considerable quantities the domestic per capita production is gradually increasing and we may confidently look forward to the home production meeting the demand in the near future. The phenomenal prices received for abacá in 1917 and 1918 put much money in circulation, and while the price of fiber has receded from the high water mark then attained, the situation for this industry cannot be regarded as other than satisfactory. The coconut industry has overtaken that of sugar cane; coconut products now rank second among Philippine exports and the prospects for continued development of this industry are very bright. The sugar interests themselves have been strengthened by the establishment of several new, modern centrals. Tobacco production has made great strides. Notwithstanding the ravages of rinderpest and other animal diseases the number of animals is steadily increasing. Yet, when one contemplates the vast expanse of still untilled, unoccupied, public land in these Islands, especially in Mindanao, the Mountain Province and Nueva Vizcaya, one realizes that the development of the Philippines is really just in its infancy and what stupendous opportunities here present themselves for the investor with capital, and, proportionately speaking, for the small farmer who lives in the over-populated regions of the Islands. For the past four years, there has been a steady stream of immigrants pouring into these unoccupied territories, small at first but steadily increasing in volume, and as Mindanao and

Basilan and their adaptibility to the major tropical export products are becoming better known one plantation after another is being opened up; and yet this is a mere beginning. How much remains to be done before these vast regions are settled and brought under cultivation. The annual importations of tropical products of the United States, as shown on another page, is enormous. Granted sufficient capital to insure adequate development work, the Philippines could meet, to a very great extent, the American need for raw material from the Tropics.

A REVIEW OF PHILIPPINE AGRICULTURE AND PHILIPPINE TRADE OPPORTUNITIES IN THE UNITED STATES [1]

By P. J. WESTER, *Agricultural Advisor.*

INTRODUCTION

Time and again attention has been called to the opportunities for development of agriculture along various lines in the Philippines, and of the trade opportunities between this Archipelago and the United States and foreign countries, but the subject is of such vital importance to the continued prosperity and welfare of the Islands that it will bear repetition.

It is true that the Philippines have prospered, that progress has been made and that the overseas commerce has increased in volume since the American occupation, but it is nevertheless also true that the natural resources of this country have as yet scarcely been touched and, as compared with Java, we are still in the infantile stage as regards the agricultural and commercial development of the Islands. In Hawaii where the agricultural development has by no means reached the limit, the exports in 1917 totaled 150 million pesos from an area of 6,406 square miles, or the combined area of the Islands of Cebu and Negros, whereas the Philippine exports were 191 million pesos from an area of 119,542 square miles during the same period rising to 270 million pesos in 1918. It may be safely stated that in areas of agricultural land, in the fertility of soil and climate the Philippines have a decided advantage over Hawaii, granting which, on the basis of area, the Philippine exports, in order to equal those of Hawaii, should have reached the amount of 3,500 million pesos.[2] A truly staggering figure.

Again, when it is considered that the exports of Java, before the trade became affected by the war, in 1914 exceeded 300 million pesos from an area of some 50,000 square miles one senses the tremendous opportunities for development and expansion that present themselves to the investor in the Philippine Islands.

It is a fact that while Hawaii and Porto Rico are well under cultivation, the productive power of these countries has by no means reached the limit, and that opportunities for the development of their resources are still present, yet it is in the Philippines with its large area, diversified climate and soil, vast

[1] In part based upon extracts from a Report made in June, 1918, to the Governor, Department of Mindanao and Sulu, after a visit made to the United States.

[2] ₱1=$0.50 U. S. currency.

regions of untilled land at varying elevations, forested or overgrown with native grasses, great tracts of virgin soil and of unsurpassed fertility, amply watered for irrigation and industrial purposes, where the big opportunities for agricultural development await the coming of American capital to render the United States largely, if not wholly, independent of other countries for tropical industrial supplies, and to supply the means by which the prosperity of the Dutch East Indies may be duplicated if not excelled, to provide the agri-industrial sinews of war, as it were, for the Philippine Archipelago.

Here, a few facts relative to the Philippines may not be out of place.

The Philippines, lying between the China Sea and the Pacific Ocean, include 3,141 islands, containing a land area of 119,542 square miles, scattered within a water surface of more than 700,000 square miles, and have a population of about 10,500,000 inhabitants. In other words, the Philippines are bigger than the States of New York, Pennsylvania, New Jersey, Maryland and Delaware combined.

The two largest islands are Luzon in the north and Mindanao in the south, with an area of 40,969 and 36,292 square miles respectively. Next in importance are the islands of Samar, Negros, Panay, Palawan, Mindoro, Leyte, Cebu, Bohol, and Masbate, which each range in size between 5,031 and 1,236 square miles. Then, there are numerous small islands, of little geographical interest but of great agricultural value.

The Philippine Archipelago is of volcanic origin and the topography of the islands is characterized by a broken surface and more or less rugged mountains. Between the mountain ranges lie several rich level valleys. In Mindanao especially there are vast, fertile table lands at varying elevations ranging from 300 to sometimes exceeding 900 meters. On all islands the mountain slopes are, to a large extent, sufficiently gentle to render them available for agricultural purposes.

The climate is mild, and free from extremes, but with considerable variation according to elevation.

The precipitation varies between 1,300 millimeters in the driest, to 3,900 millimeters in the rainest region of any considerable size. The Island of Cebu, the northern and western coast of Mindanao and the Sulu Archipelago have an average annual rainfall of less than 2,000 millimeters. The remaining northern, eastern and western coasts have an annual precipitation of more than 2,000 millimeters. The interior of the larger islands at low elevation seldom receives 2,000, while with the

Oversized Foldout

rising altitude the rainfall increases, until a maximum of 4,000 millimeters is reached in Benguet, in northern Luzon, at an elevation of 1,400 meters. Some regions of north-eastern Mindanao, eastern Samar, eastern and southeastern Luzon receive an average rainfall of 3,000 millimeters. The Sulu Archipelago, Mindanao, with the exception of the northeastern corner, and the southern half of Palawan are practically exempt from typhoons.

About 12 per cent of the area in the Philippines is under cultivation. In all provinces there is public land open for settlement under the homestead law, or it may be leased or purchased in bodies not exceeding, 1,024 hectares to one corporation. However, the largest bodies of unclaimed, fertile land for the opening up of large haciendas and estates are located in the islands of Mindanao, Palawan, and in the provinces of Nueva Vizcaya and the Mountain Province.

Rice, abacá (Manila hemp), coconuts, sugar cane, corn, tobacco, maguey, cacao and coffee are the principal crops of the Philippines, in 1918, in the order of their enumeration as follows, according to statistics compiled by the Bureau of Agriculture:

TABLE I.—*Principal crops in the Philippines, 1918.*[1]

Product	Value in provincial markets
	Pesos
Rice	135,163,375
Abacá	92,493,223
Coconut products	41,158,778
Sugar cane products	56,533,793
Corn	21,372,123
Tobacco products	15,219,155
Maguey	3,707,213
Cacao (estimated)	520,670
Coffee (estimated)	445,983

During the same year the principal Philippine exports were according to the Collector of Customs:

TABLE II.—*Principal Philippine exports, 1918.*

Article	Value
	Pesos
Abacá (Manila hemp)	117,961,969
Coconut products	73,702,601
Sugar	31,608,780
Tobacco products	27,150,626
Embroideries	4,361,352
Maguey	3,736,108
Cordage	1,733,968
Hats	1,183,446
Lumber	638,989
Shells	512,398
Pearls	177,785
Fish	151,419
Gums and resins	150,657
Candle nut oil	129,838
Fruit, fresh	78,401
Rubber, crude	75,210
Ilang-ilang oil	65,595

[1] All statistics relative to the Philippine crops have been furnished by Mr. Antonio Peña, chief, division of statistics of this Bureau.

The total exports during the same year amounted to 270,388,964.

In order to call attention to the tremendous trade opportunities of the Philippines in the United States, let us now consider the following importations into the United States for the fiscal year ending June 30, 1916, of tropical products that, from the standpoint of climatic adaptability could be produced in the Philippines, quoted in round figures from "Imports of merchandise into the United States," published by the United States Department of Commerce. More recent reports would show greatly increased import figures.

TABLE III.—*Importation of tropical produce into United States, 1916.*

Article	Value
	Dollars
Sugar and molasses	212,523,000
Rubber, crude	155,045,000
Silk, unmanufactured	119,484,000
Coffee	115,486,000
Jute, jute bags and woven jute fabrics	47,430,000
Cotton, unmanufactured	40,150,000
Sisal hemp	25,803,000
Tea	20,600,000
Tobacco, unmanufactured	14,619,000
Manila hemp	14,067,000
Indigo	8,236,000
Coconut products, oil excluded	7,122,000
Coconut oil	6,047,000
Rice, cleaned and paddy	5,083,000
Pepper	4,505,000
Cigars and cigarettes	4,815,000
Tampico fiber	3,905,000
Palm oil, African	2,798,000
Sago, tapioca, etc	2,227,000
Lemons	2,062,000
Chinese wood oil	1,978,000
Lime citrate	1,956,000
Cinchona products	1,896,000
Vanilla	1,698,000
Kapok	1,140,000
Castor beans	1,556,000
Peanuts	1,051,000
Brazil nuts	907,000
Beeswax	549,000
Ginger, dry	540,000
Lemon oil	442,000
Coir yarn	365,000
Honey	97,000
Oranges	89,000
Total	836,296,000

Since the production of some of these items require more or less elaborate machinery, or the introduction of seeds and plants from foreign countries the maturing of which would cover many years, and since the agricultural development of the Islands necessarily must proceed along the lines of least resistance, the immediate production of a number of these items may of course not be considered. They should nevertheless be kept in mind when plans are outlined for the systematic development of the natural resources of the Archipelago. Again, there are other

Planting lowland rice in the Philippines

products, aside from those in which there is already considerable trade, obtainable from plants already introduced, the culture of which is simple, and the preparation of the export article of which is not difficult, the development of which within a reasonably short time is therefore feasible.

Among those items the production of which systematically pushed might, within a reasonable number of years, be considered for export and including those in which there is already more or less trade are: Abacá, sugar, coconut products, including copra, oil and coir, tobacco, rubber, coffee, tea, maguey, indigo, sago, starch, cotton, kapok, castor beans, lumbang oil, ginger, sesame, pepper, peanuts, honey, and beeswax.

Consider the prosperity of Java. So many similarities in climate, soil and population combine to make the conditions between Java and the Philippines analogous, that the development of the industries of that Island is a matter of especial interest to the student of Philippine affairs in outlining a policy for the systematic development of the Philippine Archipelago. The following statistics of the agricultural exports from Java for the year 1914, before its trade felt the effects of the war are therefore of value.

TABLE IV.—*Agricultural exports from Java, 1914*

Article	Value
Sugar	[1] Fl 216,552,425
Tea	46,415,168
Coffee	24,209,844
Rubber	21,997,061
Copra	12,373,597
Cassava products	6,937,000
Cinchona products	6,208,385
Kapok	5.975,070
Corn	5,947,181
Sisal hemp	5,063,402
Rice	4,037,609
Pepper and cubebs	3,958,174
Alcohol	2,631,289
Coconut oil	2,354,104
Indigo	2,300,747
Peanuts	1,786,754
Hats	1,748,671
Cacao	1,170,816
Citronella oil, etc	979,254
Seed, oil bearing	756,440
Cotton	487,821
Damar	477,666
Fibers other than kapok and sisal hemp	437,307
Fruit, fresh and preserved	417,101
Coca products	369.781
Arrack	365,484
Spices	353,000
Potatos	339,128
Oils, other vegetable	322,099
Castor oil	223,320
Total	377,195,698

[1] Fl=₱0.80 in Philippine currency.

These exports constituting the surplus after her own population of about 35 million people had been provided for, Java was practically self-sustaining relative to all food stuffs.

In comparing Tables III and IV it is rather interesting to note how closely the products imported into one and exported from another country parallel each other, values, of course, excepted.

Having considered the trade opportunities of the Philippines in the United States, a brief review of the growth and development of the major plant industries in the Philippine Archipelago may now be of interest.

RICE

As in other countries in the Far East, rice is the chief cereal of the Philippine Archipelago where, as we already have seen, it also occupies the foremost position among the agricultural crops.

The status of rice production is best illustrated in the following statistics covering a period of nine years.

Except for the sharp drop in area planted to rice during 1911 and 1912 and a new record set in 1914 the fluctuations have not been very marked. The year 1917 saw a great advance in the culture of rice and this gained still greater momentum the following year which was a record breaker in area planted, yield and value of the product.

TABLE V.—*Rice production in the Philippines*

Year	Area under cultivation	Production of rice	Value
	Hectares	*Hectoliters*	*Pesos*
1910	1,192,000	14,144,314	60,621,000
1911	1,044,000	15,397,572	65,992,000
1912	1,079,000	8,716,851	42,306,000
1913	1,141,000	18,374,143	61,737,000
1914	1,245,000	17,052,610	60,925,000
1915	1,131,000	13,363,867	52,079,000
1916	1,141,000	15,659,148	62,187,000
1917	1,226,000	21,207,537	81,378,000
1918	1,368,140	26,846,284	135,163,000

Pangasinan, Nueva Ecija, Iloilo, Pampanga, Tarlac, Bulacan and Capiz are the leading provinces in the production of rice.

Large as is the production of rice in the Archipelago it is insufficient for the needs of the population, and like Ceylon the Philippines annually import large quantities, chiefly from Indo-China.

To increase the production of rice has always been one of the chief problems of the Insular Government since the beginning of the American occupation, and while rice importations

In Davao abacá is king

are likely to continue for many years to come, with a better understanding of the causes of low rice yields of the past, one may expect the rice imports gradually to decrease. So long an importer of this cereal, the Philippines will perhaps rest content when her production has increased to the point where the supply is equal to the home demand, without her coveting a foreign market.

With the introduction of modern farm machinery and the construction of adequate irrigation works, those in the Cotabato delta supplemented by the dredging of the rivers and the construction of dykes to prevent untimely inundations, the large areas of excellent rice lands in Cotabato, Nueva Vizcaya, and Nueva Ecija could easily be made to produce all the rice now annually imported.

ABACÁ

Abacá (Manila hemp) is second in importance among the agricultural industries of the Philippines, and it occupies the chief position among the exports of the Archipelago, which is the principal source in the world for this important fiber.

The 9-year period viewed as a whole has not witnessed a very greatly increased area planted to abacá. After a considerable decline from 1911 to 1914 the plantations were again enlarged, mostly within the last 3 years. It is rather remarkable that the actual production of fiber has not yet reached the high water marks attained in 1910 and 1911, the increased value of abacá being largely due to a rise in the price of the product.

TABLE VI.—*Abacá production of the Philippines.*

Year	Area in cultivation	Production	Value
	Hectares	*Metric tons*	*Pesos*
1910	475,000	168,452	26,952,000
1911	404,000	171,880	27,501,000
1912	433,000	159,473	28,705,000
1913	368,000	140,520	32,320,000
1914	437,000	137,636	29,968,000
1915	458,000	154,192	30,421,000
1916	500,000	152,756	42,767,000
1917	488,000	160,953	63,598,000
1918	512,000	166,863	92,493,000

Leyte, Albay, Sorsogon, Ambos Camarines, Samar, and Davao lead in the production of abacá.

The abacá industry is largely in the hands of Filipinos. Quite a number of Americans are engaged in growing abacá, but no great corporations, comparable with the large sugar estates, are in operation. Considerable Japanese capital is interested in abacá, chiefly in Davao.

The increasing demand for abacá fiber with consequent high prices during 1916 and 1917 resulted in a sudden great increase in the acreage planted to abacá, though as yet this does not greatly exceed the area planted to this crop in 1910, but the industry is still capable of great extension. The two large Provinces of Davao and Cotabato especially may be expected to see large areas planted to abacá in the future.

While not ranking with sugar, rubber or coffee in the world's economy, yet abacá is a crop that like these is well adapted to exploitation on a plantation basis.

Speaking of fibers, on the other hand, the sisal and maguey hemp industry, which is of recent growth, will probably always remain in the hands of the small landholder. The interest displayed in this crop during the past few years has been unprecedented, and the extension of plantations has been limited only by the supply of plants available for planting. In the Philippines maguey and sisal hemp will never rank with abacá and coconuts, for instance, in importance, yet we may expect the Islands in the future to furnish much of the hemp that is now imported into the United States from Mexico.

Like the Philippines relative to abacá, India has practically a world monopoly of the jute industry. It is said that the Dutch made an attempt to establish a jute industry in Java but abandoned the project as unprofitable in competition with India. Under those circumstances the outlook for a jute industry in the Philippines is not encouraging; yet it is worthy of note that among the textile imports of United States, jute and jute bags rank nearly equal with abacá, or $13,200,000 in round figures, also that the Philippines are well adapted to the various plants from which jute fiber is extracted.

COCONUTS

It seems but yesterday when the coconut palm was still associated chiefly with the tales of shipwrecked adventurers, pirates and the cannibals of the south seas, but, simultaneous with the disappearance of at least the latter the coconut has attained the distinction of being one of the most important and profitable crops in the tropics. Even before the beginning of the agricultural era of the coconut, this tree was extensively planted by the Filipinos for local food consumption, hence the Philippines were

Near view of abacá in the Otha Development Company's plantation in Mintal, Davao

in an excellent position to profit by the world's demand for copra from the very start of this trade. From thence to coconut growing on a commercial basis it was but a step. Also, the Philippine Archipelago is now the third most important producer of coconut products in the world, being preceded only by the Dutch East Indies and the Federated Malay States, the last mentioned being but slightly in the lead. Among the Philippine exports coconut products already rank second in importance. The following table best illustrates the progress made by the Philippine coconut industry within the last nine years:

TABLE VIII.—*Coconut statistics of the Philippines*

Year	Number of trees	Production of copra	Total value of coconut products
	Planted	*Metric tons*	*Pesos*
1910	32, 839, 000	118, 141	26, 162, 000
1911	41, 695, 000	118, 323	26, 261, 000
1912	46, 136, 000	174, 036	35, 927, 000
1913	44, 642, 000	116, 700	30, 536, 000
1914	49, 190, 000	107, 383	24, 652, 000
1915	52, 795, 000	171, 574	24, 462, 000
1916	54, 154, 000	141, 764	24, 431, 000
1917	60, 244, 000	186, 511	31, 975, 000
1918	67, 120, 000	346, 657	56, 534, 000

Since an average of 200 coconut trees are planted to a hectare there are approximately 335,000 hectares planted to coconuts in the Philippines.

It will be noted that there has been a steady increase of the planted acreage during the past five years in face of the downward trend of the value of the products from 1913 to 1916. The great drop in copra production in 1913 and 1914 was due to an unprecedented drought; then the war caused a depression in prices for copra and oil, from which it has since recovered, however.

The enlarged area devoted to coconuts and the increased production and value of the produce are especially gratifying for the past year and the future outlook of the coconut industry is eminently satisfactory.

Tayabas, Laguna, Zamboanga, Samar, Albay, Misamis, Cebu, and Bohol are the 8 principal producers of copra in the order named.

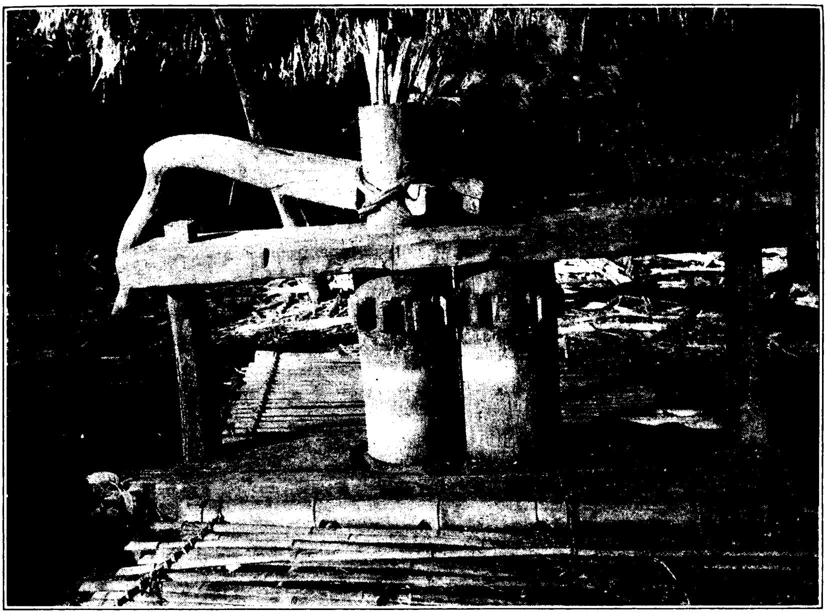
The coconut industry is largely in the hands of the Filipinos though there are some notably successful coconut plantations operated by Americans. In a publication devoted to coconut growing, the Hon. Dean C. Worcester, then Secretary of the

Interior in the Philippines, stated in 1911 that "after fifteen years of observation on the ground in the Philippines, I have reached the conclusion that no branch of agriculture there offers such certainty of steady and assured returns from comparatively small investment as does the growing of coconuts, which may be raised to advantage—to a degree nowhere excelled and seldom equalled in other countries." To this may well be subjoined the observation made by the late W. S. Lyon, at the time of his death one of the leading authorities on Philippine agriculture: "there is no other horticultural tropical product which may be grown in these Islands where crop assurance may be so nearly guaranteed, or natural conditions so nearly controlled by the planter, who, knowing the correct principles (of coconut culture) has the facilities for applying them."

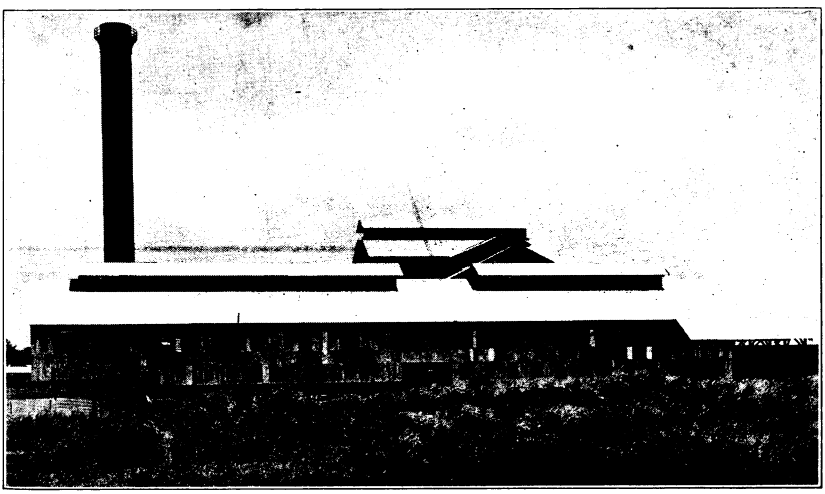
Following the lead of other great coconut countries, such as Ceylon and Java, the Philippines have also recently seen the erection of several coconut oil mills of varying capacities, one of which in perfection of appointment and the excellence of its product is probably equal if not superior to any oil mill in the Orient. The coconut oil industry is now so well established that the export of copra will never again become prominent, and it is probably only a matter of time when large vegetable butter factories will enter the field.

When we consider that the island of Ceylon with an area of but 25,000 square miles, aside from its great tea, rubber and other exports, having no greater advantages in soil and climate, yet about equals the Philippines in the value of her copra and coconut oil exports, there would appear to be ample justification for the optimism displayed by some of the biggest planters in the Philippines. As a matter of fact, there are still very large areas of unoccupied land in the Philippine Archipelago eminently adapted to coconuts, and with an ever increasing demand for copra and oil, the war being over, when the economic situation shall have adjusted itself, one may confidently anticipate a rapid expansion of the Philippine coconut industry. The fiber industry will unquestionably maintain its lead for many years to come, but the writer ventures to predict that eventually, by a wide margin, the coconut will supersede abacá as the chief export of the Archipelago.

While a general increase in the planting of coconuts may be anticipated, in time, Agusan, Cotabato, Davao, Zamboanga, and



(*a*) This type of sugar mill is rapidly going out of existence



(*b*) Modern sugar mill, Calamba, Laguna

Samar will probably show the greatest advance in copra production especially so the three first named provinces.

In the copra exports into the United States the French colonies in Oceania run the Philippines a very close race, while large amounts are also imported from the British and former German colonies in Polynesia. In the exports of coconut oil into United States the Philippines rank first by a comfortable margin though large quantities are also imported from the Dutch and British colonies and Japan.

The American coir imports are obtained mostly from British India, and the production of this article as a by-product of the copra and oil industry might well be considered in the coconut districts of the Philippine Archipelago.

SUGAR CANE

Cane sugar products rank third in importance among the Philippine exports and among the agricultural crops of the Islands. The growth of the cane sugar industry is shown in the following statistics for the past nine years:

TABLE VII.—*Sugar cane statistics for the Philippines*

Year	Area in cultivation	Production of sugar	Total value of sugar products
	Hectares	*Metric tons*	*Pesos*
1910	83,000	152,639	15,263,000
1911	120,000	243,925	24,392,000
1912	164,000	255,243	26,428,000
1913	176,000	313,051	25,698,000
1914	169,000	370,443	28,631,000
1915	173,000	382,103	33,212,000
1916	180,000	374,012	34,136.000
1917	186,000	385,798	38,705,000
1918	206,000	396,243	41,159,000

A slow but steady increase that may be expected to attain greater momentum within the next decade.

The leading sugar producing provinces of the Philippines in the order of their rank are Occidental Negros, Pampanga, Batangas, Iloilo, Tarlac, and Laguna. Cotabato, Nueva Vizcaya and the southern part of Bukidnon probably present the greatest opportunities for an extension of the sugar cane industry.

Sugar cane is one of the popular money crops of the Filipino and the one with which American capital has been most closely identified. The Island of Negros is the center of sugar production of the Archipelago. The increase of cugar production has been accompanied by the installation of modern sugar mills in place of the antiquated ones of bygone days, improved methods of cultivation, and the introduction of cane varieties from other sugar centers, such as Java, Hawaii and Louisiana, though these however, as yet are not extensively cultivated. The changes inaugurated and the improvements effected relative to the sugar industry, while they may to some extent have retarded the increased output of sugar have greatly strengthened the sugar interests, with the probable effect that the next few years will see a vastly more rapid increase in the sugar exports than we have witnessed in the past.

CORN

As late as 1905, corn constituted an import article in the Philippines, but the vigorous corn propaganda conducted by various branches of the Insular Government long ago wiped out the corn importations, and corn is now the fifth most important crop in the Islands. The status of corn production is shown in the following statistics.

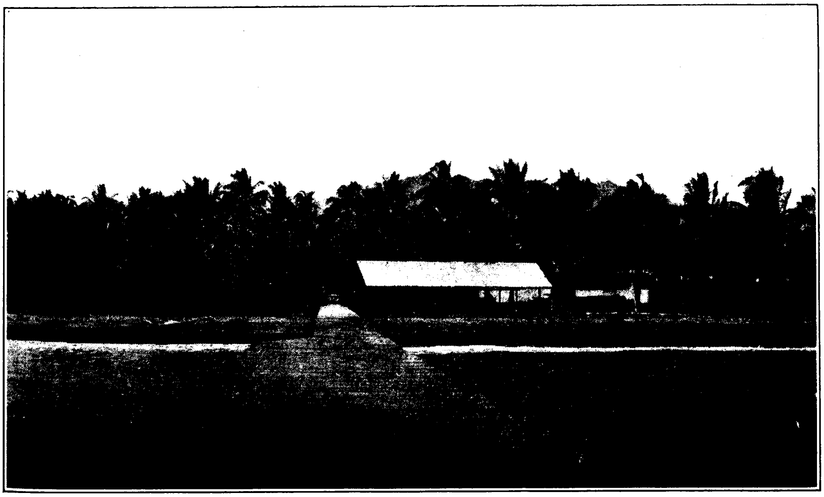
TABLE IX.—*Corn production in the Philippines*

Year	Area cultivated	Production of shelled corn.	Value
	Hectares	*Hectoliters*	*Pesos*
1910	288,000	1,851,000	8,661,000
1911	303,000	1,864,000	8,724,000
1912	340,000	2,750,000	12,868,000
1913	384,000	3,255,000	15,231,000
1914	421,000	4,700,000	15.874,000
1915	443,000	5,181,000	16,068,000
1916	432,000	4,963,000	14,724,000
1917	428,000	4,737,000	17,640,000
1918	418,000	3,971,000	21,372,000

This large amount of corn has been largely consumed by the people to supplement rice. Following a steady increase the high water mark in corn production was reached in 1915, since when there has been a gradual decline in its cultivation. Such a surplus as may accumulate in the future beyond the need for human consumption can to the best advantage be disposed of in the raising of additional cattle and hogs to take the place of the meat and cattle that are imported annually.

Cebu, Oriental Negros, Isabela, Leyte, Cagayan, and Misamis rank first as corn-producing provinces.

(*a*) Coconut Plantation at San Ramon Farm, Zamboanga



(*b*) Landing and bodega of the Culaman Plantation Company (abacá and coconuts) Malita, Davao

TOBACCO

Tobacco ranks sixth among the major crops. The status of the tobacco industry is indicated in the following table:

TABLE X.—*Tobacco statistics of the Philippines*

Year	Area cultivated	Production of leaves	Value
	Hectares	*Metric tons*	*Pesos*
1910	53,600	28,006	4,201,000
1911	69,000	25,518	3,828,000
1912	57,000	29,583	4,437,000
1913	69,000	46,060	6,909,000
1914	60,900	46,731	7,109,000
1915	53,300	38,303	5,685,000
1916	58,900	41,139	7,259,000
1917	61,800	48,929	10,884,000
1918	78,443	61,555	15,219,000

These statistics would indicate that the area in cultivation has remained practically stationary during these eight years ending in 1917 but that better culture resulted in a larger yield of tobacco, of better grade, commanding a correspondingly higher price. Last year saw a great increase both in area under cultivation and in production; the price of the product made a still greater advance. More or less tobacco is grown throughout the Philippines for home consumption if not for export, but approximately one-half of the total production is grown in the two provinces Isabela and Cagayan in the northeast corner of Luzon Island, with Pangasinan, La Union and Cebu as the next important producers. Properly handled Philippine grown tobacco is of superior quality and the excellence of the Manila cigars is undisputed. Nevertheless, they have not become well known in a broad sense either in United States or abroad, due perhaps mostly to the lack of enterprise of the manufacturers. At present Cuba and the Dutch East Indies are the principal exporters of tobacco into the United States. Judicious advertising by the Philippine producer and exporter, coupled with well directed introductions into the tobacco markets could hardly fail to greatly increase the demand for an article of recognized merit, which again would react as a stimulus to the Philippine tobacco industry.

LIVE STOCK

Ever since the entrance of rinderpest the livestock industry has been a hazarduous undertaking in the Philippines, and while the situation has improved, and the annual importations of cattle for meat and draft animals have rapidly declined within the past few years, they still totaled ₱221,000 in 1918. However, with a better understanding of the disease, outbreaks are now more readily controlled than in the past, and further improvement in the situation may confidently be expected in the future as the blood of the imported rinderpest-resistant Indian cattle makes itself felt in the herds.

Where the cattle can be adequately protected from rinderpest livestock is unquestionably one of the most profitable industries in which one may engage in the Philippines. Good pasturage is available and cattle is or may be raised to more or less advantage in every province of the Archipelago, but for undertakings on a large scale the conditions for cattle raising are exceptionally good in Bukidnon, Cotabato, Lanao, and Nueva Vizcaya, which provinces possess almost endless, well watered plains, covered with luxuriant vegetation throughout the year.

The cattle industry is very largely in the hands of the Filipino, though there are several herds owned by Spaniards and Americans. All herds are small. Few exceed 1,000 in number, and there are no herds numbering more than 5,000 cattle.

Never used for agricultural work the horse is not of great importance, being employed as a carriage horse, for riding and as a pack animal. Batangas justly has acquired insular fame for her excellent ponies which are exported to other parts of the Archipelago. The importations of pedigreed animals for breeding purposes is gradually improving the quality of the native pony.

This last statement is equally true of the swine and poultry. Some sheep and goats are raised but these animals are relatively unimportant in Philippine economics. For a "birdseye view" of the Philippine live stock industry see the following tables which show a gratifying steady annual increase of all animals.

TABLE XI.—*Live stock statistics for the Philippines*

CATTLE

Year	Carabaos	Other cattle	Value
			Pesos
1910	756,724	269,963	
1911	863,649	315,495	
1912	958,512	362,230	
1913	1,047,164	418,114	
1914	1,147,433	477,736	
1915	1,221,866	534,106	
1916	1,228,836	566,199	149,662,782
1917	1,271,208	602,756	164,821,212

Birdseye view of the Basilan rubber and coconut plantation, the oldest rubber plantation in the Philippines

TABLE XII.—*Live stock statistics for the Philippines*

MISCELLANEOUS ANIMALS

Year	Horses and mules	Swine	Sheep and goats	Value in—
				Pesos
1910	142,604	1,681,550	535,621	
1911	151,696	1,703,078	548,632	
1912	170,861	1,888,122	574,450	
1913	179,089	2,016,736	632,327	
1914	215,826	2,285,880	710,052	
1915	223,195	2,521,143	773,496	
1916	203,430	2,734,684	803,254	53,676,947
1917	214,204	2,810,737	878,359	65,524,836
1918	234,125		906,768	

PROSPECTIVE INDUSTRIES

Having disposed of the major industries of the Archipelago we may now consider the prospects for the production of other tropical staples imported into United States, such as rubber, coffee, tea, cacao, pepper, and cinchona.

The diversified soil and climate of the Philippines admit the cultivation of all these crops in the Archipelago.

Briefly stated, it may be said that the successful production of rubber, coffee, and pepper has been demonstrated, and that there are good indications that the conditions are favorable for the growth of tea and cinchona. Large areas of the Philippine Archipelago possess the requisite climate and soil for cacao, but insect pests and diseases inimical to this crop prevail to such an extent as to make a future cacao industry in the Philippines problematical, to say the least, in face of the relative absence of similar pests in tropical Africa and America.

Of the other crops, tea was introduced by the Spaniards, and cinchona has been successfully imported from Java within the last few years, but no attempts have been made to establish plantations of either. The observations of the writer who visited the cinchona and tea districts of Java in 1915, lead him to believe that the conditions are favorable for the growth of cinchona in the higher altitudes in the Mountain Province in the island of Luzon, and that tea would flourish both in the same province and the adjoining Province of Nueva Vizcaya as well as in the fertile highland region of the Island of Mindanao. At the same time it is recognized that both a tea and a cinchona industry in these regions could not be established without considerable preliminary experimental work, and large expenditures of money in opening up communications between the coast and the interior of the Islands incident to the establishment of plantations. The latter statement is especially true of northern Luzon. It is worthy of note that for the production of a good staple article cinchona is essentially a large plantation crop rather than adapted to culture on a small scale by the individual grower; to a somewhat less extent is this true of tea.

The tea imports of the United States originate chiefly in Japan, China and British India, though Java also furnishes a considerable quota.

Pepper, also introduced long ago by the Spaniards, was an article of export during the Spanish régime. This is a crop that is well adapted to the small culture system, a fact that has been taken advantage of by the Chinese and the native inhabitants in the Dutch East Indies, who produce the pepper exported from these Islands. Thc Philippines could easily produce all requirements of this spice by the United States which now are supplied by the Dutch and British colonies in tropical Asia.

At one time coffee was a flourishing industry and, because of its excellency, Philippine grown coffee commanded a premium in the word's market. But the disease that all but wiped out the cultivation of coffee in Java and Ceylon also invaded the Philippines and within a few years destroyed the coffee industry.

After many years of patient research, the Dutch have been rapidly reëstablishing their coffee industry in Java within the last few years by the planting of disease resistant varieties of coffee, which include several types that vary considerably in their soil and climatic requirement. The results obtained from the earlier introductions of these coffees into the Philippines were sufficiently encouraging to warrant the importation from Java of additional large quantities of these coffees by the Insular Government, and the growth of the trees so far has been very satisfactory. The area adapted to coffee in the Philippines is very large and the crop is of such a nature that it can readily be handled alike by the small culture method and on a large plantation basis. Also, there seems to be every reason to believe that coffee is destined to become one of the important items of export from the Philippines. Lanao, Bukidnon, Cotabato, Nueva Vizcaya and the Mountain Province have enormous areas of unoccupied public land suitable for coffee and these provinces may be expected to become the centers for coffee production in the future.

Of all the major plant industries, rubber was the latest to arrive and not so many years ago it was considered the most profitable. It is still profitable though values will probably suffer a decline if the recent American discoveries relative to the manufacture of rubber from fish scales and the successful cul-

Para rubber in the fourth year, Balaktasan, Basilan

ture of guayule come up to expectations. The phenomenal growth of the plantation rubber industry in other countries may be realized when it is considered that the earliest plantations having been set out about 1900, the area planted to rubber increased to 30,000 hectares in 1905, to 314,000 in 1910, and to 551,000 hectares in 1915. The production of plantation rubber, with a modest beginning of 145 tons in 1905, increased to 8,200 tons in 1910, and leaped to a production of 107,000 tons in 1915. By far the greater amount of rubber is already a plantation product, the production of wild rubber having come practically to a standstill. Here it may be said that with few exceptions all rubber plantations are located in the Eastern Tropics, Ceylon, the Federated Malay States and the Dutch East Indies, the two last mentioned countries at the very door of the Philippines.

Rubber is obtained by the United States chiefly from the British colonies in Asia and Africa, Brazil and the Dutch East Indies. During the earlier years of American occupation, when the acreage planted to rubber increased by leaps and bounds, the erroneous impression gradually took form that the Philippines were unsuited to rubber, and even American capital passed by the Islands for investment in rubber in the Dutch and English colonies to the southwest. Only one planter persevered until he demonstrated to the satisfaction of capitalists that rubber could be grown in the Philippines. A company was then formed that altogether has planted some 80,000 rubber trees. The success of this enterprise has since induced others to plant rubber, and while the Philippine output of rubber is still insignificant, it may be said that the rubber industry has come to stay.

The rubber territory of the Philippines is confined to Mindanao, especially Davao and Cotabato, the adjacent island of Basilan, the Sulu Archipelago and southern Palawan. With the exception of the northeastern corner of Mindanao this region is exempt from typhoons, the rain is ample and of equal distribution and the soil abundantly fertile. As the adaptability to rubber of this large region becomes known, we may expect to see large plantations established, until eventually rubber should become one of the big items of export from the Philippines.

The production of the following items might well be considered for exportation into the United States: Indigo, sago, cotton, ginger, kapok, castor beans, lumbang oil, honey, and beeswax and silk.

The indigo imported by United States is procured principally from China, India and Japan; a small amount is furnished by the Philippines. Java, India, Japan, and China all increased their indigo output after the outbreak of the war, an example that might well be emulated in the Philippines where considerable indigo was grown during the Spanish régime, the culture of which is easy and the manufacture of the product relatively simple.

The true sago palm grows wild in Mindanao and some of the Visayas, and the cassava is one of the most easily cultivated of all the Philippine crops, the manufacture of either sago or tapioca and starch is extremely simple, yet the Philippines are even importing all of these products, not to say not taking advantage of the trade opportunities in these items in the United States, where sago, for instance, is imported mostly from the Straits Settlements and the Dutch East Indies.

The United States is so well-known as an exporter of cotton that it is somewhat of a surprise to find that this country is also a great importer of the same product, nearly all of which is a long staple cotton obtained from Egypt. Of recent years California has begun to grow this cotton very successfully, and a special variety of this cotton has fetched a price of exceeding ₱3.30 per kilo. The climate and soil of the Philippines would unquestionably permit the culture of this cotton here, the one drawback being detrimental insect pests. Cotton has generally been regarded as a failure in the Philippines because of the cotton pests but the present price of long-staple cotton is so high and the variety originated in California so superior that the question whether or not cotton may be grown profitably in the Philippines might well be reconsidered.

Kapok is imported into the United States chiefly from the Dutch East Indies. This crop has frequently been advocated as a profitable crop in the Philippines. It can scarcely be recommended as a plantation crop, however, though very considerable quantities of kapok might be produced for exportation by the more general employment of the tree for planting along boundary lines, and on unoccupied ground.

The castor beans imported into the United States are nearly all procured from India. Ordinarily this also is a crop more to be grown on otherwise unprofitable land rather than on land suited to other agricultural crops.

Chinese tung oil is imported from China, where it is derived from the nuts of a tree closely related to the native lumbang. It is extremely doubtful whether the lumbang nut would be sufficiently profitable under cultivation to warrant its domestication, but there can be no question but that it would be sound

Para rubber, now an unimportant article of export, may be expected to become one of the major Philippine crops. Isabela, Basilan

policy to reforest waste land with this tree from where ultimately nuts could be gathered at a slight expense for the expression of oil. The tree has a relatively abundant leaf fall and the land would be enriched rather than impoverished by the tree, which is of rapid growth and also furnishes a good match wood.

Ginger is imported principally from Jamaica, British West Africa and British India. This crop also succeeds well in the Philippines, and the preparation of the root is simple and easily accomplished. It is worthy of note that ginger is one of the few crops that can be successfully interplanted with coconut palms in bearing.

The sesame imports into the United States probably approach about 225,000 kilos, employed in the manufacture of candy and salad oils. It is of interest to know that the Turkish sesame is the most valuable for this purpose and commands a price ranging from ₱26.50 to ₱48.50 per 100 kilos when Chinese sesame is sold at ₱17.50 to ₱24.20 in New York.

In the face of annual importations of peanuts into the Philippines, there is scarcely need to argue for increased production of this staple for which there is also a market in the United States which now supplies her need of this nut chiefly from Japan and China.

The Brazil nut and the nearly related Sapucaia, which is said to be of even better quality, would unquestionably succeed over a large area of Mindanao, Palawan, Tayabas, the Bicol Provinces, Samar, Leyte, the Sulu Archipelago and Basilan, but the difficulty of introduction and the slow growth of the tree renders this industry a very remote possibility. In lieu of these nuts the Philippines have the Pili, which could become an industry of no mean proportions.

While citrus products, oranges, lemons, citrate and lemon oil are imported into United States the fruit is unlikely to be exported there from the Philippines since their handling for successful export to distant ports requires exceptional care. On the other hand, citrate of lime might be produced in the Philippines to supplant the product imported from the British West Indies, and the lemon oil might be produced as a by-product of a citrate and lime juice industry. There should be a good future for a canning and preserving industry including pineapples, mangoes, mangosteens, roselle, ginger and many other fruits, but such an enterprise presupposes a slow development covering a period of many years before the industry would attain any magnitude.

The production of honey and beeswax has assumed very respectable proportions in Cuba and Porto Rico, and even Hawaii exports considerable quantities of honey. The honey exports from Porto Rico attained a value of ₱212,000 in 1917. The honey exports of Hawaii for the same year were ₱125,000. That beekeeping in the Philippines could be developed into a considerable industry can scarcely be doubted.

Japan, China, and Italy furnish the silk imported into United States. The climate of the Philippines over a large area presents no difficulties in the way of sericulture. It is an industry that would give light employment to large numbers of women and children. In a word, silk production is another opportunity for development of great proportions as yet untouched in the Philippines.

CONCLUSION

In presenting the above review of the agricultural progress of the Philippines within the last nine years, an attempt has also been made to briefly call attention to the main opportunities for agricultural development in the future.

While one may not question the ability of the Filipino to seize a number of these opportunities it is equally well recognized that the Islands do not possess the capital necessary for the development of large plantation ventures at a rate comparable to that in other tropical countries.

Every student of Philippine affairs is well aware of the progress that has been achieved along various lines of endeavor since the American occupation of the Archipelago; yet those well informed on this subject are equally well aware that in the adjacent Dutch and English colonies in Java, Sumatra and the Federated Malay States, agricultural and industrial development has been even more rapid, and it is apparent that equal in climatic advantages and soil fertility, in the future the Philippines will lag still further behind those countries in material development unless there is a greater influx of capital. When it is considered, then, that agricultural plantation ventures in the Philippines would at once assist in rendering the United States in a large measure independent of other nations for a number of the more important industrial raw materials required, and that at the same time they would also assist in the upbuilding and even in the creation of important agricultural industries in the Philippine Archipelago, bringing in their train steady employment and greater prosperity to a large population, it would appear that the agricultural possibilities of the Philippines are well worthy of investigation by American capitalists whose coming is welcomed by all Filipinos.

Oversized Foldout

ZAMBOANGA PROVINCE: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR AGRICULTURAL DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

Zamboanga Province, (Plate XI), includes most of the peninsula projecting east of Pangil Bay in the north and Illana Bay to the south, on the Island of Mindanao, and Basilan, Olutanga and some 146 smaller islands, and has an area of 6,383 square miles and a population of 146,846 inhabitants. Zamboanga is, therefore, larger than the States of Connecticut and Rhode Island.

Located between 121° and 123° east longitude, and between 6° and 9° north latitude, Zamboanga is bounded on the east by Misamis Province, Pangil Bay and Lanao; on the south by the Celebes Sea; and on the north and west by the Sulu Sea. The coast line, approximately 700 miles long, is indented by several bays of which Sibugay, Dumankilas and Sindangan are the largest. Caldera Bay, Masinlok, Port Santa Maria, Panabutan, Talagilung, Sambolauan, Margosatubig, and Port Banga are smaller but well protected bays with excellent anchorage.

Zamboanga peninsula is largely a mountain range, with several peaks rising to now and then 600 or more meters in height. Numerous short streams and rivers wind their way between the mountains to the sea, of which the Dipolog, Dapitan, Lubungon, Piau, Siokon, Sibuku, Vitali, Kumalarang, Kabasalan, Kulasian, Tukuran, Bakalan and Labangan are the largest and the most important. Many of these rivers could be utilized as a source of power for industrial purposes but all are too small and too shallow to be navigable for any but small river craft, and then only for a few kilometers inland, owing to the rapidly rising formation of the land.

Because of the mountainous character of the mainland, this part of Zamboanga is not well adapted to agricultural pursuits except in small, isolated valleys and pockets here and there along

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[1] The writer wishes to acknowledge his indebtedness to Governor F. W. Carpenter, Department of Mindanao and Sulu, for access to the provincial annual reports of Zamboanga and to Col. Ole Waloe, for access to the Constabulary monograph of Zamboanga which latter has been heavily drawn upon for information in preparing this paper. Plate VII-*a* is from a photograph taken by Mr. H. E. Neibert, supervising surveyor, Department of Mindanao and Sulu, and furnished through the courtesy of Governor Carpenter. The map of Zamboanga has been traced by Mr. C. N. Villanueva from a map furnished by Mr. H. E. Neibert.

the coast, usually at the mouth of a river. The largest of these valleys are located at Dipolog, Dapitan, Lubungon and Sindangan. Then, the following rivers flow through smaller but also very fertile valleys:

The Tukuran River, which empties near the Lanao boundary into Illana Bay and is navigable for 6 miles from the coast by small boats; the Labangan River, which empties a few miles east of the Tukuran River, which it exceeds in length and volume of water; the Kumalarang River draining Lake Danao and emptying into Dumankilas Bay; the Kabasalan River, which forms a small delta emptying at the head of Sibugay Bay, navigable for motor boats for about 10 miles; the Bakalan River, navigable for a small launch for 5 miles from the coast; the Dinas River, that forms a marshy delta emptying into the sea in three arms off Pisan Island; the Sibuku River entering the bay of the same name on the west coast of the peninsula; the Siokon River flowing into Siokon Bay; and the Piau or Sindangan River, which empties into Sindangan Bay and is said to be navigable for small motor boats for 10 miles from the mouth of the river. The basin draining into Sindangan Bay includes the largest single grazing area in Zamboanga Province adapted to cattle raising. In the large, fertile Dipolog valley, the river is navigable by motor craft to Polanko and by smaller boats still further inland. The Dapitan river is navigable by launch to Ilaya.

The land formation of the Island of Basilan, the largest and the most important in the Province, some 430 square miles in extent, located about 20 kilometers to the south of Zamboanga, the provincial capital, differs radically from that on the "mainland." The rise of the mountains is here so gradual that though several attain an elevation ranging from 300 to 1,020 meters, the greater part of the now heavily timbered slopes ultimately will be available for agricultural purposes when the lumber cutting now in progress is finished. Between the mountains lie several plains of unrivaled fertility of which the Lamitan plain, extending on both sides of Gubauan River and emptying into a shallow bay to the north east; the Balaktasan plain, extending from Latuan to Isabela, centered around Balaktasan River, which really is only an extension of the Lamitan valley; and the Malusu valley, on the southwest of the river of the same name, are the most extensive. While the mountains are forested, the vegetation on the plains and on the lower slopes consists of secondary jungle growth and cogon, *Imperata cylindrica.* The soil varies from rich, alluvial deposits devoid of, or containing more or less late-

Coffee and coconut plantation, Patalon, Zamboanga

rite to volcanic ash; as a rule it is friable. Generally free of stones and boulders, again, in other localities these are present in such numbers as to seriously impede ordinary cultivation and render the employment of motor drawn implements impracticable. According to the surveys of the Bureau of Forestry, Zamboanga has 1,320,233 hectares commercial forest, 78,924 hectares cogonales. Mangrove swamps and noncommercial forest cover 102,726 hectares, 31,906 hectares or 1.9 per cent of the land is under cultivation, 119,408 hectares are still unexplored.

CLIMATE

The rainfall of Zamboanga is quite varied, which in part may be seen from the following table adapted from the records published by the Philippine Weather Bureau.

Zamboanga has the lowest mean annual precipitation recorded in the Philippines. This condition applies, however, to a very circumscribed area adjacent to the city itself, and the rainfall is very much greater within a few miles of Zamboanga proper. In Dapitan the rainfall is more than double that of Zamboanga, in Isabela nearly so. Again, the rainfall table of the latter place, while probably representative of the coast line and valleys in Basilan, does not indicate the true figures of the precipitation in the interior, where the rainfall on at least some mountain slopes at even less than 150 meters' altitude is twice that in Isabela, with still greater precipitation at the higher elevations. In the Margosatubig district the rainfall, which is very equally distributed throughout the year, is estimated at not less than 3,000 millimeters annually and it is probably considerably greater.

TABLE I.—*Mean monthly and annual rainfall in Zamboanga Province*

Months	Municipalities		
	Zamboanga	Isabela Basilan	Dapitan
	mm.	*mm.*	*mm.*
January	37.2	54.4	118.4
February	62.0	89.2	123.3
March	21.0	58.2	55.7
April	38.2	89.2	110.2
May	72.0	108.0	70.9
June	88.8	210.6	117.7
July	99.0	208.4	151.6
August	95.0	205.8	89.3
September	106.3	201.6	141.6
October	116.1	261.7	246.0
November	106.5	168.4	369.7
December	84.3	138.6	277.4
Total	926.4	1,794.1	1,871.8
Rainy days	94.8	153.1	140.5

TABLE II.—*Annual rainfall at the Basilan plantation*

Month	1912	1913	1914	1915	1916
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
January	127.0	76.7	36.8	68.5	487.6
February	48.2	27.9	19.0	12.7	125.7
March	----------	196.8	29.2	50.8	121.9
April	57.1	212.0	180.3	60.3	68.5
May	57.3	194.3	218.4	333.4	226.5
June	300.9	440.6	312.4	410.7	306.0
July	359.4	265.4	254.0	584.7	242.5
August	163.8	248.9	68.5	259.0	429.2
September	111.7	289.5	264.1	286.2	247.6
October	436.8	429.2	144.7	326.3	721.8
November	101.6	162.5	128.2	247.6	222.2
December	49.2	163.8	128.2	584.2	391.6
Total	1,843.0	2,707.6	1,783.8	3,424.4	3,591.1

The observations in Table II were made about 2 kilometers inland from Isabela, at an elevation approximately 50 meters above sea level.

POPULATION

As stated already on a previous page, the population is over 146,000 souls. A few of these are Americans and Europeans, mostly living in Zamboanga and representing commercial houses, or in charge of plantations. The Filipinos live principally in the Dipolog and Dapitan district and in and around Zamboanga, and are occupied by agricultural pursuits. The Moros inhabit the coast and the adjacent islands from Lanao on the south coast to Sindangan in the north, and gain their livelihood by fishing and farming, chiefly the former occupation. The Subanos inhabit the interior of the Zamboanga peninsula, and the Yakans inhabit Basilan. These two tribes are both very primitive and they support themselves by hunting and farming.

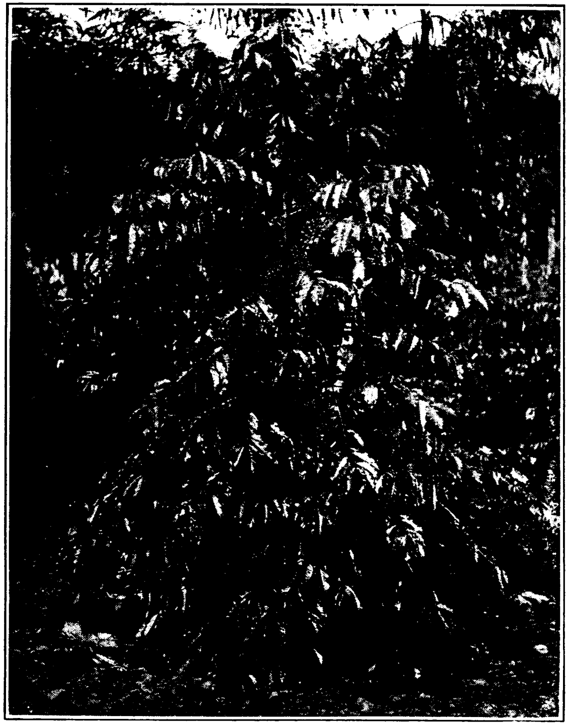
For plantation labor the Subanos are considered the best workers. Yakans are less efficient. The Filipinos and the Moros are engaged in their own pursuits and with few exceptions are not available for hire. Here as in all other provinces of the Archipelago, the local trade is largely in the hands of Chinese. The Japanese settlers are few.

HISTORICAL REVIEW

To the American having in mind the rapid development of his own country, the old history of present day Zamboanga seems almost inconceiveable.

Dapitan passed under the yoke of Spain in 1565. Cinnamon, probably the Kami, *Cinnamomum mindanaense,* is recorded to have been exported in large quantities as early as 1598 from Cal-

PLATE XIII



(*a*) Arabian coffee, 2 years old from planting in the field, Patalon, Zamboanga.

(*b*) Robusta coffee in the fourth year after field planting, Patalon, Zamboanga

Liberian coffee in the fourth year, Patalon, Zamboanga

dera, which for some time previous had been a trading post. The first Jesuit mission was established in Dapitan in 1631. The earliest Spanish settlement in Zamboanga was made in 1635. Basilan was ceded to the Spanish crown in 1726, and the fort at Isabela was constructed in 1842. In 1831 the first custom house was established in Zamboanga. The city was occupied by the Americans in 1899 and Zamboanga was made a province and civil government established in 1914.

AGRICULTURAL INDUSTRIES

Coconuts, rice, abacá, corn, rubber and coffee are the principal crops of the province, in the order named, and were, in 1918, planted in the following areas according to statistics compiled by this Bureau:

Crop	Area, hectares	Quantity	Value
			Pesos
Coconuts	[a] 20,560	[a] 61,299	[c] 9,183,638
Rice	4,020	[d] 70,448	291,953
Abacá	4,799	[e] 2,439	826,620
Corn	3,642	[d] 37,243	201,935
Sugar cane	729	[e] 537	76,065

[a] Calculated at the rate of 204 trees to the hectare.
[b] Copra, metric tons.
[c] Value of all coconut products.
[d] Hectoliters.
[e] Metric tons.

By far the most coconuts are produced in the settled country adjacent to Zamboanga, from Patalon in the north to Manikahan on the east coast. Smaller areas are planted in Isabela, Basilan, and in the Dipolog and Dapitan valleys, with scattered, small plantations here and there along the coast. In rice production Dipolog leads, which also is the principal abacá district. Zamboanga leads all provinces in the Philippines in rubber production. Considerable quantities of coffee is also being grown. The production of sugar, cacao, maguey, and tobacco is insignificant.

The principal vegetables and miscellaneous food crops grown in Zamboanga do not differ very greatly from those in other provinces in the Philippines except that cassava is very extensively grown by the Moros. The other more important vegetables include: camotes, squash, pumpkins, upo, tomatoes, eggplants, sitao, peanuts, gabi, ubi and cucumbers.

At San Ramon Farm a very great variety of temperate zone vegetables are grown very successfully. The production of Bermuda onions of excellent quality is especially worthy of note, considering that this item forms such an exceptionally high figure in the vegetable imports of the Archipelago, in 1918 amounting to 4,702,912 kilos valued at ₱331,883.

The following list contains the names of the varieties of the different crops as grown around the capital of Zamboanga, in various municipalities on the north and west coast of the peninsula and in Basilan, and could undoubtedly be lengthened very considerably by systematic exploration work.

FOOD PLANTS CULTIVATED IN ZAMBOANGA

RICE VARIETIES

Arabon	l-al-c	Kanakan	u-al-c
Asusena	l-al-w	Kandauan	l and u-al-w
Balayong	l-al-w	Lambu	l and u-al-w
Bandoy	l-al-c	Makalimbom	l-al-w
Beitik	u-al-w	Malakit	l-al-w
Buayan	l-al-w	Poutan	u-al-c
Buenabunag	l-a-w	Poutan bayan	u-al-w
Buko-buko	u-al-w	Poutan-item	u-al-c
Dawin	u-al-w	Tambakon	u-al-c
Guyod	l-al-w		

CORN VARIETIES

Dalian.	Moro.
Malakit.	Poutan batad.

SUGAR CANE VARIETIES

Baubot.	Manabaual.
Belian.	Mekka.
Blanco.	Negro.
Buay.	Patung.
Colorado.	Ueuey.

CAMOTE VARIETIES

Balagon.	Mampay.
Bayan.	Sinon.
Kalabasa.	Siokon.
Kuitan.	

CASSAVA VARIETIES

Camanting.	Camote-cahoy.

GABI VARIETIES

Mampay.	Palauan.
Manario.	Ureng.

UBI VARIETIES

Jarigni.	Mampay.
Kolebra.	Tuat.

COCONUT VARIETIES

Blanco.	Niño.
Colorado.	Romano.
Mamis.	

A herd of carabaos, Philippine Islands

BANANA VARIETIES

Amas.	Mundo.
Banegas.	Pitogo.
Bata.	Platano.
Buñgulan.	Saba.
Butuhan	Sulaybaguio.
Chesik.	Tadiao.
Dedudama.	Tando.
Kosta.	Tumbaga.
Libaguio.	Tunduki.
Matabia.	

The following species of fruits have been noted wild or cultivated:

Barobo, *Diplodiscus paniculatus.*
Bauno, *Mangifera caesia.*
Bignay, *Antidesma bunius.*
Breadfruit, *Artocarpus communis.*
Bulala, *Nephelium mutabile.*
Carambola, *Averrhoa carambola.*
Cashew, *Anacardium occidentale.*
Chico, *Achras zapota.*
Ciruela, *Spondias purpurea.*
Citron, *Citrus medica.*
Coffee, Arabian, *Coffea arabica.*
Coffee, Liberian, *C. liberica.*
Coffee, Robusta, *C. robusta.*
Custardapple, *Annona reticulata.*
Dalayap, *Citrus aurantifolia*, var. *aromatica.*
Dendé, *Elaeis guineensis.*
Dauag, *Capparis micracantha.*
Durian, *Durio zibethinus.*
Grape, Vinifera, *Vitis vinifera.*
Guanábano, *Annona muricata.*
Guava, *Psidium guajava.*
Huani, *Mangifera odorata.*
Jak, *Artocarpus integra.*
Kabuyao, *Citrus hystrix.*
Kalayo, *Erioglossum edule.*
Kamia, *Averrhoa bilimbi.*
Kamanchile, *Pithecolobium dulce.*
Kanari, *Canarium commune.*
Kayam, *Inocarpus edulis.*
Lanzon, *Lansium domesticum.*
Lemon, *Citrus limonia.*
Lilikoi, *Passiflora edulis.*
Lime, *Citrus aurantifolia.*
Limoncito, *Triphasia trifolia.*
Mandarin, *Citrus nobilis.*
Mango, *Mangifera indica.*
Mangosteen, *Garcinia mangostana.*
Marang, *Artocarpus odoratissima.*
Mulberry, *Morus nigra.*
Orange, *Citrus aurantium.*
Paho, *Mangifera altissima.*
Pangi, *Pangium edule.*
Papaya, *Carica papaya.*
Pineapple, *Ananas sativus.*
Pomegranate, *Punica granatum.*
Pomelo, *Citrus maxima.*
Rambutan, *Nephelium lappaceum.*
Santol, *Sandoricum koetjape.*
Sugarapple, *Annona squamosa.*
Tersana, *Eugenia malaccensis.*
Tamarind, *Tamarindus indicus.*

The Bauno, Huani, Marang and Rambutan are especially worthy of note as being found wild or naturalized in great numbers in Basilan and being of remarkably good quality, more particularly the Marang and Bauno. Mangosteens were planted in Dapitan many years ago, and there are several trees 10 to 12 meters high, bearing abundant annual crops.

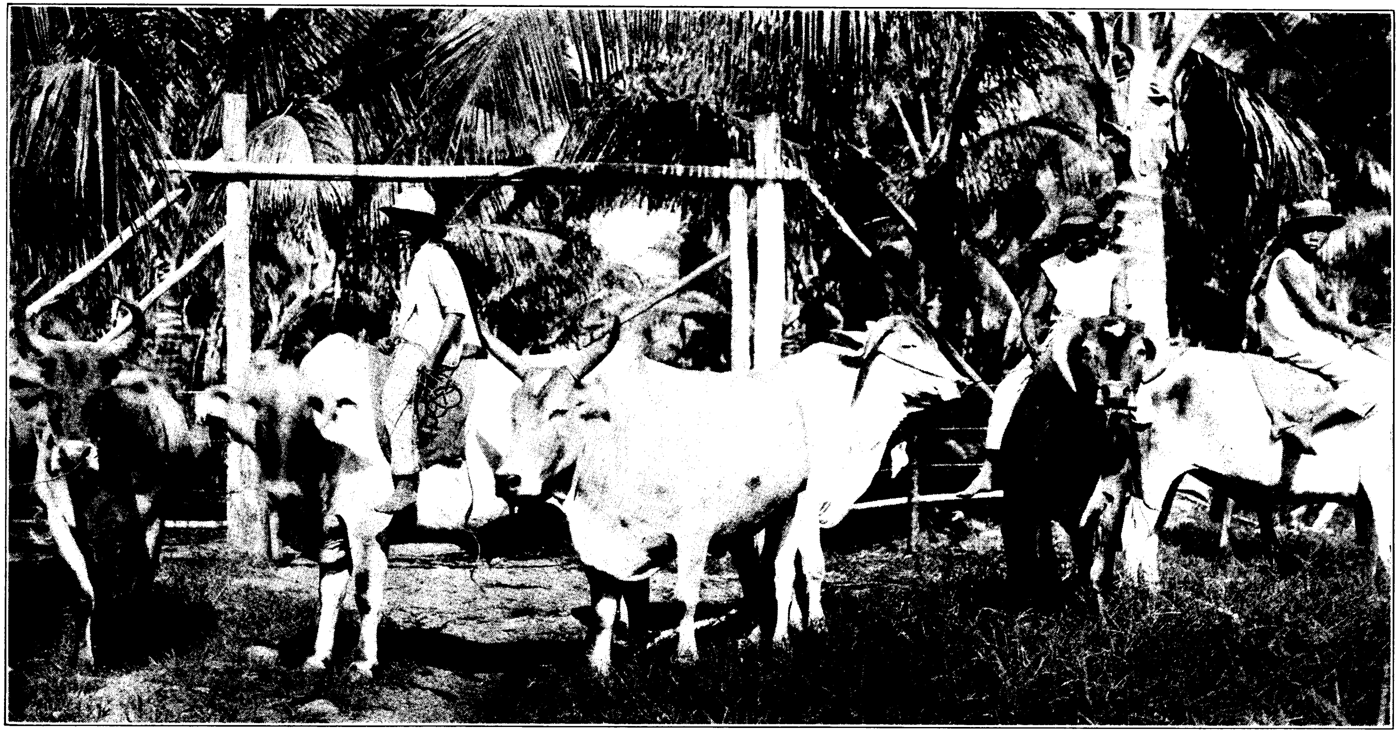
PLANTATIONS

Aside from several more modest ventures, nine corporations capitalized at from ₱50,000 to ₱500,000, are engaged in developing plantations of coconuts, abacá, coffee and rubber from 230 to 1,024 hectares in extent. The most notable of these is the Basilan Plantation Co. with an area of 1,024 hectares, which is the pioneer rubber plantation in the Philippines and now has about 81,000 Para rubber trees growing, and a large area planted to coconuts. Some 600 hectares are under cultivation on this plantation and the clearing of the remaining jungle has been delayed only because of insufficient labor. It is the success attained by this plantation that has induced other capitalists to later rubber ventures in Basilan and Mindanao. A modern rubber drying house 12 by 36 meters two stores high has been erected by this company within the last year.

The 17,000 Para rubber trees on the Balaktasan estate, Basilan, acquired by Japanese in 1918, continue to make satisfactory progress.

The Patalon plantation, a few kilometers to the north of San Ramon, devoted to coconuts and coffee, is signally successful and is an eminent example of what can be accomplished in Philippine plantation ventures under good management. As coffee plantations go in other countries, the one at Patalon is, of course, a very modest affair, including only some 36,000 trees. Nevertheless, it enjoys the distinction of being at present the largest rationally cared for coffee plantation in the Philippines, and the first to definitely demonstrate that Robusta coffee can successfully be grown in these Islands. The soil being of a very patchy character, it has shown how wonderfully productive Robusta coffee is when the soil conditions are what they should be for this coffee, but failure in other fields have strikingly demonstrated how unprofitable Robusta is when planted under uncongenial conditions. Robusta and Liberian are the two varieties principally planted, while several of the new, rust-resistant kinds are also being tried; the Excelsa and Quillou being especially promising. The Liberian coffee produced is disposed of at ₱94 and Robusta at ₱74 per 100 kilos in Zamboanga.

The American Plantation Company has made more rapid progress in development work than any other corporation during the past year. The concession of this company includes some 1,000 hectares of excellent land located on the Balaktasan river, a short distance from Isabela, Basilan. More than 500 hectares have already been cleared, of which a large area is planted to Para rubber, and at the present rate of progress the entire tract will probably be occupied by rubber at the end of 1921. The American Plantation Company is the first concern to employ tractors in developing a plantation in this part of the Philippines.



Cattle and coconuts make a good combination, Patalon, Zamboanga

The edge of a sago, *Metroxylon sagu*, swamp on the Cotabato River, Mindanao. Covering thousands of hectares these swamps have never been exploited

NATURAL RESOURCES AND PRODUCTS OTHER THAN AGRICULTURAL

The Island of Basilan presents very great potential opportunities for agricultural development but the immediately available resources of the province are the large forests, which are exceeded in area and value only by those of Davao and Cotabato. The timber trees range from the soft lightwoods, such as lauan, *Shorea* spp., *Pentacme contorta, Parashorea plicata* and *Anisoptera thurifera;* lumbayao, *Tarrietia javanica* and calantas, *Toona calantas;* to heavy hardwoods, such as yakal, *Hopea* spp. mancono, *Xanthostemon verdugonianus;* ipil, *Intsia bijuga;* molave, *Vitex* spp.; pagatpat, *Sonneratia caseolaris;* camagon, *Diospyros discolor;* dinglas, *Eucalyptus naudiniana,* narra, *Pterocarpus indicus;* and tindalo, *Cassia javanica* and *Pahudia rhomboida,* of which the hardwoods are used for posts, piles, ties and cabinet woods, while the lightwoods are employed for light construction and interior finish.

Lumber mills are operated by the following corporations: The Basilan Lumber Co., with mills at Isabela and Malusu; the Olutanga Sawmill Co. with mill at Olutanga; the Mindanao Sawmill Co., with mills at Naga-naga and Margosatubig; and the Port Banga Sawmill Co., with mill at Bangaan.

Other forest products which are collected in greater or less quantities for export are almaciga, gutta-percha, cascalote (tan bark), rattans and beeswax, but the production of all could be greatly increased.

Coal of good quality has been known for a number of years to exist on the peninsula between Payao and Malangas, and the National Development Company, with headquarters at Malangas, has been occupied for nearly two years with surveys and other preliminary work incident to mining the coal deposits which are believed to be very extensive.

The marine products of Zamboanga include pearls and shells, the exports of which totaled ₱81,943 in 1918. Small amounts of bêche de mer, shark fins, coral and sponges are also produced. Fish of excellent quality is plentiful in the markets at all times of the year. Salt is produced in Talontalon near Zamboanga for local consumption.

ZAMBOANGA, THE CAPITAL

Zamboanga is the capital of the province which it has given its name.

With its balmy climate, clear, limpid skies, brilliantly blue water, the wonderfully colorful sunsets over the vast expanse over the sea, the opulent vegetation, its tall, waving coconut palms, shady streets, and effects in decorative landscape gardening not forgetting turbaned Moros gay in their habiliments of bright colored cloth, the city of Zamboanga possesses a charm quite foreign to the seaports to the north in the Philippine Archipelago. Violent storms are rare. So different from the islands in the north is, indeed, the general atmosphere of Zamboanga that here one might imagine oneself in a foreign country, more akin to Java and all that name implies.

TRANSPORTATION AND COMMUNICATIONS

For connection with the outside world Zamboanga is served by several steamship lines. The Nippon Yusen Kaisha steamers plying between Yokohama, Hongkong, Manila and Sydney make Zamboanga a port of call. All inter-island steamers from Manila to Jolo, Cotabato and Davao, such as the *Islas Filipinas, Yazoo, Neil MacLeod, Albay, Fernandez Hermanos, D. Ildefonso, Mindanao, Raritan* and others call at Zamboanga on their way to and from Manila via Cebu and Dumaguete. The *Tablas* provides monthly communication with the north coast of Mindanao as far as Butuan, touching at all the important points, such as Dapitan, Dipolog, Misamis, Kolambugan, Iligan and Cagayan, and at the less known points whenever there is sufficient cargo to warrant a stop; on the south coast calling at Cotabato, Lebak, and the Davao ports as far as Mati, and making occasional trips to Jolo, Cagayan de Sulu and Siasi, which as a matter of fact, is also done by the *Mindanao*. There are also steamers plying monthly between Zamboanga, Borneo and Singapore. Direct connection with Iloilo and other insular ports not mentioned is erratic and irregular and as a rule travel there from Zamboanga must be made via Manila. The U. S. Army transports arrive monthly from Manila. Large and small launches handle the inter-provincial trade, while many sailing vessels touch there from domestic and foreign ports.

Zamboanga has direct cable communications with Basilan and Jolo, and with Manila via Cebu and Dumaguete; it also has a wireless station. The Zamboanga telephone system extends to San Ramon and Patalon on the one coast and to Manicahan and Buena Vista on the other. Dapitan is also connected by a cable with Cebu, and a local telephone system links up the settlements in the northeast corner of the province with each other and with the adjoining part of Misamis Province.

The Philippine "carabao" is the best mango in cultivation. It might be made the basis of a big preserving industry

Pineapple canning is still an infant industry in the Philippines. A Cayenne pineapple plantation 15 months after planting, Lamao Experiment Station

A first class road has been constructed from Zamboanga to San Ramon on one hand and to Manicahan on the other, and a second class road is under construction from Isabela to Lamitan. Transportation between the different municipalities in the province is consequently almost entirely by water on the sea coast.

TRADE

The foreign exports of the port of Zamboanga during 1918 amounted to ₱498,187, while the domestic exports amounted to ₱2,798,723, the bulk of which consisted of copra, lumber, abacá, marine shells and rubber, in the order named. According to the Annual Report of the Bureau of Customs the foreign imports for the same year amounted to ₱1,354,051. These figures do not, however, represent the total imports and exports of the province. There were 44 entrances and 35 clearances of foreign vessels during the year, while 804 and 827 coastwise vessels entered and cleared respectively.

SAN RAMON FARM

This article would hardly be complete without a mention of the San Ramon Penal Farm.

This institution, located about 15 miles north of Zamboanga, on the coast, was established as the result of an order issued as far back as 1866, by the Spanish government, and as such was taken over by the American government after the occupation of the Islands. As now managed the San Ramon Penal Farm is a model institution of its kind. The convicts perform all the labor on the farm which is managed according to the most advanced methods in tropical agriculture and is now a self-supporting institution, and is also largely self-sustaining relative to food requirements. The land is practically all occupied by coconuts, with small areas devoted to vegetables for home consumption and sale in Zamboanga. At the San Ramon Farm the prisoner is made to support himself while serving his sentence, and while in durance is so occupied that he leaves the institution a far more intelligent and efficient and healthier person than when he entered the Farm, and has a far better conception of the management of coconut palms and other general farm work than a majority of the farmers in this part of the world.

PROSPECTIVE AGRICULTURAL INDUSTRIES AND DEVELOPEMENT WORK

Richly endowed with forests, Zamboanga for many years will continue as one of the principal sources of lumber in the Philippines and the exports will increase as new mills, for which there is ample room, are erected.

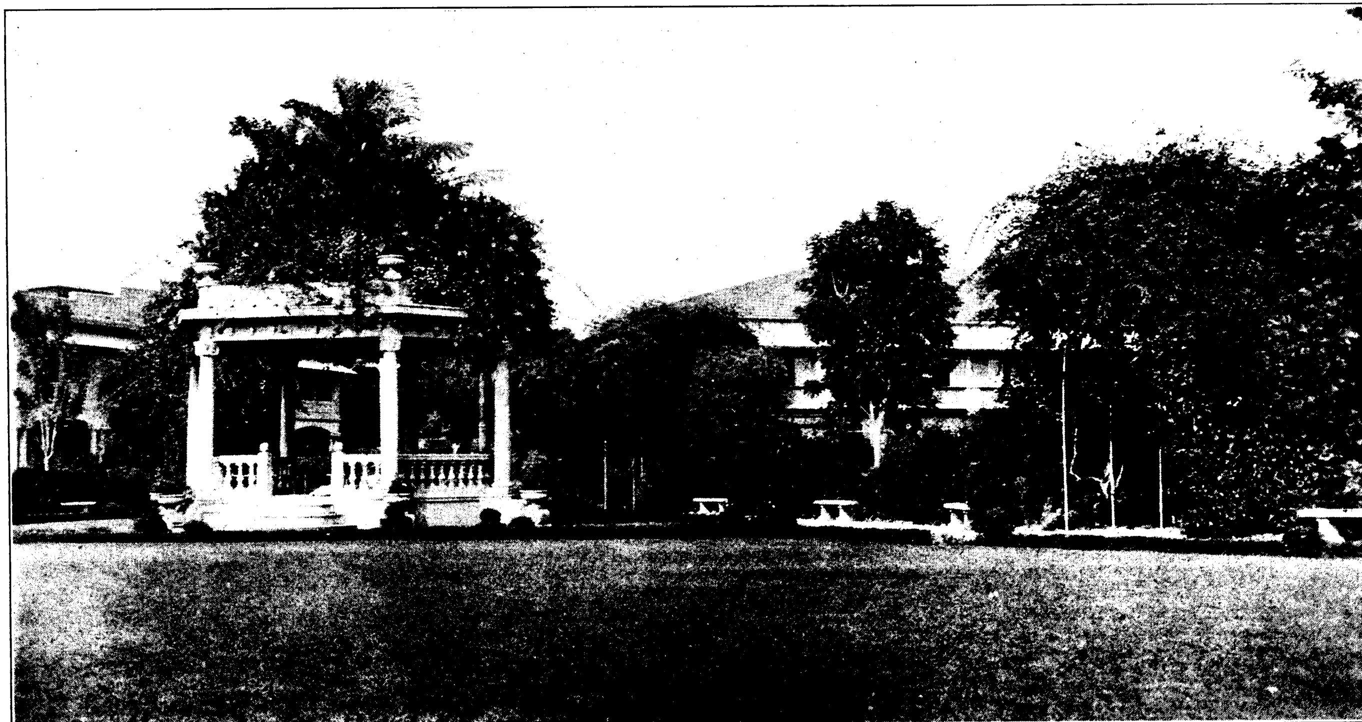
While it is true that, due to the mountainous character of the country, by far the greater part of Zamboanga Province is unadapted to agriculture, in other parts of the province the opportunities for agricultural development are exceptionally good. For the investor with big capital, who wishes to engage in the culture of coconuts, rubber, abacá or coffee, on Basilan there are large areas of excellent public land available for occupation within easier reach of the beaten path of travel than anywhere else in the Philippines.

Possessing deep water close to the shore and being well protected by the nearby island of Malamaui, Isabela, the capital of Basilan, has excellent advantages for development into a good harbor and shipping point, a fact long ago appreciated by the Spaniards who, in connection with the strongly constructed fort, since fallen into ruins, operated at Isabela a naval station and shipyard before the American occupation. At a more advanced stage in the development of the fertile Island of Basilan, Isabela will unquestionably grow into a lively trade center for Basilan and adjacent islands to the south and southwest, and her rubber, coffee, abacá and coconut oil be loaded direct on the ocean going steamers for export to America and Europe.

Probably too wet for coffee, the Margosatubig district is worthy of investigation by rubber, abacá and coconut planters. The large valley in Sindangan offers opportunities to the cattle rancher and possibly to the coconut planter.

Though the opportunities for exploitation by big capital are limited to Basilan, the Margosatubig district and Sindangan, the opportunities for settlement and investment by the small farmer desirous to take up a homestead or the small planter who contemplates the development of a plantation 50 to 200 hectares in extent are almost unlimited.

While coconuts, coffee and abacá are recommended for planting in the more remote regions, the city of Zamboanga would absorb very considerable quantities of vegetables, fruits and poultry products of all kinds which at present are very scarce and command a high price; and vegetable and poultry



View in municipal plaza, Zamboanga

Corner in municipal plaza, Zamboanga

farms should prove the source of a very comfortable income to the intelligent farmer in this locality. It is a remarkable fact that though pineapples, bananas, papayas, jaks, lanzones, citrus and many other fruits grow with the greatest luxuriance, that they are of good quality and the supply of these fruits is very limited and the prices are high, yet not one has taken advantage of these conditions to supply the demand. Citrus fruits of good quality are produced, yet oranges and lemons are imported from far away California and Australia.

The shipping facilities are not sufficiently good for the production of mangosteens for export from Dapitan and Dipolog, but Basilan has a soil, climate and location that would insure the success of a big mangosteen project with a view to supplying Zamboanga, Cebu, Iloilo, Leyte and even Manila with mangosteens, which cities now receive fitful shipments of this fruit from Saigon and Singapore, and while it is true that the mangosteens can be grown on the entire north and south coast of Mindanao from Zamboanga to Surigao and to Davao respectively in Laguna, in the Bicol provinces and in the moist Visayas, the Basilan mangosteen planter would in all probability have the entire Philippine mangosteen market to himself on the principle that it is always so much easier to buy than to grow mangosteens.

THE SULU ARCHIPELAGO: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

DESCRIPTION

The Sulu Archipelago (Plate XXI) is a group of islands located between 119° and 122° east longitude and between 4° and 7° north latitude, extending in a southwesterly direction from Basilan to Borneo, bounded by the Sulu Sea on the north and the Celebes Sea on the south and east. The entire length of the Archipelago is approximately 137 miles, and it includes about 130 fairly large islands, most of which are inhabited, and some 170 islets and reefs chiefly of geographical interest. The Sulu Archipelago has an estimated area of 1,030 square miles and a population of 156,212 inhabitants according to the census of 1919.

As in the other parts of the Philippines, all the larger islands in the Sulu Archipelago are of volcanic origin, and the location of these islands and the topography of the sea bottom suggests that once the Sulu Archipelago may have been the connecting link of a continent extending from Mindanao, the Visayas and Luzon in the northeast, to Borneo in the southwest.

The Sulu Archipelago is usually considered in two large groups, the Jolo group and the Tawitawi group. These two agglomerations are again divided into 13 small groups with principal islands as follows:

(1) The Samales group, lying east of Jolo, including among others the following inhabited islands: Tatalan, Bukutua, Bulan, Tonquil, Balanguingui, Simisa, Bangalao and Manuñgut.

(2) The Jolo group, including the Islands of Jolo, Kapual,

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[1] The writer gratefully acknowledges his indebtedness to Governor F. W. Carpenter of the Department of Mindanao and Sulu for access to the Provincial Annual Reports of Sulu, and to Col. Ole Waloe, Philippine Constabulary, who loaned him the Constabulary monographs on the Province of Sulu, in the course of the preparation of this article. The Constabulary monographs have been found to be of especial value and most of the specific information relative to the different islands has been obtained therefrom. The accompanying map was traced by Mr. C. N. Villanueva, from a chart furnished by the Coast and Geodetic Survey, Manila. Plates XXII and XXIII have been made from negatives owned by the Bureau of Science, Manila.

Oversized
Foldout

Bitinan, Tulayan, Gujangan, Bankungan, Morongos, Pangasinan, Hegad, Manis, Bubuan, Kabukan, Pantokunan and Sulade, all of which are inhabited. Jolo is the largest island in the Archipelago; and here Jolo, the provincial capital is located.

(3) The Pangutaran group, comprising the following inhabited islands: Pangutaran, Pandukan, Kulassein, Tubigan, Teomabal, North Ubian, Malikut, Tikul, Usada and Kunilan.

(4) The South Jolo group, including Patian, Lumbian, Damokan, Tambulian, Dongdong and Pata, which are inhabited.

(5) The Tapul group, which consists of Tapul, Lugus, Taluk, Paquia, Kabingaan, Tara, Laminusa, Siasi, Lapak, Manubul and Tapaan, all of which are inhabited.

(6) The Kinapusan group, including the following inhabited islands: Tabawan, Bintoulan, Kinapusan, Loran and South Ubian.

(7) The Tabuan group, comprising a number of little islands of which one, Tabuan, is inhabited.

(8) The Tawitawi group, including Tawitawi, Tandubas, Secubun, Latuan, Mantabuan, Banaran, Bilatan, Manukmanca, Simunul, Laa, Bongao, Papahag, and Sanga-Sanga, inhabited islands.

(9) The Sigboye group, of which the following islands are inhabited: Sigboye, Tambagaan and Tagao.

(10) The Tataan group, of which only Basun and Tinagta are inhabited.

(11) The Sibutu group, including Sibutu, Omapui, Sipankot, Tumindao and Sitanki, inhabited islands.

(12) The Pearl Bank group, of which Cap is the only inhabited island.

(13) Cagayan de Sulu group, of which Cagayan de Sulu, Taganak and Baguan are inhabited.

The majority of the smaller islands and reefs are coraline and the approach to many of these is very dangerous and difficult because of the shallow water and the narrow, tortuous channels between the reefs. The coral islands are all distinguished by the flat, low formation of the land and comparatively shallow, light sandy soil, whereas those of volcanic origin rise more or less abruptly out of the sea or, if they are of gentle slope, are characterized by mountains rising to a greater or less height.

Among the islands worthy of more than passing mention: Bakungan is a precipitous, densely wooded island about one mile long and half as wide, located about 11 miles east of Jolo. The inhabitants are occupied principally in fishing. The best anchorage is found on the south side of the island.

Bongao is a small, rocky island off Sanga-sanga, with good anchorage. The precipitous mountain of the same name is about 340 meters high and a striking landmark from a great distance. Farming and fishing are the principal occupations of the people. The town has a small dock approachable by a good-sized launch.

The little Island of Buan, located about midway of Tawitawi on the south side is difficult of access and can be approached only by small motor boats and vintas. It is mentioned because of its numerous springs from which water is obtained by the inhabitants on the neighboring islands. The principal occupations of the population are fishing and farming.

Cagayan de Sulu is about 8 miles long and 5 miles wide, and well elevated above the sea, culminating in a mountain 330 meters high. The island has two small, deep lakes near the south coast and many springs with excellent drinking water. The anchorage at the dock is very good. The island is very fertile and considerable copra is produced; cattle and edible bird nests are other export products.

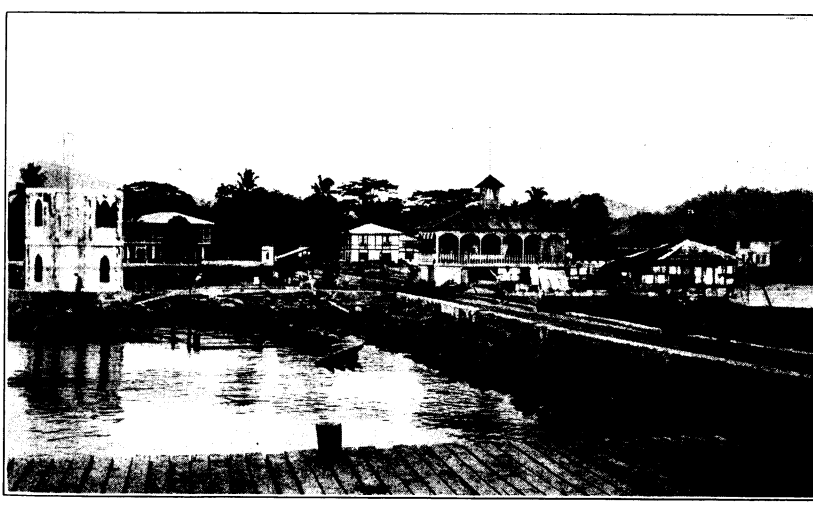
The Island of Jolo extends from east to west in its greatest dimensions. It is about 60 kilometers long and 23 kilometers broad at its greatest width, with a narrow neck in the middle approximately 6 kilometers wide, again widening at both ends of the island. There are several mountains of considerable height, for instance, Tumantangis, 870 meters high; Sinumaan, 730 meters; Dahu, 700 meters; and Bagsak, 680 meters, but the rise of the land is so gradual that the mountain sides are largely available for agricultural purposes. While by far the greater part of the forests were long ago cleared away there are still considerable areas in forest of which teak is the most valuable.

The landscape of Jolo is extremely pleasing, with its general configuration of a series of mountains and hills of gentle slope rising out of the sea, undulating hills and valleys, mostly cultivated, or overgrown with cogon and other grasses.

One of the outstanding features of the Jolo landscape are the striking bauno trees, *Mangifera caesia,* which dot the landscape everywhere. Especially conspicuous are these during the blossoming season in June and July, when the trees stand out against the solid green of the forest or on the plains like giant lilacs.

With its many mountains the rainful of Jolo is also quite abundant and the island is well watered by numerous streams,

(*a*) Old city gate to Jolo seen from the dock



(*b*) Jolo from the dock

of which the Palag and Bilaan "rivers" are the most important. They have several tributaries.

Port Tulayan, to the east of Jolo on the north coast, is the best harbor on the island and possibly may some day become of importance.

There are a number of small lakes in the craters of extinct volcanoes, of which Siit Lake and Crater Lake are the largest and best known. These are very deep.

Jolo, the provincial capital of the Sulu Archipelago, is located on a wide bay on the north side on the western end of the island. The city is connected with Zamboanga by cable, and has a local telephone system reaching out to several of the more important island villages.

The road system on Jolo is rather incomplete, though one may reach Maibung, Parang, Indanan and Camp Romandier by auto.

The *Islas Filipinas* calls from Manila and Zamboanga twice monthly and there are monthly steamers between Singapore, Sandakan, Borneo and Zamboanga which call at Jolo in passing that port each way. Various smaller craft maintain additional communication with Zamboanga and the Sulu island ports of Siasi, Bongao, Sitanki and Cagayan de Sulu, where there are small docks.

The foreign and domestic exports of Jolo are shown in the table below. These include most of the exports from the entire Archipelago.

TABLE I.—*Domestic and foreign exports from Jolo*

Article	1916	1917	1918
Abacá	606,354	1,031,896	1,301,109
Copra	164,494	728,169	[a] 900,000
Pearl shells	297,475	231,686	196,071
Railroad ties		34,534	105,000
Rice		17,027	103,864
Dried fish	47,871	102,974	85,452
Cloth	54,699	74,411	70,162
Shark fins	23,733	38,010	56,611
Cattle	60,492	56,655	39,388
Trepang	21,150	22,919	29,936
Sugar	4,389	33,484	29,159
Lumbang nuts			12,244
Tortoise shells	2,418	1,148	8,195
Hides	13,669	17,516	7,868
Sea horses	1,582	2,629	4,400
Beeswax	2,904	257	1,337
Almaciga	25,942	8,612	
Sponges	13,238		
Gutta-percha	3,607	2,012	
Gambier	1,634		
Tanbark	750		
Cinnamon	467		
Miscellaneous			
Total	1,592,082	2,675,420	3,217,203

[a] Estimate.

Laminusa is a small, low coral island about a mile long largely covered with mangroves. It has a good anchorage but poor water, and is mentioned chiefly because of its pearl and trepang fisheries. Excellent mats are made and exported from Laminusa.

Laparan is a low coral island some seven miles long, in the interior of which is a large lagoon about three miles long. The island has no water and is uninhabited.

Lapak is located across the narrow channel from Siasi and has good anchorage on the north and south coasts. The water, obtained partly from springs and partly from wells, is good. Farming and fishing are the principal occupations of the people. Some copra is exported. Lapak is nearly five miles long and three miles wide, with two mountains at the opposite ends of the island, the one in the north 300 and the one in the south 450 meters high, with a wide plain of good to excellent agricultural land in the middle, practically all uncultivated and overgrown with cogon. Attempts have been made by American planters to grow rubber and cassava on this island but all of them have failed.

Lugus is about four and a half miles long and three miles wide, with a good anchorage on the northern and the west coasts. The land formation is a series of fertile hills rising to one peak about 290 meters in height. There are two small lakes on the island but the drinking water is poor and brackish. The population subsists by farming and fishing, the island being quite well cultivated. Copra is the principal export article.

Mantabuan is a small, flat, quite populous island to the south of Tawitawi, with a good anchorage in the channel between it and Latuan island. The population is occupied principally in fishing. Some trepang and shells are exported.

The little Island of Manubul, located a little ways from Lapak to the southwest is one of the fishing centers of the Sulu Archipelago, exporting dried fish, shark fins and trepang. The anchorage is good but there is no drinking water on the island.

Manukmankau is a flat coral island about two miles wide and twice as long lying a little to the south of Simunul. The anchorage is poor. The drinking water is of fair quality and is obtained from a small pond in the center of the island. The people are occupied principally in farming, especially in growing a tobacco which by the Sulus is preferred to all other kinds. Some rattan mats and pottery are also made for export.

Pangutaran is a low, flat coral island some 10 miles long with good anchorage, but having very poor drinking water. Farming is the principal occupation of the inhabitants who export copra and cattle.

Panducan is a low coral island, some 6 miles long and about 2 miles wide, located about 23 miles northwest of Jolo. The people are occupied chiefly in farming. Copra, cattle and mats form the articles of exports. The anchorage is good on the south coast. The drinking water is very poor.

Pata is an almost circular island of volcanic origin about four and a half miles in diameter with a mountain in the center some 330 meters in height. Pata has a good anchorage and good drinking water from springs. The island is well elevated above the sea, the soil is fertile, and most of the land is under cultivation. Copra and cattle are exported.

Sangasanga is an island about 6 miles long located between Tawitawi and Bongao, the population of which are occupied chiefly in farming.

Secubun is a small, low flat coral island with poor and brackish water, the inhabitants of which support themselves by farming and fishing. Dried fish, trepang, pearl and tortoise shells and copra are exported from Secubun.

Sibutu is a long, narrow island some 16 miles long and perhaps 4 miles at its greatest width, lying southwest of Bongao and only about 25 miles from Borneo. The island is partly of volcanic origin, partly coralline. The people are occupied chiefly in farming and cattle raising though some dried fish and trepang are exported. The cutting of railroad ties is the principal industry.

Simunul is a flat rocky island south of Bongao about eight kilometers in diameter. There is no good anchorage off this island but the water is good, being obtained from springs in the center of the island. The exports are principally pearls, shells and trepang. Wild hogs are quite numerous and there are many wild carabaos descended from escaped domestic animals, most of the island being tilled. Chongos Bay on the southeast coast is a good harbor.

Siasi is an almost circular island of volcanic origin some 10 miles in diameter located 37 miles southwest of Jolo, and is the third most important island in the Sulu Archipelago. There is a gradual and even slope of the land from the sea to the top of Mount Gorra in the center, attaining a height of 400 meters. The soil is fertile and the land is largely cultivated up to the mountain top or overgrown with cogon. The town of Siasi has a good anchorage and is equipped with a water system. The water, which is excellent, is obtained from springs on the higher slopes of the island. The inhabitants are occupied chiefly by farming and fishing, and copra, abacá, cattle, dried fish, shark fins, trepang, pearls and shells form the export products.

There is a small ceara rubber and robusta coffee plantation in Siasi owned by an American corporation. Local industries include mats, pottery and shell bracelets.

Sitanki is a small island and seaport southwest of Bongao and west of the south end of Sibutu with a good anchorage, but all drinking water is obtained from Sibutu. Some dried fish, trepang, and shark fins are exported.

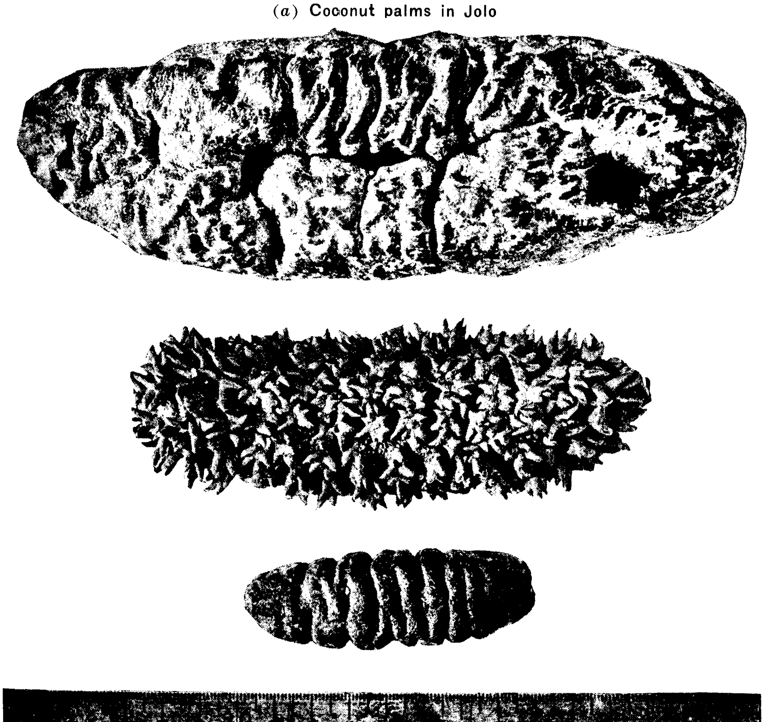
South Ubian is a small, low and flat coral island about 64 miles southwest of Jolo with a good anchorage, but having very poor, brackish water. South Ubian is one of the most thickly populated islands in the Archipelago and is well cultivated. Pearls and shells and trepang are exported from South Ubian.

Tandubas is a small island southeast of the east end of Tawitawi. Agriculturally the island is of no importance but it is quite populous, the inhabitants being occupied with fishing. Pearls and shells and trepang form the chief exports. The anchorage is good on the east coast of the island opposite the town of Ungas Matata. The drinking water is poor and brackish.

Tapul is an island of volcanic origin and with a good anchorage, located about 25 miles southwest of Jolo, the highest peak rising to an elevation of 500 meters. The island is nearly circular and about eight miles across, with springs in the interior that provide good drinking water. The greater part of the island is under cultivation and it is considered as one of the most prosperous in the Archipelago. Excellent mandarins are produced. The exports include coconuts, hemp, citrus fruits, pearls and shells, trepang and dried fish, and some cattle and horses.

Tawitawi is the second largest island in the Sulu Archipelago, being some 35 miles long and 13 miles broad at its greatest width. Unlike Jolo, Tapul, Siasi and Lugus, which are well adapted for agricultural purposes, the topography of Tawitawi is very broken, rough and mountainous with a range of mountains extending throughout its entire length of which several peaks rise at 300 meters or more, one, the Bihabiha, attaining a height of 580 meters. Several small rivers or, more correctly speaking, streams, find their way from the interior to the sea; of these

(*a*) Coconut palms in Jolo



(*b*) Trepang or Beche de Mer, one of the marine products of Jolo

the Dungun and Malum Rivers are the largest in the Sulu Archipelago. The anchorage on the north coast is good, which is also true on the south coast as far as the town of Balimbing. Drinking water is good and plentiful. Nearly the whole island is covered with dense forest which as yet is largely unexplored. Some railroad ties are being cut and shipped out of the island, but because of its mountainous character Tawitawi will never attain any importance agriculturally.

Tonquil is a narrow, crescent-shaped, flat coral island about 10 miles long located south of Basilan and east of Jolo, with a good anchorage but poor, brackish water. A large part of the island is covered by mangrove. The exports include dried fish, trepang, pearls, shells and copra.

To the traveler with a love and appreciation of scenic beauty, picturesque surroundings and a study of the primitive, simple life, sufficiently spiced with danger to render the experience more fascinating than an ordinary outing, a cruise through the Sulu Sea is certainly to be recommended.

To the visitor from the temperate zone who travels in the tropics for the first time, the Visayas and other islands to the north of Sulu seem entrancing enough; nor does the eye tire of beholding the wonderful beauty of these islands during successive voyages. But somehow, as one approaches the latitude of Zamboanga and turns soutwest towards the Sulu Archipelago, the sky seem bluer and the water more transparently clear, and the atmosphere breathes more of the fabled south seas of which we read in the tales of Stevenson and Marryat. As we pass by a short distance from the shore, there is the white, sandy beach glistening in the brilliant sunlight and the waves gently lapping the shore fringed with the inevitable, stately coconut palms waving indolently in the light breeze over the half decayed timber of a schooner wrecked in bygone days, that set one speculating on the fate of its crew. Part of the beach is occupied by the native village, the nipa houses built over the water and connected with the shore by a gangplank, the typical home of the Samal and the Badjao, or "sea gypsy," as the latter is called. Nor are the people themselves, with their reputation for piracy and smuggling, of less interest than their country, for all that at least the days of the pirate are now past history even in his part of the world. They are accomplished sailors and handle their vintas with great skill, and they are expert fishermen and pearl divers.

If the weather is pleasant, and it is rarely very rough, the cruise is especially enjoyable. The green clad islands rise like emeralds out of the sea on every side in varying sizes and shapes. Mostly wooded or low, of coral line formation, largely uninhabited. Or one lifts itself abruptly above the waves, a rock with scanty soil and scrubby vegetation. Again, the lighter hue of others indicates that the forest has given way to the cogon or the tilled field.

At Siasi the traveler, having passed Tapul and Lugus, on the way from Jolo to the southwest, arrives at a small dock from which extends a road the length of two city blocks which is crossed by another of the same length. Chinese stores wall in the sides of the first block and stretch down one side of the cross road to a ramshackle market built on a pier over the water. Little groups of Samal houses extend out over the water on each side of the town. Further down the channel that divides Siasi from Lapak the visitor sees a good sized village of houses standing on a reef in the water, more than a quarter of a mile from the land. Across on the island of Lapak he gets a good view of a wide stretch of cogon which appears almost like a great lawn surrounding the attracive, new buildings set in the center of it. These buildings belong to the Lapak agricultural school.

By the time the boat is made fast to the dock the townspeople have gathered to see who has come. There are naked brown children, many with Chinese features; there are Moros who happened to be in town trading; there are dirty Samals, and perhaps a Bajao or two with sunburnt hair falling to the shoulders. The Chinese merchants are out to see what cargoes the boat has brought. A Filipino with bare feet, carrying a shotgun, would, if asked why he was there, reply that he was a policeman and had come to receive the mail. A Constabulary lieutenant has come down from his quarters just beyond the old plaza. The lieutenant will conduct the visitor about the town and show him Siasi. This is not a long task, for there is nothing much to see. But there is plenty to smell. The outside walls of the tiendas are hanging with sharks' fins and tails and in the streets are square mats covered with trepang drying in the sun. These things are the source of the disagreeable odors, especially the shark fins, for there is plenty of flesh attached to the fin that must shrivel and rot away before this is ready for export. (Constabulary Monograph on Sulu Province by C. R. Livingstone.)

The visitor to Siasi should remain long enough to make a hike to the top of Mount Gorra, 500 meters high, in the center of the island, whence a better view of the central Sulu Archipelago with its vast number of islands and reefs may be had than from any other point.

Next to Jolo, Siasi is the most important trading center in Sulu. The anchorage is good and the channel between Lapak furnishes a reasonably safe harbor. The soil is fertile. Also, a large part of the island is under cultivation. At Tandubas one's attention is drawn to the gigantic coral vases standing in the sea, chiseled out by the waves, the tops crowned with shrubby vegetation.

The bottom of the sea with its innumerable coral forms in all the colors of the rainbow and its many starfish is a never ending source of admiration on the shallow reefs and channels. The fish themselves one does not see, of course, in the sea, but "least we forget" no visitor should fail to visit the Jolo fish market with its wonderful variety of fish in every imaginable color and hue.

CLIMATE

The climate of Sulu is mild without violent changes in temperature. The nights are always cool.

The rainfall is plentiful and equally distributed throughout the year. According to the Weather Bureau, whose observations extend from 1902, the mean annual and monthly rainfall is as follows:

	Millimeters.
January	89.1
February	122.4
March	85.2
April	118.2
May	160.2
June	203.3
July	172.0
August	170.4
September	184.4
October	222.9
November	193.0
December	144.8
Total	1,865.9

This rainfall corresponds to that of the seacoasts of the Island of Jolo. Further inland on the mountain slopes this precipitation is unquestionably considerably augmented. While the rainfall on Tawitawi probably closely corresponds to that in Jolo, on the remaining islands scattered over the sea, with no mountains of considerable height, it is much less, possibly averaging not more than about 800 or 900 millimeters annually.

POPULATION

The population of Sulu, numbering 156,212 souls, is greater than that of any province in the Department of Mindanao and Sulu, though in area it is smaller.

Tribally the population may be divided into three groups. The Sulus are the most advanced of the native inhabitants, who, before the advent of the Spaniard and American, were the ruling people of Jolo. The Sulus constitute the agricultural population of the Archipelago and from them are largely recruited the labor employed in cutting railroad ties, the one industry in Sulu in which Americans are engaged. They are also engaged in fishing and pearling.

The Samals are, together with the Bajaos, in the majority on the smaller islands and on the coasts of Jolo. Both make their living from the sea, and while the Samals are somewhat more advanced in civilization than the Bajaos, there is really very little difference between the two tribes. The agriculture engaged in by the Samals is of the crudest form, while the Bajaos prefer the sea altogether. The Filipinos in Sulu are very few and of the white race there are still fewer representatives. The Chinese trader in Jolo, Siasi, Bongao and Sitanki one may not escape any more than in any other trade center in the Philippines. He is the almost indispensable link between the farmer and fisherman and the export houses in the centers of trade in the Philippines.

HISTORICAL REVIEW

The authentic history of Sulu begins about 1380, when the first Arabian missionary is believed to have arrived. He built the first mosque, the ruins of which are still standing in Sulu on the island of Simunul. Some 10 years later the Raja Baginda arrived from Sumatra. Few people are aware that he brought with him a pair of elephants which were liberated in Jolo and became the parents of a herd of wild elephants which unfortunately were exterminated long ago.

The coming of the Spaniards in 1578 marked the advent of the Caucasian in Sulu, though the suzerainty of Spain was merely nominal for many years. Several expeditions were dispatched by them to Sulu from time to time, some successful as raids, others ending in disaster and defeat inflicted by the Moros. Not until 1851 did the Spaniards permanently occupy Jolo, and even then their authority was never completely established even in Jolo over the entire island and their authority in the outlying islands was merely nominal, and maintained by garrisons at Siasi and Bongao, and in Tataan on the north coast of Tawitawi. In 1899 Jolo was occupied by the Americans. The military régime continued in force until 1914, when civil government was established and the Sulu Archipelago was incorporated into a province in the Department of Mindanao and Sulu.

AGRICULTURAL INDUSTRIES AND FOOD CROPS

The agricultural practices in Sulu do not differ materially from those in the other regions in the Philippines, and production per unit area could be greatly increased by more modern methods of culture.

Abacá, the principal product of Sulu, is grown chiefly on the island of Jolo; the quantity of fiber produced on the other islands is negligible. Soil and climate both are well adapted to abacá over a large area of Jolo island and the area planted could be increased very considerably, especially in the interior. However, the extension of the abacá plantations may well be left to take care of itself. The more urgent measures are the education of the Moro farmer in the need of more thorough preparation of the land before planting, better cultivation and instructions in stripping and grading of the fiber.

Copra constitutes the second largest export article of Sulu but it will unquestionably supersede abacá within the next few years. Most of the copra is probably produced on Jolo island though there are few inhabited islands where coconuts have not been planted. On the outlying islands the largest number of coconut trees are found on Tonquil, Pangutaran, Bangalao and South Ubian. However, the nuts, are, to a great extent, consumed as food in the localities where they are grown. In systematic planting and care of his trees the Moro appears to be behind the Filipino planter in the Visayas and Luzon, in fact, it is doubtful whether there are any, even small plantations, regularly spaced or otherwise properly cared for, and there is a crying need for farm advisers to set the people right in these respects. This is equally true in regard to control measures for beetles and weevils. To no other crop are the numerous coral islands so well adapted as to coconuts and too much could not be done to encourage the extension of coconut plantations on these islands.

Cattle raising is another industry that goes well in hand with coconuts on the larger islands where good water is available. It is especially worthy of attention considering the isolation of the islands and the ease with which diseases can be kept out of this region.

From the export figures quoted on another page, it might be inferred that rice beyond the needs of the population was produced, whereas the rice imports rose to ₱900,000 worth in 1918. Several varieties of upland and lowland rice are grown, upland rice predominating. Most of the rice is grown in Jolo.

In 1918, there were 20 small sugar mills in operation in Jolo but these of course were all of a very primitive type and the quantity of sugar produced was insignificant. Considering how well adapted to coconuts, coffee, rubber and abacá Jolo Island is, and how well occupied the land in small holdings by the present population, there does not appear to be much room for a sugar industry and it is probable that land now planted to sugar cane could be far more profitably occupied by other crops.

Corn is not of especially great importance as a food crop in Sulu. Cassava is very extensively grown, there being possibly a greater area planted to cassava than to any other single crop. Camotes, ubi and gabi are also grown to some extent. Other crops of less importance are borona, sesame and adlay.

The more popular vegetables include patani, squash, patolas, pepinos, tomatoes, watermelons, chili, and kankong. Sago is made from the sago palm.

FRUITS

Jolo is noted for its many fruits, and the climate and soil are very favorable for fruit culture. Mangosteens, baunos, marangs, huanis, durians and rambutans, unobtainable nearly everywhere else in the Philippines, are abundant in Jolo, in addition to many other fruits, such as the lanzon, bulala, papaya, banana, jak, etc.

The bauno, huani and marang have hitherto been considered indigenous species but it is a question if this is not a mere assumption and if all these species were not in reality introductions made by the Sulus many years ago. In any event there is a legend among the Joloanos that once a Radja, Ahmat Ansang, sailed to the country of the Malays and brought back seeds of the "Wannih, Mampalam, Baonoh and Marrang." Another time a certain Bandikal Alam sailed to Brunei, Borneo, and brought back the "Doyan, Tomusan and Mangis." However this may be, certain it is that these trees do not grow in any part of the Philippines beyond where Moro influence has exerted itself, the Tomusan, *Nephelium mutabile,* excepted. It is true that the marang was described from Mindoro, but this island was a frequent rendezvous of the Moro in the early history of the Philippines and the introduction of the marang into this island might well have been made from fruits brought along as provisions by the Moro pirates.

The mango produced in Jolo, Zamboanga, Cotabato, Lanao and Davao is very different from those found in the islands further north and here at least there can be no question but that the original introduction was from an altogether different source than that whence came the carabao, pico and pahutan mango of Luzon and the Visayas. It calls to mind the inferior mangoes one sees in the markets of Singapore.

The huani is to all practical purposes a large, green mango with long, coarse fibers and a strong flavor of turpentine, and while ordinarily one would not care for this fruit, those who live in Jolo once having acquired a taste for the huani become very fond of it and some even profess to prefer it to the carabao mangoes of Cavite. There is a yellow-fruited form of huani in Jolo called "sangay."

The mangosteen is a fruit the taste of which no one needs to acquire; it is a favorite from the first bite. The Jolo mangosteen is rather larger than those of Singapore and Saigon, and has a thicker rind. The flesh is more acid and has more character than the milder flavored fruit of the Malay peninsula and Java. The seeds are larger. In Jolo an unexcelled preserve is made by boiling the flesh and seeds of the mangosteen in brown sugar, the seeds adding greatly to the excellence of the preserve by their nutty flavor.

The bauno is one of the most common fruits in Jolo and while its odor is almost offensive and the flesh quite fibrous, a liking for this fruit is very readily acquired and usually one becomes very fond of it after a few trials.

The marang at first offends by its too overpowering aroma, but one needs but eat one or two of these richly flavored, sweet fruits to like them. To be at its best the marang should be neither under or over ripe as in either event it is of but indifferent eating quality.

The lanzons are one of the common fruits in Jolo and there is one variety called viradali that is eggshaped and much larger than the lanzons ordinarily grown elsewhere in the Philippines.

Durians are abundant and occur in a number of forms, some markedly less malodorous than the ordinary durian.

On the island of Tapul excellent mandarins are grown and shipped to Jolo. They ripen in June. In Parangan, on the island of Samamput, mandarin trees of unusual vigor and size have been noted which were said to yield fruit of excellent quality. The limes in Jolo are very juicy and of excellent quality, and good pomelos are likewise reported to be grown. Moreover, the citrus fruits in Jolo are all, so far as observed, entirely free from serious diseases and insect pests such as occur in so many other parts of the Philippine Islands.

Rambutans are quite abundant but are not equal to the best kinds in Java and Singapore. Various other unidentified species of *Nephelium* and *Euphoria* have also been noted.

One of the more interesting finds during a visit to Sulu in 1918 was a clump of Kinubo, *Rubus moluccanus* L., growing at sea-level in Tataan, Tawitawi, while several fine specimens of *Mimusops kauki* L. were found growing in Tandubas, in all probability introduced, since this species has never been reported elsewhere in the Philippines.

The following is a list of the food plants of Sulu as noted by the writer during a visit in the Archipelago in 1918 but this list could probably be lengthened.

RICE VARIETIES

Allalbimbang	u-ng-w	Katumbal-palauan	l-c
Amas	u-c	Kohapu	l-w
Anakpay	u-ng-w	Landi	u-w
Bagonansakit	u-ng-c	Langsay	u-c
Baki	u- and l-c	Malandi	u- and l-ng-w
Balayang	l-ng-w	Maya	u-c
Bikin	u- and l-c and w	Mokol	u-ng-w and c
Gomonanya	u-w	Potan	u- and l-ng-w
Guyod	u- and l-w and c	Pulapula	u-ng-c
Hundongan-mano	u and l-w and c	Taaran	l-c
Kaboong	u-w	Tinkoantunan	u-w
Kalino	u-ng-c	Tinkutanag	u-ng-c
Kamanyan	u-w	Tudloandatu	u-w
Katumbal	l-c		

CORN VARIETIES

Dali.	Kasumba.	Lugay.

SUGAR CANE VARIETIES

Itom.	Malapon.	Pute.
Kallit.	Patong.	Sambolauan.
Laba.		Uba-uba.

CAMOTE VARIETIES

Bujang.	Saluping.	Simonol.
	Sallat.	

GABI VARIETIES

Hopi.	Kari.	Sibuku.

UBI VARIETIES

Mampay.

CASSAVA VARIETIES

Bulus.	Itom-itom.	Nito-nito.
Dali.	Kaumpang.	Pula.
Europa.	Kapok.	Sagangankeat.
Honkong-dahon.	Lagguay.	Taluk.
	Mangamid.	

BANANA VARIETIES

Amuna.	Pootan.	Tindok.
Bata-bata.	Panyaal.	Timbokan.
Duka.	Saba-manolo.	Tadiao-tumbaga.
Hinogon.	Sulay-badyo.	Tangong.
Manorong.	Sinangil.	Tadiao-lobo.
Panayaual.	Tudlok.	Tadiao-lahi.

COCONUT VARIETIES

Bulan.
Impug-impug.
Kapal-kapal.
Katabagan.
Kayomamis.
Mamis.
Timaal.

FRUITS, NATIVE AND CULTIVATED

Banana, *Musa paradisiaca* L.
Banauak, *Uvaria rufa* Bl.
Bangár, *Sterculia foetida* L.
Bauno, *Mangifera caesia* Jack.
Breadfruit, *Artocarpus communis* L.
Bulala, *Nephelium mutabile* Bl.
Bunag, *Garcinia benthami* Perr.
Carambola, *Averrhoa carambola* L.
Cashew, *Anacardium occidentale* L.
Chico, *Achras zapota* L.
Ciruela, *Spondias purpurea* L.
Citron, *Citrus medica* L.
Coffee, Arabian, *Coffea arabica* L.
Custardapple, *Annona reticulata* L.
Dalayap, *Citrus aurantifolia* var. *aromatica* West.
Date, *Phoenix dactylifera* L.
Dauag, *Capparis micracantha* DC.
Dendé, *Elaeis guineensis* Jacq.
Durian, *Durio zibethinus* L.
Grape-Vinifera, *Vitis vinifera* L.
Guanábano, *Annona muricata* L.
Guava, *Psidium guajava* L.
Huani, *Mangifera odorata* Griff.
Kalayo, *Erioglossum edule* Bl.
Kamanchile, *Pithecolobium dulce* Bth.
Kami, *Cinnamomum mindanaense* Elm.
Kamia, *Averrhoa bilimbi* L.
Kayam, *Inocarpus edulis* Forst.
Kinubo, *Rubus moluccanus* L.
Lanzon, *Lansium domesticum* Jack.
Lemon, *Citrus limonia* Osb.
Lilikoi, *Passiflora edulis* Sims.
Lime, *Citrus aurantifolia* Swg.
Limoncito, *Triphasia trifolia* P. Wils.
Lingaro, *Eleagnus philippinense* Perr.
Mabolo, *Diospyros discolor* Willd.
Mandarin, *Citrus nobilis* Lour.
Mango, *Mangifera indica* L.
Mangosteen, *Garcinia mangostana* L.
Marang, *Artocarpus odoratissima* Blanco.
Mulberry, *Morus alba* L.
Orange, *Citrus sinensis* Osb.
Papaya, *Carica papaya* L.
Pineapple, *Ananas sativus* Schult.
Pomegranate, *Punica granatum* L.
Pomelo, *Citrus maxima* Merr.
Rambutan, *Nephelium lappaceum* L.
Sandia, *Citrullus vulgaris* Schrad.
Santol, *Sandoricum koetjape* Merr.
Sugarapple, *Annona squamosa* L.
Tamarind, *Tamarindus indica* L.
Tersana, *Eugenia malaccensis* L.
Yambo, *Caryophyllus jambos* Stokes.

This list does not include the large number of species introduced into Jolo through the provincial nursery, beginning in 1917.

FOREST AND FOREST PRODUCTS

At present there is only one sawmill in operation in Sulu; it is located in Jolo.

Properly developed the forest products of Sulu should become a very important source of revenue. Public commercial forests are located on Tawitawi, Sibutu, Sangasanga, Simunul, Manukmankau, Lintian, Tandubatu, Basbas, Tata, Ampoy and Tabulunga. These forests contain much the same timbers as the forests in other parts of the islands, both hard and soft wood, such as: Ipil, *Intsia bijuga, Pahudia rhomboida* and *Adenanthera intermedia;* Yakal, *Hopea* spp., *Isoptera borneensis,* and *Shorea balangeran;* Calantas, *Toona calantas* and *Azadirachta integrifoliola;* Lumbayao, *Tarrietia javanica;* Guijo, *Shorea guiso;* Narra, *Pterocarpus indicus;* and Molave, *Vitex parviflora* and *V. pubescens.*

The only commercial teak forest in the Philippines is located in Jolo, being some 2,500 hectares in area. This is now being logged by the province on a small scale. The most important forest product is railroad ties. Almaciga formerly was collected in considerable quantities but production dropped off to a negligible quantity during the past year. Gutta-percha and gambier have never been collected in appreciable quantities. Some tanbark is obtained and this is an industry that could be increased very considerably. Some lumbang nuts are collected and exported. The Archipelago produces a small quantity of cinnamon. These minor products will never attain much importance, but lumbering, the cutting of railway ties and the collection of tanbark are capable of development into industries of considerable magnitude.

MINING

There are no mining operations in progress anywhere, though manganese has been discovered on various islands and gold has been found in Jolo. Oil has been reported from Siasi but no attempt has been made to make borings. It is quite possible that the manganese deposits are large enough to be worth investigating considering that, according to analyses made by the Bureau of Science, the ore contains 62 per cent pure manganese.

MARINE INDUSTRIES

Pearls, pearl shells, tortoise shells, fresh and dried fish, trepang, and shark fins constitute the marine products of Sulu. Of these the fresh fish is the most important, and dried fish is one of the major exports. The fishing grounds are very rich in fish; so rich indeed, that the possibilities of establishing canneries are worth looking into. The fish drying industry has had a remarkable growth. It is, in fact, a new industry, for in 1915 the dried fish exported were valued at but ₱6,094, and it is capable of still further expansion.

The shark fin industry has been of steady growth, but no effort has been made to make oil from the shark livers and guano from the sharks themselves. Diving and fishing for pearls and shells is one of the most important industries in the Sulu Archipelago which produces most of the shells and pearls for export from the Philippines. Moros as well as Japanese and Chinese are engaged in this work.

There are many sponge beds in the Sulu Archipelago and several attempts have been made to engage in sponge fishing, which, however, has been abandoned within the last three years. The sponges are reputed to be of good quality. Failure to cure them properly is said to have caused their arrival in the United States in bad order.

Trepang fishing could undoubtedly be engaged in on a far greater scale than at present, which is probably also true of tortoise catching. It is of interest to know that young tortoises are frequently caught and kept in captivity for several years before they are killed. One of the curious sea products of Sulu is the so-called "sea horse," a small animal with head and neck like a miniature horse, which is dried and exported to China because of its supposed medical value.

PROSPECTIVE INDUSTRIES

With few exceptions the development of the industries of the Sulu Archipelago would appear to lie in the hands of the present inhabitants, and opportunities for investment by big capital are not many. There is unquestionably much timber, especially in Tawitawi, but the broken topography of that island would probably make transportation of logs from the interior to the sea more difficult and expensive than in other parts of the Philippines. Railroad ties can be brought out more readily, and this industry may be expected to expand during the next few years. Considerable teak may be expected in the market from the government reservation but owing to the small area of this forest no very great output can be anticipated for more than a short period. Whether the pearl beds are so extensive that a larger pearling fleet could find profitable work is doubtful. On the other hand it would appear that a well organized sponging outfit, prepared to properly care for the harvested material and place it on the market would be profitable. The value of the pearl and sponge fisheries might be greatly enhanced by the judicious planting of new beds.

As the shark fin industry grows there would appear to be room for a small guano factory to take care of the shark meat and to prepare the oil from the livers that is practically a total loss at present. It is not generally known that shark liver oil is very similar to, and can be used for all the purposes for which cod-liver oil serves.

Broadly speaking, the great agricultural export crops of Sulu will always be copra or coconut oil and abacá. The plantations will be small and probably always remain in the hands of the Moros. There is not sufficient public land available at any one point to induce the American and European with his heavy overhead expenses to engage in coconut growing in this part of the world, considering how much more favorable for plantation ventures all conditions are in Mindanao and Basilan. The same is, of course, true of Para rubber. Coffee is well adapted to native culture and on Jolo there are numerous streams that could be utilized in preparing the coffee, so that there is no reason why, with the adoption of a more diversified system of farming by the Moros, coffee should not become a crop of some importance. In some sections there is excellent tobacco land.

Much land within a radius of eight kilometers of Jolo that is too shallow for other crops could to advantage be planted to pineapples, and a cannery in Jolo would be at the same time within easy reach of the plantation and of the wharf, and it might in part be employed for canning fish.

In fine, a region of unsurpassed scenic beauty and romantic interest, inhabited by a virile race of picturesque, interesting people, the Sulu Archipelago, with an older authentic history than any other part of the Philippines, is of unusual interest to the traveler and tourist. Already quite densely populated, Sulu offers but little inducement to the investment of big capital, especially along agricultural lines, and apparently is destined to be developed chiefly by her sturdy native inhabitants.

PAST AND PRESENT STATUS OF THE PHILIPPINE TOBACCO INDUSTRY

By DOMINGO B. PAGUIRIGAN, *Former Senior Tobacco Inspector,* Bureau of Internal Revenue

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Tobacco was introduced into the Philippines during the last quarter of the sixteenth century by Spanish missionaries coming from Mexico, shortly after the establishment of Spanish sovereignty. The production of tobacco, however, did not become a real industry until 1781, when the Spanish government enforced its exclusive rights to traffic in the product and when the production and sale of the commodity were formally made a state monopoly. This monopoly lasted throughout the hundred years from 1783 to 1883. Under Government control every detail of the industry, from the preparation of the seedbeds to the marketing of the leaf or its products, was strictly supervised by qualified officials. In the field, there was a chief appraiser, styled "interventor," residing at the provincial capital, who had forces of subordinates known as "alumnos aforadores." These officials were further administratively aided by the municipal "caudillo" (headman) who was also the "gobernadorcillo" (little governor) and his "tenientes" (lieutenants or overseers). Penalties were inflicted upon growers who failed to observe the instructions or orders issued by the Government.

The crop produced by a grower was limited by the Government according to the size of his family and cured only in especially built drying sheds. The product therefore gained an enviable reputation for quality. But hard and strict as the measures regulating the growing and curing of tobacco were at that time, the natives, soldier-like, soon became accustomed to the discipline. As a proof of this fact, later on, when it was rumored that the system was to be abolished, most of the native growers energetically opposed its discontinuance to such an extent that even the friars advocated their cause. Only the scandalous abuses and the graft which generally prevailed among the subordinate officials finally lead to the absolute abolishment of the system.

During the existence of the tobacco monopoly, it was the chief source of income to the Government and even in its irregular last year, it yielded enough to cover about fifty per cent of the total budget of expenditures.

Contrary to expectation, once the force which had compelled the growers to follow fixed regulations was withdrawn, the methods of production gradually went from bad to worse. The planters ignored quality for quantity and the general results were that good practices were more or less neglected. However, the planters should not be too much blamed for because the prevailing method of buying tobacco even today is based chiefly on weight—the standard being the Spanish quintal which is equivalent to forty-six kilos. Competition is so keen among the buyers that they do not take the proper time to examine the quality of the crop but simply offer a price for each lot as a whole.

In 1909 when the United States Congress passed the Payne Bill, which includes a provision admitting Philippine tobacco into the United States free of duty, contrary to the belief that such a privilege would help restore the value of our tobacco, the situation became still worse.

The causes of failure of Philippine tobacco in the United States proved to be such as proper pre-acquaintance of American business ways could have easily prevented. The farmers were allowed to grow their tobacco as they pleased. Leaves from the provinces come to the factories in Manila in awful mixtures and on account of rush orders from America the leaves were used without being thoroughly sorted. One of the inevitable results following such practices was that the identity of the cigar brands became lost. A brand cannot be identified unless it is made of the same color and grade of leaf or leaves, so that the flavor will be uniform and peculiarly distinguishable from other makes.

On account of the extremely big orders, which Manila manufacturers were not used to, the same error committed by the growers in producing for quantity instead for quality also prevailed among factories in the manufacture of cigars. Barely trained apprentice cigar makers were employed in the manufacture of export cigars. The factories were kept working even nights. Colors cannot be easily distinguished in their true shades at night.

Local manufacturers did not realize that they were dealing with shrewd American business men. Neither did they realize that the production and manufacture of tobacco is also one of the greatest American industries. American tobacco journals published incessantly defamatory articles to the effect that our factories were the filthiest and the operators were diseased in one way or another. No attempt was made to distribute Philippine cigars uniformly throughout the United States. It si really no air castle building to suppose that out of every thousand smokers over there it is possible to find at least twenty who either already like the mild aroma of Philippine tobacco or who would learn to like it had they but a chance to get the cigars. Our manufacturers just turned loose their cigars. They did not stop to think that the majority of those who formed the vanguard of American importers were really the most determined enemies of Philippine tobacco. The best Manila cigars were sold at a nickel each. In most cases, Manila cigars were sold cheap and even at a loss simply to hypnotize the American public smoker into the belief that Manila cigars are of cheap stuff. "An unwary reporter of the 'Tobacco Leaf' one day remarked that 'one half million backed Manila Perfectos were sold at a nickel apiece in the Flatiron Building in a couple of hours' and also remarked that twice the number could have been sold in the same time at twice the price." Smaller importers of good faith not being able to stand against cut prices of the powerful importers had to cease handling Manila cigars. Another peculiar fact that contributed to the failure of Manila cigars immediately following the passing of the Payne Tariff Law was the inability of Manila manufacturers to supply the American public with large stocks. These resulted in daring falsification on the part of fraudulent American jobbers. Cheap and low grade American cigars were labeled as "best Manilas" after the stock of Manilas had become exhausted.

The Insular Government, seeing the deplorable condition of the trade after six years of "cutthroat competition," enacted a law in February 1916, "to improve the methods of production and the quality of tobacco in the Philippines and to develop the export trade therein." This law "proved to be of inestimable value to the development of the Philippine tobacco trade, by establishing a system of inspection for leaf and manufactured tobacco and at the same time carrying on an advertising campaign intended to bring home to the American importer the good quality of Phillippine tobacco."

To quote from a former publication issued by the Bureau of Internal Revenue:

For the purpose of furthering the advertising campaign, it has been found practicable and necessary to entrust this work to the hands of Mr.

C. A. Bond, who is well known to the tobacco trade and who has had experience in the Philippines, having been at one time a newspaperman in Manila, by engaging his services as Philippine tobacco agent pursuant to the provisions of Act 2613. Since the passage of that Act, the trade has progressed apace, the exportation to the United States rising gradually from 114,006,746 cigars in 1916 to 216,124,310 in 1917 and 264,871,253 in 1918. This increase is a happy omen that the Manila cigar trade is gaining popularity in the United States market.

Prior to 1916, the amount of Philippine leaf tobacco exported to the United States was negligible. During the year 1916, the export of leaf tobacco to the United States increased to almost twelve times the amount exported during 1915, and more than twenty times the amount exported during 1914. In 1918, leaf exportations to the United States reached 2,957,264 kilos, an amount representing a decrease in comparison with 3,283,264 kilos exported during the previous year. The greater number of cigars exported and the limited quantity of the 1916 and 1917 crops are responsible for this condition.

The actual exportation of Philippine leaf tobacco to the United States for the last five years was as follows:

	Kilos.
1914	20,683
1915	39,637
1916	633,771
1917	3,283,607
1918	2,957,264

The European War contributed to the increased demand for Manila cigars on account of the large supplies of tobacco products sent to Europe and because of the fact that a large number of hands formerly engaged in the tobacco factories in the United States had to be diverted to war activities. The cigar that has appealed most to the American smoking public is the five-cent Manila.

During the year, several complaints have been received that musty cigars were arriving in the United States, and in most cases the blame has been placed on both the manufacturer and the Government. Act 2613, although guaranteeing the tobacco products exported to the United States, sets limitations on this guarantee. The motives behind these complaints, however, need investigation considering the fact that in spite of them the average price per thousand paid for Manila cigars in 1918 was ₱43.68, as compared with ₱38.25 paid in 1917.

Through the Bureau of Agriculture the Government is determined to procure greater production and higher quality of tobacco. Curing under proper methods is required by law. A five-year testing project has been undertaken in Isabela Province, with the following aims in view:

1. Isolation by selection of the highest grade strains from local varieties.
2. To obtain by constant testing, strains of the highest hereditary value.
3. Distribution of selected seed.
4. Production of standard wrapper tobacco by—
   a. Seed selection.
   b. Cultural methods.
   c. Hybridization.
   d. Acclimatization of foreign wrapper tobacco.

5. Constant testing of wrapper strains.
6. Study and control of tobacco pests.
7. Curing experiments.
8. Miscellaneous experiments.
9. Extension work with the coöperation of the tobacco inspectors on behalf of wrapper tobacco production.

While the work at the Tobacco Experiment Station is progressing, the farmers are being instructed and expert seed selection and other approved cultural methods are being demonstrated to them by especially qualified Government tobacco inspectors. As the results of investigations and the propaganda campaign being undertaken by the Bureau of Agriculture, Nueva Vizcaya, a province heretofore growing hardly any tobacco, was found to possess soils and a climate similar to those of Isabela and consequently was induced to grow tobacco on a large scale, so that now it is one of the only three provinces in the Islands that produces the tobacco from which standard brands of cigars are exclusively made. It is expected that other regions suitable for the growing of superior tobacco will soon be located. The Government, although tobacco is grown practically in every region of the Philippines, is determined to limit the manufacture of standard cigars to those from leaves produced only in regions peculiarly suited for the production of cigar tobacco. The Cagayan Valley is the Vuelta Abajo of the Philippines. As an infallible evidence of the justice of this claim, is the fact that the present product is so good as to be considered unsurpassed by many in spite of prevailing haphazard methods.

The standard Manila smoke guaranteed by the Government is noted for its mild, free-burning and aromatic quality. The naturally agreeable flavor of Philippine tobacco makes the employment of chemists in the Manila tobacco factories unnecessary. In America, thousands and thousands of smokers now believe that 'Manila cigars are selling on their merits and not on their prices.' The Philippine Government affixes to each box of Manila cigars sent to United States an official inspection label certifying that the cigars are made by the Spanish hand process, packed under modern sanitary conditions, under the supervision of competent Government officials, and that upon arrival in the United States every box of 'Manilas' is in proper condition.

There are splendid opportunities for the investment of capital in tobacco growing in the Philippine Islands. The Cagayan Valley, which is the region where the finest tobacco is grown, is unequaled for its natural advantages. This valley lies between two mountain ranges situated in the northern part of the island of Luzon, and contains a tobacco belt about 150 miles long and varying in width up to 10 miles. The valley is inundated annually to a depth of from 5 to 40 feet, and there is a consequent annual deposit of silt amounting to several inches in thickness. Under these conditions, artificial fertilizers are unnecessary and so unknown in the district. Many thousands of acres of choice tobacco land are lying idle and unoccupied on the banks of this 'Nile of the Philippines.' These lands are a part of the public domain, and are open to occupancy under the homestead law or by purchase. By purchase the price would be about $2 per acre, and this nominal price may be paid in installments, a total period of five years being allowed for its completion. Corporations are limited to 2,500 acres of this land. Outside of some ten or twelve large plantations, practically the entire tobacco crop in the Cagayan Valley is grown by the 28,000 small planters having holdings of 3 or 4 acres. Labor in the valley is scarce, but the Government is ready to aid them through its established agencies in securing laborers from the thickly populated districts on a contract basis. If the owner of a large plantation will look out properly for the social and hygienic welfare of his laborers and treat them with absolute fairness in their business relations, a loyal and intelligent force can be trained in the proper methods of cultivation in a short time. Experiments with proper methods have shown an increased yield of such superior quality that it is certain that if some of the attention and care which is bestowed upon leaf tobacco in other countries where to be bestowed upon Philippine leaf, the Cagayan Valley could produce cigar filler the equal of Havana in popular estimation, and wrapper leaf the equal of the famous Sumatra. Today there is hardly sufficient leaf of the needed quality for the local markets. In 1916 the 10,000,000 Filipinos who inhabit this Archipelago smoked some 80,500,000 tax-paid cigars, and 4,135,000,000 cigarettes. Every year since 1904, when the Internal Revenue Law, took effect, the consumption has increased by leaps and bounds. Not only is there the ever-growing domestic market to be considered; there is the European market, which in the past has been a steady purchaser of large quantities of leaf, and in spite of the war has absorbed a quantity only slightly less than before the war. Now that peace has come, a substantial increase in the European demand is to be reasonably expected.

The annual production of tobacco is given below from figures prepared by the Division of Farm Statistics of the Bureau of Agriculture:

	Area cultivated.	Quantity produced.
	Acres.	*Pounds.*
1912	140,948	65,219,646
1913	170,477	101,545,657
1914	150,459	102,809,218
1915	131,809	84,264,780
1916	144,574	90,506,183
1917	152,549	107,642,966
1918	193,832	135,421,708

YAM CULTURE

By F. G. GALANG, *Assistant Horticulturist*, Bureau of Agriculture

Until lately the numerous root crops in the Philippines were not considered to be regular field crops, nor planted for that purpose though many of them produce valuable human foods, and some have value as condiments and medicines, as, for example the gabi, *Colocacia esculenta;* apulid, *Eleocharis tuberosa;* cassava, *Manihot utilissima;* arrowroot, *Maranta arundinacea;* ginger, *Zingiber officinale;* yautia *Xanthosoma sagittifolium;* sweet potato, *Ipomoea batatas;* and the yams, *Dioscoreceae,* which family comprises 150 species or more. About 15 of these species are found in the Philippines according to Merrill, in his "Flora of Manila."

Yams have long been grown on a small scale in many parts of the Islands for home consumption. Yet in few localities, if in any at all, has it been realized that yams could with advantage be substituted for rice and potatoes. Yams are so far used only by the mountain people as a rice substitute.

The importance of yams as a food crop was amply demonstrated by the results of the analysis made by the Bureau of Science of the yam collection at the Lamao Experiment Station in the year 1915. This analysis showed that some of the species give as high as 5.21 per cent sucrose, 3.49 per cent reducing sugar, 5.42 per cent protein and 36.36 per cent starch per hundred weight.

As has already been pointed out, yams can be classified as one of the most important of human foods, and so the Bureau of Agriculture has made an attempt to collect all varieties of yams found in the Archipelago. These have been planted at Lamao for trial. The introduction of yams was started as early as 1911, but no particular care was given at first to the collection made, and practically all were lost. The present collection now at Lamao Experiment Station were procured by Mr. P. J. Wester from the different provincial exhibits during the Philippine Exposition in 1912 and by writing abroad for different kinds, including *Dioscorea alata, D. aculeata, D. pentaphylla, D. triphylla, D. bulbifera, D. daemona, D. fasciculata* and other of the *D. species.*

Cultivation.—Yams are quite drought-resistant plants. They thrive well in dry places as well as in humid regions. For this reason they may be planted at any time of the year, though the best time for planting them is at the beginning of the rainy season. At this season the young plants will obtain all the necessary moisture for their development.

The soil best adapted for yams is either loam or sandy loam containing an abundance of vegetable matter. The plants, however, grow even in clay or sandy soils. But no matter what kind of soil is used it must be well drained and should be in the open. The ground is prepared in the same way as for any of our other cultivated crops; it should first be plowed, then harrowed before the formation of the raised furrows or ridges. Either vertical or horizontal poles are requisite for the best development of this crop. In the Philippines the yams are cultivated in a very crude way, and no systematic method has ever been followed. The plants are set close together in any vacant place in the yard and given no further cultivation, so high yields are seldom obtained. In order that a yam plantation may give a reasonable profit, the plants should be set at least one meter apart each way, and a little more in the case of fertile lands. This will allow animal cultivation. They should be placed in hills from 5 to 10 centimeters deep. No selection of tubers for seeds has ever been practiced in the cultivation of this crop. This is poor practice; seeds for planting should be taken from selected tubers of medium sizes, free from any diseases, and high yielding plants.

Weeding should be done whenever necessary until the plants are large enough or until the animals can no longer pass between the rows without breaking the vines. How often depends upon the growth of the weeds. The object is only to remove the weeds so that the plants may develop well. When the plants have attained their full size, that is, when their leaves shade the whole ground, practically no further cultivation is needed. During cultivation, the cultivator should not be allowed to run close to the plants because parts of the roots

Batangas yielded as much as 11.88 kilos per hill

are liable to be destroyed and as a consequence but a few small tubers be produced.

Harvesting.—The maturity of the fields of yams may be indicated by the drying of the leaves and sometimes by the cracking of the soils due to the expansion of the tubers. From planting to harvest time will be from eight to nine months. Harvesting and curing are the most difficult parts in the cultivation of this crop. The yam is a little expensive compared with other root crops, because some of the varieties need individual digging up because of their deep root systems. In the case of the shallow tuber varieties, after their poles or trellises are removed they can be plowed like sweet potatoes, while with the deep tuber varieties a spade or any similar tool will do. Another difficulty encountered with in the harvesting of this crop is the presence of pines on some of them. In curing, the tubers should be air-dried and not exposed to the sun. By this process fungus (damping off) will not invade the tubers and consequently they can be kept under normal condition for quite a long while. The tubers intended for seeds, if kept under the same conditions, will neither germinate nor rot for two or three months. Precautions should be taken while harvesting to avoid injuring the tubers as far as possible, for such injuries will create fungus diseases, and thus cause the tubers to rot within a short time. However, if newly injured tubers be treated with common lime the further ravages of the fungus may be checked.

Yams should be harvested neither too early nor too late, as is pointed out by L. S. Clemente in the Philippine Agriculturist and Forester, Vol. VI, No. 8. He says: "Young immature roots are found to contain a relatively smaller starch content than the more mature ones, while those that have passed maturity and are developing young shoots tend to decrease their starch content naturally."

The Bureau experiment now going on which is hereunder discussed has for its objects the following:

1. To find out the best yielding varieties under the same field conditions and treatment.
2. To find the probable cost of planting a hectare of a yam field.
3. Comparison of yields by using vertical and horizontal

poles or trellises, and which is the more economical of the two methods of poling yams.

In the 1914 culture test, there were one hundred varieties cultivated. A series of notes made by Mr. P. J. Wester covering both the vegetative characters and the comparative culinary value of all the varieties planted during the month of April of that year, showed many to be of no value for further propagation. Notes also were taken during the same year on the overground parts of the plants and these were followed by notes upon the tubers, which later were analyzed, in 1915, to determine their starch and sugar contents, by the Bureau of Science. Many were found to be poisonous varieties, so were discarded, leaving only 32 varieties for cultivation during 1916, 1917 and 1918. The varieties now maintained are all of excellent quality as determined by analysis and cooking tests. The culture during the years 1917 and 1918 went further than the testing the quality of the different varieties, and included finding out the best yielders under the headings already given.

After testing and eliminating the undesirable yams harvested in 1916, an area of about 0.1319 hectare was planted to 39 varieties, including the newly introduced varieties in April 1917. This planting ended the early part of May. The harvesting of that crop began December 15th and was completed the 28th of the same month.

The yams for the year 1918 were planted between March 15 and April 25, and covered 0.257 hectare. Due to the lack of laborers during that year, harvesting was delayed until January and February of 1919. The land used during 1919 is a new, open field, formerly covered with brush and a few bamboos, while that planted in 1917 was an old field that had borne a crop of yams during the previous year. So there may be noted from Tables I and II not only the probable yields per hectare of each of the varieties cultivated but also how a new and an old field compare for yam culture.

The amout of rainfall during the years 1917 and 1918 was 2160.9 mm. and 3063.9 mm., respectively. Both amounts produced abundant crops.

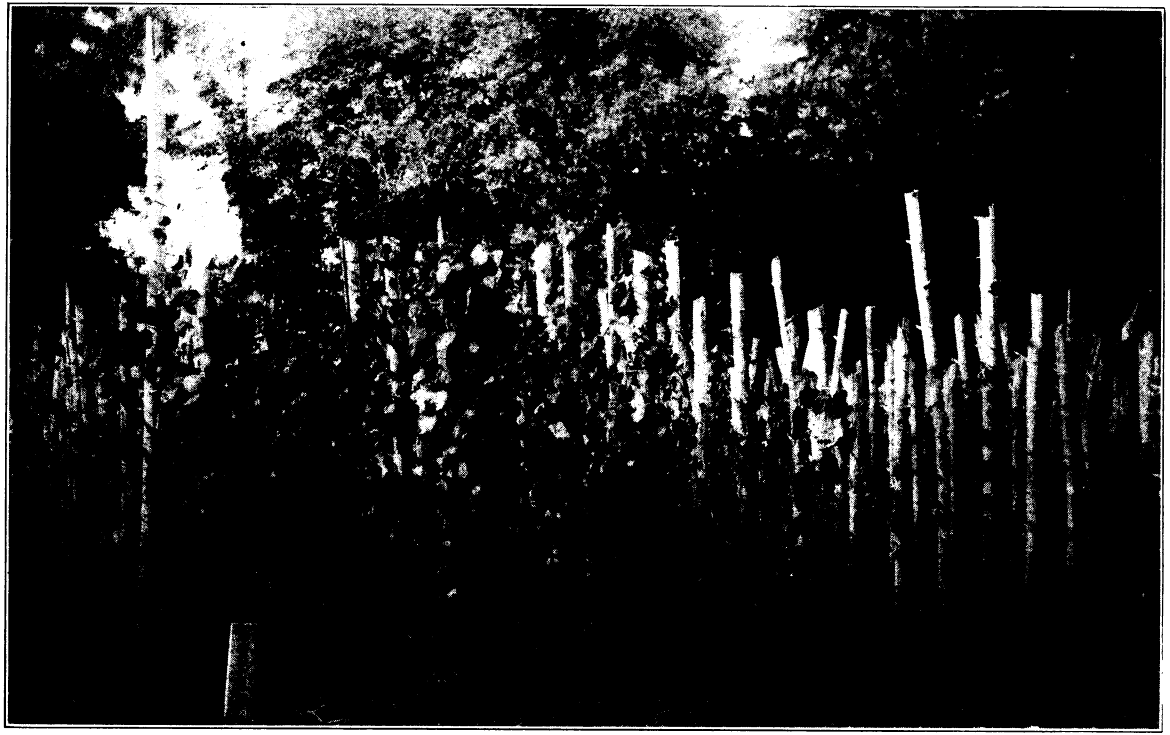
Tables I and II indicate the yields per hectare for the years 1917 and 1918.

TABLE I.—*1917 crop*

Variety Nos.	Variety name	Actual area planted	Number of hills planted	Yield in kilos	Computed yields per hectare
		Sq. m.			*Kilos.*
1 S. M.	(*D. aculeata*)	13	13	24.45	18,800
6	(*D. alata*)	6	6	1.56	2,600
827	(*D. aculeata*)	21	21	17.86	8,500
871-A	Tugui (*D. aculeata*)	56	56	53.08	9,478
871-B	do	113	113	121.68	10,767
1010-A		46	46	41.43	9,006
1011-A	(*D. aculeata*)	45	45	59.73	13,273
1012	do	17	17	16.81	9,880
1013-A	do	33	33	48.66	14,746
1014	Nami (*D. aculeata*)	16	16	13.44	8,400
1015	Tugui (*D. aculeata*)	47	47	105.76	22,502
1016	do	9	9	7.48	8,310
1016-x-mix		20	20	11.36	5,680
1017	Tugui (*D. aculeata*)	1	1	0.68	6,800
1017-A	do	11	11	7.80	7,090
1017-B	do	65	65	52.00	8,000
1017-C	do	55	55	81.44	14,807
1018	Tubayan (*D. aculeata*)	18	18	20.94	11,630
1019	Ubi (white) (*D. aculeata*)	7	7	2.87	4,100
1020	Ubi (red)	3	3	1.16	3,860
1030	Tugui (*D. aculeata*)	26	26	24.96	9,600
1037-A	do	79	79	115.67	14,640
1037-B	do	46	46	36.50	7,930
1049	do	8	8	2.49	3,107
1057	do	45	45	47.78	10,617
1057-A	do	53	53	91.63	17,402
1062-A	do	25	25	30.61	12,244
1062-B	do	49	49	30.89	6,304
1063	Carrot	2	2	2.16	1,080
1387	(*D. alata*)	1	1		
1387-A	do	16	16	5.50	3,430
2303		3	3	0.58	1,930
2394	Batañgas (*D. aculeata*)	232	232	639.50	27,564
4258	Quinampay (*D. aculeata*)	8	8	14.45	18,060
5545	(*D. aculeata*)	25	25	20.39	8,150
2-mix		19	19	11.85	6,230
No. L-1		48	48	68.85	14,340
No. L-2		32	32	36.48	11,400
	Total	1,319	1,319	1,870.48	372,257

TABLE II.—*1918 crop*

Variety Nos.	Variety name	Actual area planted	Number of hills planted	Yield in kilos	Computed yields per hectare
		Sq. m.			*Kilos.*
1 S. M		36.4	40	74.00	20,320
6		3.0	3	9.46	31,530
827		32.0	36	47.35	14,790
871-A	Tugui	185.6	221	239.19	12,880
871-B	do	212.0	227	204.28	9,630
1010-A		108.0	113	196.10	17,970
1011-A		103.5	73	242.39	23,410
1012		16.5	18	54.64	33,100
1013		54.0	60	57.76	10,580
1014	Nami	3.0	3	1.69	5,630
1015	Tugui	67.6	87	203.83	30,150
1016		4.0	4	2.60	6,500
1016-x mix		1.0	1	0.38	3,800
1017-A	Tugui	2.0	2	3.66	18,300
1017-B	do	114.6	129	166.65	14,540
1017-C	do	76.8	78	195.75	25,480
1018	Tubayan	36.0	40	49.06	13,620
1030	Tugui	57.9	60	70.85	12,230
1037-A	do	146.0	152	301.33	20,630
1037-B	do	57.6	60	67.17	11,650
1057	do	105.0	79	178.78	17,020
1057-A	do	83.8	105	324.95	38,700
1062-A	do	68.9	76	95.12	13,800
1062-B	do	32.0	35	45.04	14,070
1063	Carrot	1.0	1	0.78	7,800
2394	Batañgas	187.6	225	385.40	20,540
No. L-2		100.9	147	169.12	16,760
No. L-1		114.0	120	296.24	25,980
2-mix		3.0	3	3.44	11,460
5545		10.0	10	3.24	3,240
	Total	2,023.7	2,208	3,690.25	506,110



Yams growing on vertical poles at Lamao Horticultural Station

In 1918 culture numbers 1017, 1019, 1020, 1049, 1387–A, 2303 and 4258 produced no tubers. This failure was due to the shade of the bamboos where these yams were planted.

From the above tables it appears that a hectare of land will yield a minimum of 1,080 kilos and a maximum of 38,700, depending, of course, upon the varieties grown. It is calculated that the market price of yams is ten centavos per kilo, so the minimum value of the produce would be ₱108 and the maximum ₱3,870. The tables show a wide range of variation in the yield of the different varieties of yams under the same culture and field conditions. The variety Batañgas No. 2394 produced as much as 11.88 kilos per hill. Taking into consideration that no definite selection of tubers has so far been made for this crop, there is a great probability that if high yielding plants be selected the yield as given per hill will undoubtedly be maintained or even increased to its maximum. (Plate XXIV, showing the highest yield obtained per hill.)

The figures of yields are low on some of the varieties planted, especially those planted near the bamboos. The yields per hectare as calculated give enough profit to the planter, as can be seen in the table of probable cost computed per hectare.

Virgin soils all the way through gave higher yields than the old cultivated fields, except in the case of Batañgas No. 2394 and 1013, and Nos. 871–B, 1014, 1016, 1016-x-mix and 5545. The latter five varieties were planted near the bamboos. This result obtained from the new soil shows that fertilization of yams may considerably increase the yields.

The cost of planting a hectare of yams at the Lamao Horticultural Station is estimated as follows:

1. Field preparation including leveling, plowing, harrowing and the formation of raised furrows or ridges, 110 hours	₱22.22
2. Poling, including digging, erecting, hauling and cutting of poles, 409¼ hours	45.47
3. Planting, including staking and labelings, 101 hours	10.10
4. Cultivating, including hoeing. (This began in April, May, June and stopped in October), 219½ hours	24.39
5. Irrigation, 18 hours	2.00
6. Harvesting, including the removing of dirt around the tubers (can be performed by girls), 415½ hours	46.16
Total	150.34

The above figure of ₱150.34 shows the actual expenses incurred in the cultivation of 2023.7 sq. meters, which yielded a total of 3690.25 kilos of yam tubers with a money value of ₱369.02, leaving a net profit of ₱217.56 on the 0.2023 hectare of land.

Comparing the yields of the different varieties planted by methods of 1, 2, 3, 4 tubers in a hill respectively the following Table III, shows the results obtained.

TABLE III

Variety Nos.	Variety name	Average weights per hill in kilos			
		1-tuber	2-tubers	3-tubers	4-tubers
1 S M		1.505	2.395	1.861	2.062
827			1.194	0.629	0.575
871-A	Tugui	1.470	1.749	2.697	1.922
871-B	do	0.885	2.161	2.068	2.108
1010-A		1.310	1.404	1.467	1.267
1011-A			3.740	3.567	3.048
1013-A		0.640	1.343	1.500	0.912
1015	Tugui	0.850	3.047	2.582	0.918
1017-B	do		1.013	1.024	2.786
1017-C	do	1.420	2.086	2.511	1.948
1018	Tubayan		1.345	1.073	1.059
1030	Tugui	0.502	1.192	0.992	1.083
1037-A	do	0.896	2.234	2.530	2.550
1037-B	do	0.200	1.267	0.980	0.854
1057	do	0.841	2.848	2.568	2.740
1057-A	do	1.312	4.289	3.550	3.073
1062-A	do	1.291	1.708	1.134	1.216
1062-B	do	1.300	2.186	0.792	0.923
2394	Batañgas	1.910	1.949	2.851	3.193
5545			0.777	0.626	0.949
2-mix		0.220	0.650	0.890	0.463
No. L-1		1.547	3.399	2.845	3.205
No. L-2		0.756	1.452	1.510	2.068

DISCUSSION OF TABLE III

There were not enough tubers to carry out the planting of 1, 2, 3, 4 tubers in a hill among the following varieties: Nos. 6, 1012, 1014, 1016, 1016-x-mix, 1017, 1017–A, 1019, 1020, 1049, 1063, 1387, 1387–A, 2303 and 4258.

In the 1917 crop, one row each of 1, 2, 3, 4 tubers were planted in a hill in order to find out which method would be the most profitable. From the first observations made, it was evident that by planting 1 tuber alone in a hill the yields were too low as compared with the yields when more were used. This method was then discarded the next year, and in 1918 only the 2, 3, 4 tuber methods were followed, as previously. The above table is the average of the two years' experiments, except column one, as already stated.

The low yields of the 3 and 4 tuber methods of some of the varieties cultivated may be due to two causes, namely, cultivation; in the 3 and 4 tuber methods are used the tubers planted on the opposite side of the ridges are liable to be destroyed by the passing of the cultivator and consequently higher yields can not be expected from them. In other cases, even if they were left undisturbed the vegetative growth of the plants would probably be too crowded on the individual pole, and their best development

Yams growing on horizontal trellises at Lamao Horticultural Station

thereby checked. However, several of the varieties were not at all affected by either one of the two probable cause just mentioned above.

The varieties recommended for the different number of tubers to be planted in a hill for the cultivation of yams are as follows:

1. Planting one tuber in a hill should not be done at all.
2. For 2–tuber varieties, numbers 1 S. M. 827, 871–B, 1010–A, 1011–A, 1013–A, 1015, 1017–B, 1017–C, 1018, 1030, 1037–A, 1037–B, 1057, 1057–A, 1062–A, 1062–B and No. L–1.
3. For 3-tuber, numbers 871–A, 1010–A, 1011–A, 1013–A, 1017–B, 1017–C, 1037–A, 105–A, 2394.
4. For 4-tuber, numbers 1037–A, 1057, 2394, No. L–1 and No. L–2.
5. No definite conclusion can be drawn as yet as to variety numbers 5545 and 2 mix-, for the reason that only a few these tubers have been planted as yet.

The vertical and horizontal poles referred to are shown in Plates XXV XXVI respectively.

Poling is considered the most expensive item in the cultivation of yams. At Lamao the amount expended in poling the 2457 hills planted in 1918 amounted to ₱45.47, which included 1565 vertical poles and 892 hills covered by the horizontal poles. Taken in a lump sum the average expenses in setting up these poles per hill was ₱0.018.

The time consumed in the erection of the vertical poles per hill was more than twice that with the horizontal ones, besides the vertical poles took more bamboos. By this method every hill needs individual bamboo stumps, while with the horizontal poles each whole bamboo can be split into four pieces which will serve as well in the absence of "buho." It is because of this difficulty and the greater expense in putting up the vertical poles that an attempt was made to conduct an experiment as herein reported in table below No. IV.

TABLE IV

Variety No.	Variety name	2-tubers		3-tubers		4-tubers	
		Vertical	Horizontal	Vertical	Horizontal	Vertical	Horizontal
1 S. M.		2.070	3.146	1.700	2.202	2.037	2.078
827		1.905	1.460	0.826	0.815	0.545	0.538
1013		1.377	1.246	1.802	1.071	1.177	0.700
1017-B	Tugui	1.316	1.243	1.568	1.169	0.872	0.694
1018	Tubayan	2.305	1.187	1.533	1.310	1.610	1.223
1030	Tugui	1.580	1.103	0.825	1.111	1.400	0.871
1037-B	do	1.555	1.820	0.857	1.318	1.522	0.576
1062-A	do	2.268	1.855	1.380	0.901	1.336	1.131
1062-B	do	1.710	1.435	1.080	0.720	1.735	1.232

Generally yams can not be grown to advantage under horizontal poles, as shown from the above table. The yams, as is shown in Plate III, do not run horizontally and unless a piece of stake be driven for their support they just crawl over the ground and never climb up to the horizontal poles. Under this condition the young plants remain dormant and finally they die off. If horizontal poles as described in this paper be used for their support, proper stakes should be planted for every individual young plant. By this means as good yields can be expected from horizontal poles as from vertical ones. However, some of the varieties will probably grow and produce an equal amount of tubers by either of the two methods of poling yams, as, for example, varieties, Nos. 1 S. M. and 1037–B.

A method newly devised for poling yams will be tried out with the coming crop. It may be described as follows:

Four bamboo stakes will be tied together at the top and the other ends spread apart so that the bottom end of each of the two stakes will form a square resting on the ridges, thus making the framework of a roof. The yam tubers will then be planted at the ends of these stakes, so the plants may climb. The only possible disadvantage in employing this method is that the ground under the roof cannot be cultivated.

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CURRENT NOTES—FOURTH QUARTER

BY P. J. WESTER, *Agricultural Advisor*

MISCELLANEOUS CROPS AND OBSERVATIONS IN HAWAII AND GUAM

BREEDING TARO IN HAWAII

The Gabi, *Colocasia esculenta,* was formerly the staple food of the native Hawaiians and it is still an important food plant in Hawaii, where no less than 200 varieties are cultivated and where the species is known under the name of taro. Considering the value of this crop in the Philippines it may be of interest to know that Mr. G. P. Wilder, Honolulu, has begun the breeding of new taro varieties, and has now under test quite a number of seedlings. So far as known this is the first attempt on record of the breeding of taro. Twenty Hawaiian taro varieties were obtained from Mr. Wilder for introduction into the Philippines.

A NEW ROOT CROP FOR THE PHILIPPINES

The Sembu, *Canna edulis,* is a starchy root crop grown to a limited extent in Hawaii. This is a perennial plant of the habit of the ornamental canna, but more robust, attaining a height of 1.75 meters in height, grown as an annual, with a growing period of six to eight months. The tubers are white fleshed, about the size of potatoes. According to Mr. C. A. Sahr, assistant agronomist of the Hawaii Agricultural Experiment Station, Honolulu, the yield averages from 37 to 49 tons of tubers to the hectare in Hawaii. The tops are a valuable forage. The sembu will grow in both wet and dry districts but produce the best on sandy soil.

A few tubers received from Mr. Sahr and planted in Zamboanga made excellent growth during the past year and the sembu promises to become a valuable addition to the Philippine root crops.

ONIONS

Among the vegetables imported into the Philippines, onions form one of the largest items. According to current reports the Bermuda onion is grown successfully in the British West Indies and I found that they are also successfully grown in Hawaii. Excellent Bermuda onions have been grown at the San Ramon Penal Farm, Zamboanga. Also there is every reason to believe that the entire demand for onions in the Philippines could be met by home production and that the crop would be a profitable one if properly handled.

NOTES ON FRUITS

An extremely large number of exotic plants, economics as well as decorative, have been introduced into Hawaii. Of these introductions the most notable fruit tree is unquestionably the avocado, which now is a common feature in the landscape everywhere in those Islands. Growing into trees of very large proportions in abandoned pastures, fence corners and along the road sides everywhere, this valuable fruit tree might be said to have naturalized itself in Hawaii where the avocado is now a regular article of the diet of the native population. Among all the foreign fruits probably no one so well deserves wholesale introduction into the Philippines as the avocado.

The seedless breadfruit, of which there are two varieties quite distinct from those in the Philippines, is far more commonly grown in Hawaii and is used very extensively as a food. In the Philippines this excellent fruit is still a rarity in the markets where it should be a staple article.

The Isabella grape, a purple, rather acid grape, somewhat larger in size and growing in larger bunches than the "Cebu" grape, is cultivated to considerable extent in Hawaii and the market was plentifully supplied with the fruit at the time of my visit in April, 1918. Small vineyards were seen from sea level up to an elevation of 550 meters in various parts of Hawaii, the vines growing luxuriantly, trained on an over-head trellis, both in comparatively dry districts as in Kona and in the moist country near sea level at Hilo. This grape of which a few plants were obtained from Mr. J. E. Higgins, horticulturist of the Hawaii Agricultural Experiment Station, Honolulu, seem to be remarkably well adapted to the tropics and may conceivably become a fruit of considerable importance in the Philippines.

Observations of the Loganberry and the "Himalaya" blackberry in California incline me to the belief that these fruits would succeed well at an elevation of 1,200 meters and upwards in the Mountain Province. In fact, I found that in Guam, where it was introduced some years ago, the "Himalaya" has made very good growth. It has failed to fruit, however, due undoubtedly to insufficient elevation.

THE ALGAROBA

Much has been said about the value of the algaroba, *Prosopis juliflora,* as a cattle feed and source of honey, and it has been imported from Hawaii into the Philippines several times. The algaroba is adapted to a dry climate and grows on poor soils, and in the Philippines would probably be worth planting in localities where the soil is thin and poor, where the rainfall is slight, or the dry period long and pronounced, for instance in Cebu, in western Luzon from Batangas and northward with rainfall and soil as indicated, in the immediate vicinity of Zamboanga, and on the dry coral islands in the Sulu Archipelago.

The algaroba is sufficiently attractive to be worthy of attention as a shade tree in the localities where it will thrive, in which connection it is interesting to note that the finely divided foliage is capable of holding in suspension a very large amount of rain, that on most trees would fall to the ground. The tree is a very rapid grower and makes good firewood.

FORAGE PLANTS

Para grass has in Hawaii proven a greater success than Guinea grass, and I found it naturalized and grown for forage in several localities, making very luxuriant growth from sea level up to 500 meters.

I also found Natal red top, *Tricholoena rosea,* naturalized in Paauilo at an elevation ranging from 300 to 500 meters. This grass is said to have naturalized itself very successfully in certain other parts of Hawaii. There is a strong probability that both these grasses would succeed well in parts of Bukidnon and in the Mountain Province; Para might also do well in Lanao.

In Guam a variety of *Paspalum dilatatum* was found to make an excellent forage under conditions closely approximating those in Bukidnon and many parts of the Mountain Province.

The sunflower, *Helianthus annuus,* has been introduced into the Philippines where it succeeded exceedingly well in the trials made some years ago at the Lamao Experiment Station, but no efforts have been made to introduce it as an agricultural crop notwithstanding its value as a human and poultry food. In Guam this plant has yielded at the rate of more than 1,675 kilos of sunflower seed per hectare, which probablv could be eoualled in these Islands.

A well arranged vegetable garden. San Ramon Farm, Zamboanga.

THE PHILIPPINE

Agricultural Review

VOL. XIII SECOND QUARTER, 1920 No. 2

CONTENTS.

ILLUSTRATIONS

EDITORIAL

By ADRIANO HERNANDEZ, *Director of Agriculture*

The world war in its wider sense is over, but the danger of a food shortage still remains with us, with attendant high prices for all foodstuffs. We may not yet expect to produce our full requirements of rice and importation of foreign rice will continue to be considerable during the current year. These importations could, however, be very materially reduced if the farmer devoted more attention to the production of corn, legumes, root crops and the various garden vegetables, especially considering the fact that a varied diet embracing plenty of vegetables and legumes is more wholesome and muscle-building than the monotonous rice diet.

Three very valuable food plants grow practically wild in the Philippines or are raised in only a desultory fashion, each of which serves as the staff of life in some tropical country. They are: cassava, breadfruit, and legumes, among which last-named might be classed the kayam, *Inocarpus edulis*. In Brazil cassava is a staple food over a large area of that enormous country, and the breadfruit and kayam occupy a similar place in the diet of the peoples in some of the large archipelagoes in Polynesia. In India mungos and other annual legumes are extensively employed to supplement rice. To the great advantage of this country, we might well emulate the populations of these lands, and an energetic and ceaseless campaign should be waged until the domestic consumption of the foodstuffs obtained from these plants would be measured in thousands of tons where now it is figured in kilos—to say nothing of the exportation of cassava starch and tapioca.

For the culture of the many food crops that may be grown in the Philippines attention is directed to the "Cultural Directions for Field Crops and Vegetables," published elsewhere in this Review. In this connection, the great importance of proper and thorough preparation of the land, scrupulous attention to all details, clean culture, i. e., keeping the fields clean of weeds, cannot be too strongly emphasized if good crops are to be obtained.

CULTURAL DIRECTIONS FOR FIELD CROPS AND VEGETABLES

By P. J. WESTER, *Agricultural Advisor*

FIELD CROPS

Rice, sugar cane, and corn excepted, which will grow even on heavy soils, the field crops mentioned hereafter succeed best on loamy, friable, well drained soils, provided that they are reasonably fertile. Light, sandy soils are especially adapted to rootcrops such as cassava, camote, potato, tongo and ubi. The gabi occurs in three general types: (1) Those adapted to well drained land; (2) those that do best under submersion or on wet lands; and (3) those which succeed under either of those conditions.

The preliminary work in preparing the field for all these crops consists of clearing the land of the native growth, trees, shrubs, cogon or other vegetation, and plowing, cross plowing and harrowing until the land is in a good state of tilth. Ordinarily the land is then ready to plant any of the crops mentioned, such as rice, corn, peanuts, cowpeas, etc., but if it is desired to further improve the land this can best be done by planting cowpeas and plowing them under as soon as they have attained a good growth, or the land may be planted to patani, the Lyon or velvet beans. When these legumes are planted as a preliminary or cover crop the seeds should be planted at about two-thirds the distances given in the table if it is desired that the plants cover the ground quickly.

After the young plants, except those which are planted broadcast, have made their appearance above ground, the field should be cultivated frequently with animal or motor drawn implements, and also hoed to keep all weeds well under control until they shade the ground sufficiently to render further cultivation unnecessary.

Whenever a crop has been harvested unless the land is again planted to another crop it should be an invariable rule to sow it to some legume to prevent weed growth and to improve the soil.

Rotate all crops. That is, do not plant the same crop nor two closely related crops twice in succession, such as rice and corn, ubi and tongo. By means of crop rotation the soil fertility is maintained, better crops are obtained, and the danger from plant pests is lessened. As a sample of correct crop rotation plant, on a given field, rice, to be followed by peanuts; after their harvest plant corn, followed by cowpeas, then cassava, again followed by mungos, then rice, etc.

THE VEGETABLE GARDEN

Location.—In locating and making a vegetable garden the following points should be kept in mind: (*a*) That the prospective garden must be well sheltered from strong winds; (*b*) that the land must be well drained; (*c*) that the soil must be fertile, rich in humus, light, and easily worked.

If not naturally protected by buildings or vegetation, a windbreak may be constructed by the planting of shrubs or small trees around the garden, yet it should be well exposed to the sun. Well-drained land is absolutely essential; if the site for the garden is not well-drained naturally, drainage must be provided by ditching.

Preparation of the Garden.—A well planned garden is laid out in long, broad beds, of a convenient width, so that the vegetables can be watered, weeded and cultivated with ease. (See Plate I.) The land should never be cut up into small, short or narrow beds with more paths than necessary in order to properly care for the plants. This is wasteful of land and labor, and the soil dries out more rapidly and requires more irrigation than if large beds are made. Ordinarily the high beds shown in Plate I are not to be recommended as the soil dries out too rapidly, but they are sometimes necessary where the rainfall is excessive or where the drainage of the level land is imperfect.

Spade or plow the ground well to a depth of not less than 20 centimeters; break up all lumps, remove all trash, and level the land with a garden rake. If the soil is not naturally fertile, and is heavy, stiff, and inclined to bake, it may be improved by adding to it stable manure or decaying vegetable matter and a little sand, which substances should be thoroughly worked into the soil. As a matter of fact, unless the ground is exceptionally fertile, heavy applications of well decayed manure or compost should be the rule rather than the exception, and the grower will find himself surprisingly well repaid for this extra expense in the better vegetables produced. A poor growth of vegetables in a large majority of cases is due merely to the fact that the land is not sufficiently fertile or that the land was not properly prepared. Especially is this true of European vegetables, many of which ordinarily cannot be grown at low elevations but which prove very satisfactory if the soil is enriched. Do not attempt to work the soil when it is wet and soggy after a heavy rain. The soil is about right for working and planting when it crumbles and falls apart under moderate pressure in the hand; the land is then in good condition for planting seed direct in the soil or for the setting out of plants from the seed bed.

Seed Beds.—Many plants succeed better if the seed is sown in a seed bed, where, during the early stages of their growth, they may be protected better from the hot rays of the sun, heavy rains, and noxious insects, than if the seed is sown in the open ground. If the seed bed is prepared in the garden, a small bamboo frame should be erected over it, and a shelter made of palm leaves or cogon grass to turn the rain.

Seed Boxes.—If insects, particularly ants, are troublesome, it is best to sow the seeds in shallow boxes, commonly called "flats," placed under a rain-proof shelter. Make the flats about 10 centimeters deep, and in nailing them allow enough space between the bottom boards (3 to 5 millimeters) to provide for drainage; a number of small holes bored in the bottom of the flat will also serve to carry off any surplus water. Good seed flats are obtained by sawing a kerosene box in two so as to make two shallow boxes.

Cover the bottom of the flat with a layer (about 2 centimeters deep) of coal ashes, gravel, or small stones, and then fill the flat to within a centimeter of the top with fine, rich, preferably sandy loam. Heavy, sticky soil is not suitable. Level, and pack the soil moderately firm before sowing the seed.

In seed beds and flats sow the seeds in rows about 4 to 5 centimeters apart, from 3 to 10 millimeters apart in the row, depending upon the size of seed and vigor of the plant. Cover the seed slightly with a layer of soil, or two or three times the thickness of the seed planted, pack the soil well and then water thouroughly.

After planting the seed do not allow the soil in the flat to dry out, or the seed will not germinate; nor on the other hand, should it be watered so often that the soil is kept continually wet and soggy, for in this case the seed decays or the young plants are likely to rot off at the surface of the ground. With many plants this stage is the most critical in their development and many are lost by excessive watering if this is not carefully attended to.

After the plants have appeared above ground, a good rule

(*a*) Seguidilla, *Psophocarpus tetragonolobus*. Lamao Experiment Station.

(*b*) The "Lamao" Lima, *Phaseolus lunatus*. Lamao Experiment Station.

is to allow the soil to become so dry that the plants are on the point of wilting and then water the flat thoroughly so that the water penetrates to the bottom. Frequent and shallow watering is very pernicious in that it encourages a shallow root system near the surface of the soil and prevents the development of deep-going roots, and thus stunts the plants.

Weeds should, of course, be pulled out whenever they appear.

If ants and other crawling insects are troublesome, place the seed boxes on a table made of bamboo with the legs standing in tin cans filled with water.

Transplanting.—When the young plants begin to crowd each other transplant them about 3 to 5 centimeters apart into other boxes prepared as heretofore described. Before removing the plants the seed flat should be watered thoroughly and the flat into which the plants are transplanted should be well watered after the operation. Then, when the plants are 6 to 12 or more centimeters tall, depending upon the kind, they are ready to set out in their permanent position in the garden. It is well to place the plant box in the full sunlight a few days prior to setting out the plants in order to accustom them to the change. The transplanting of the plants from the seed bed or flat to the garden is best accomplished during a cloudy day or late in the afternoon. Cut off about one-half of the leaves. Disturb the roots as little as possible, and firm the soil well around them when the plants are set out. Water them unless it is raining.

In the case of most plants, such as beans, peas, radishes, carrots, maize, cucumbers, melons, okra, etc., it is best to plant the seed direct in the field. However, if for any reason it is desired not to do so, make small baskets of banana leaves or stalks about 8 centimeters in diameter, fill them with earth, plant 3 to 5 seeds in each and place them side by side in a flat. When the plants are large enough to set out in the field, water the plants thoroughly, carefully remove the basket, and set out each plant with its ball of earth without breaking it.

Saving Seeds.—Seed of European vegetables deteriorates so rapidly in the Philippines at sea level that it is usually not advisable to collect seed for planting another year, the better plan being to obtain fresh, imported seed for each season. At the higher elevations seed saving is more successful. On the other hand vegetables of tropical origin, such as segidilla, eggplant, sitao, libato, and the cucurbits produce seed abundantly. It should be the rule to save enough seed for planting the next crop. Save the seeds from the best plants when they are ripe, spread them out to dry on a paper in the shade, and well dried place them in a tightly corked bottle stored in a cool place. Seeds in vegetables like the tomato, eggplant, cucumber and melon should be carefully washed of all pulp and then dried. It is well to remember that seeds do not, as a rule, retain their vitality long in the Philippines, and that the sooner they are planted the better.

Insect Control.—Most insects that attack plants in the seedling stage devour the foliage and tender shoots. They are easily controlled by dusting the plants with a mixture of Paris green and air-slaked lime, dry road dust, or fine soil. For this purpose mix 25 grams Paris green to 1 kilo of the diluting substance and stir together the two ingredients thoroughly. Place the mixture in a bag of thin cotton cloth or a gunny sack and shake it over the plants until they are covered with a thin layer of dust. This is best done in the morning while the plants are still wet with dew. Do not apply the mixture thickly as then it may injure the plants.

Cucumbers, squash, melons, eggplant, and okra are frequently troubled by aphids, which are small, green or brownish, sucking insects. These are readily destroyed by the application of tobacco dust. The aphids usually attach themselves to the under side of the leaves and in order to be effective the tobacco dust should therefore be thrown on the plants from the side and upwards. Apply the tobacco dust early in the morning while the plants are wet with dew. Repeat the application at intervals of two or three days until the insects have been eradicated.

For other insect pests and their control see Bureau of Agriculture Circular No. 12, which will be sent upon application addressed to the Director of Agriculture, Manila.

Remember that *Paris green is a dangerous poison and therefore should never be placed where it is accessible to children or domestic animals.*

PLANTING TABLE FOR FIELD CROPS AND VEGETABLES

NOTE.—By "drill" is understood the sowing of the seeds in a line; the expression "hills" is here used when several seeds of a robust plant are planted far apart so that the field can be cultivated at right angles; it does not mean that the soil should be heaped up in hills in which the seed is planted. Small seeds like the tomato, pepper, lettuce, etc., that are sown in seed flats should be covered very thinly with soil, seeds like radish, carrot, etc., sown in the open should not be covered more than 15 millimeters deep. Where the soil is moist there is no need of planting even the larger seeds more than 4 centimeters deep, tubers may be planted 5 to 7 centimeters deep.

Vegetables of a short growing period such as beans, radishes, beets, corn, etc., should be planted in small lots in succession at intervals of

Pods and beans of the "Lamao," a very productive, white, climbing lima which originated at the Lamao Experiment Station.

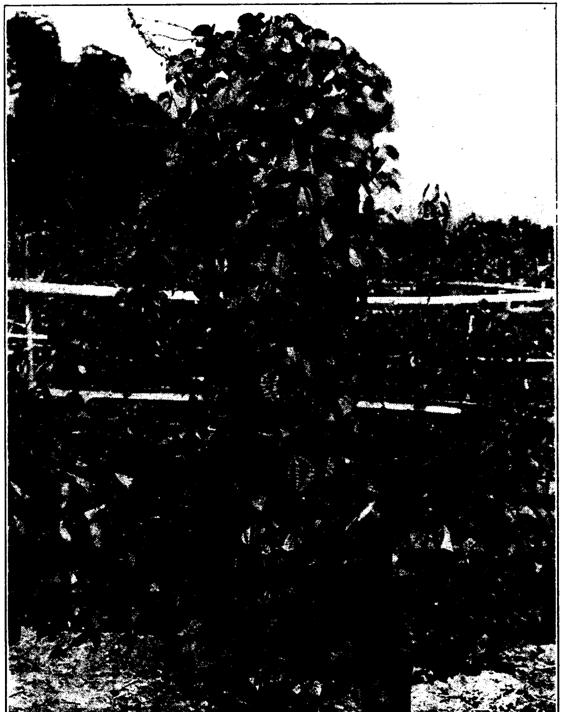
about 10 days. By so doing the season of these vegetables can be lengthened very considerably.

Poles should be 2 to 2.5 meters high above the ground. Trellises 1.20 meters high or more and, if desired, may be constructed so that the plants can run on a lattice overhead.

Referring to the following table, the distances at which to space the plants of a certain crop should be governed by the climate, and the fertility of the soil. The more favorable the conditions for the growth of a plant the wider should be the spacing.

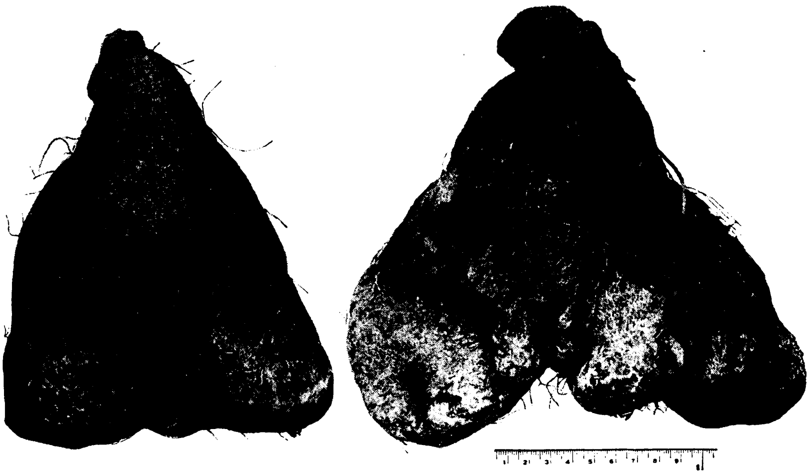
Name of plant.	Distance in row.	Distance between rows.	Remarks.
	Centimeters.	*Centimeters.*	
Adlay	30-50	60-75	4-5 seeds in each hill.
Anipay	100-150	125-150	4-6 seeds in each hill; pole or trellis; or drill 5-8 centimeters apart in rows 1 meter apart, allowing the vines to trail on the ground.
Aroro	30-35	60-90	Plant tubers as indicated.
Apalia	75	125	3-4 seeds in each hill; trellis.
Batao	100-125	150	3-4 seeds in each hill; trellis or pole.
Bean:			
Bush	8-10	50-60	Drill as indicated.
Lyon	60-100	100-125	2-3 seeds in each hill; pole if desired.
Marutong	75	100	2 seeds in each hill.
Patani (Lima)	125-150	150	3-4 seeds in each hill; pole. (Plate II*b*, and III.)
Scarlet runner	100-125	125-150	3-4 seeds in each hill; pole.
Seguidilla	100	125	3-4 seeds in in each hill; pole. (Plate II*a*.)
Sitao	75-90	100-125	3-4 seeds in each hill; pole.
Velvet	60-100	100-125	2-3 seeds in each hill; pole if desired. Lyon and velvet beans are usually planted as cover crops, the former may be eaten while immature.
Beet	10-15	25-35	Drill and thin as indicated; transplant thinnings.
Borona	----------	50-60	Drill thinly.
Cabbage	50	75	Sow in seed flats and transplant.
Cadios	100-150	150-200	3-4 seeds in each hill.
Camote	40	100	Ridge land; plant cuttings 25 centimeters long.
Cantaloupe	150-200	150-200	4-6 seeds in each hill.
Carrot	3-4	20-25	Drill; thin as indicated.
Cassava	60-75	100-125	Plant cuttings 15-20 centimeters long, of well matured stems.
Cauliflower	45	60-75	Sow in seed flat; transplant seedlings as indicated.
Celery	12-20	50-90	Sow in seed flat and transplant as indicated. When fullgrown blanch by means of paper or short, halved bamboo joints tied around the stalks or by boards.
Chayote	200	200	1 fruit in each hill; trellis.
Chili	50-60	75-100	Sow in seed flat and transplant as indicated.
Condol	150	150-200	3-4 seeds in each hill; trellis if desired.
Corn	75-100	75-100	3-5 seeds in each hill; thin to 2-3 plants.
Cowpea	----------	65-90	Drill thinly.
Cucumber	150	200	4-6 seeds in each hill.
Curuba	150	150	3-5 seeds in each hill; trellis (Plate VI).
Dill	15-20	30-40	Drill thinly and thin as indicated, transplanting thinnings; or sow in seed flat and transplant.
Eggplant	60-75	75-100	Sow in seed flat and transplant as indicated.
Endive	18-20	20-25	Drill and thin as indicated, transplant thinnings; or sow in seed flat and transplant.
Fennel	15-25	15-25	Drill thinly and thin as indicated transplanting thinnings; or sow in seed flat and transplant.
Gabi	40-50	60-75	Plant tubers as indicated.
Garlic	10	20-25	Drill and thin as indicated, transplanting thinnings or plants sets as indicated.
Guar	----------	45-55	Drill thinly.
Kohlrabi	20-25	30-45	Drill and thin as indicated; transplant thinnings.

Name of plant.	Distance in row.	Distance between rows.	Remarks.
	Centimeters.	*Centimeters.*	
Leek	6-8	25-30	Drill; transplant as indicated when 10-15 cm. high, setting the plants in a deep furrow; hill the rows as plants grow larger.
Lettuce	15-20	20-30	Sow thinly and thin to 15-20 cm., transplant thinnings; or sow in seed flat and transplant.
Libato	75	100-125	3-5 seeds in each hill, or sow in seed flats and transplant; erect inverted V-shaped trellis in alternate middles 75-100 cm. high. (Plate VII.) Easily grown from cuttings 25 cm. long, planted like camotes.
Marutong; see under bean.			
Mungo		60-70	Drill thinly.
Mustard		20-25	Drill thickly.
Nami	75	125	Ridge land, set up poles as indicated; plant 2 tubers by each pole.
Okra	50	90-100	3-5 seeds in each hill; thin to 2 plants transplanting thinnings.
Onion	8-10	25-30	Drill; thin as indicated, transplant thinnings; or plant sets.
Parsley	8-10	20-25	Drill; thin as indicated, transplanting thinnings.
Parsnip	4-6	20-25	Drill; thin as indicated.
Patani; see under bean.			
Patola	75	125	4-6 seeds in each hill; trellis.
Pea	4-5	50-90	Drill as indicated; use brush for supports.
Peanut	30	75-100	2-4 seeds to a hill; ridge land after flowering.
Pechay	15-20	25-30	Drill; thin as indicated, transplanting thinnings, or sow in seed flat and transplant.
Pepper	40-50	60-75	Sow in seed flats and transplant as indicated.
Potato	30	75-90	Plant tubers as indicated; ridge land as potatos begin to form.
Pumpkin	150-200	200	3-4 seeds in each hill.
Radish		20-25	Drill.
Ragi, upland	30-40	30-45	Drill thinly, or sow in seed bed and transplant as indicated when 12-20 centimeters high.
Rape		25-35	Drill like mustard.
Rice, upland			Sow broadcast.
Roselle	100-250	100-250	4-6 seeds in hills; thin to 2 plants, transplanting thinnings.
Rutabaga	25-35	30-45	Sow in seed flats and transplant.
Sapang	60-75	125-150	Ridge land, set up poles as indicated and plant 2-3 tubers around each.
Seguidilla, see under beans.			
Sembu	60-75	100-120	Plant tubers as indicated.
Sesame		40-50	Drill thinly.
Shallot	15-20	15-20	Plants sets as indicated.
Sincama	20-35	75-90	2-3 seeds; trellis.
Sitao, see under bean.			
Sorghum	40-50	75-90	Drill; thin to 3-4 plants as indicated.
Soya		50-75	Drill thinly.
Spinach, New Zealand		30-35	Drill thinly.
Squash	150-200	200	3-4 seeds in each hill. Old, mature vines can be made into cuttings and planted like those of the camote.
Sunflower	50-70	75-100	4-5 seeds in each hill, thin to 2-3 plants to a hill.
Sugar cane	40-65	100-125	Plant mature cane points.
Talinum	20-25	25-30	Sow in seed flats and transplant as indicated. Easily grown from cuttings, from tops or stems, 10 centimeters long, set out direct in field.
Tomato	60-75	100	Sow in seed flat and transplant as indicated.
Tongo	75-90	125-150	Ridge land, set up poles as indicated and plant 2-4 tubers around each pole. (Plates IV and V*b*.)
Turnip	10-15	30-45	Drill, and thin as indicated.
Ubi	75-90	125-150	Ridge land, set up poles as indicated and plant 1-2 tubers by each. (Plate V*a*.)
Upo	125-150	125-150	4-5 seeds in each hill; trellis.
Water melon	150-200	200	4-5 seeds in each hill.
Yautia	50-65	70-90	Plant tubers as indicated.



(*a*) Plant of the Tongo, *Dioscorea aculeata*, illustrating method of culture (poling) of the Tongo, Ubi and Sapang, Lamao Experiment Station.

(*b*) A hill of Tongos, illustrating the productiveness of this plant, Singalong Experiment Station.



(*a*) A desirable type of the Ubi, *Dioscorea alata*. Lamao Experiment Station.

(*b*) A desirable type of the Tongo, *Dioscorea aculeata*. Lamao Experiment Station.

Apalia, cadios, cassava, condol, curuba, gabi, nami, patola, roselle, sapang, seguidilla, sesame, sembu, sincama, tongo, ubi, upo, and yautia should be planted from March to not later than the first days of June; adlay and ragi should be sown in June and early part of July.

Beets, cabbage, carrot, endive, kohlrabi, lettuce, onion, parsley, parsnip, pea, potato, radish, rutabaga, shallot, New Zealand spinach, turnip and most temperate vegetables do best if planted during the late or early part of the year so as to get the benefit of the cool season, though in the highlands this is a matter of minor importance.

All other crops may be planted any time of the year subject to favorable conditions with respect to rainfall.

Excepting those referred to below, for description and more detailed information relative to the regions best suited to the above plants, see "The Food Plants of the Philippines."

CHAYOTE. *Sechium edule* Sw.

A cucurbitaceous trailing or climbing vine, sometimes exceeding a length of 15 meters; a native of the West Indies. The fruit is irregularly oblong-obovoid, ribbed longitudinally, averaging about 10 centimeters in length, pale-green to cream colored or white, smooth to spiny, containing one large seed, and is eaten boiled like squash. The roots of some varieties are fleshy and are eaten like camotes. In propagating this plant the entire fruit must be planted. Introduced from the United States in 1920.

In Ceylon, where it has long been introduced and is quite commonly cultivated, the chayote is said to grow best above an elevation of 450 meters.

RAGI. *Eleusine coracana* Gaert.

A stout, erect grass about 1 meter high, native of India, the small grains of which are eaten in various ways like rice, or ground into flour and made into bread. Like rice there are two types of ragi, upland and lowland (irrigated), the latter grown submersed like lowland rice. The upland ragi may be sown broadcast, but does the best drilled thinly to permit at least one weeding during the growing period. Or the seeds is sown thinly in a seedbed and when 12 to 20 centimeters high the plants are transplanted to the field and set out 30 to 40 centimeters apart. In India, where ragi is a very important crop, upland ragi yields an average crop of from 1,125 to 1,700 kilos of grain per hectare and lowland ragi about twice this crop.

Upland ragi has been introduced into the Philippines this year.

RAPE. *Brassica napus* L.

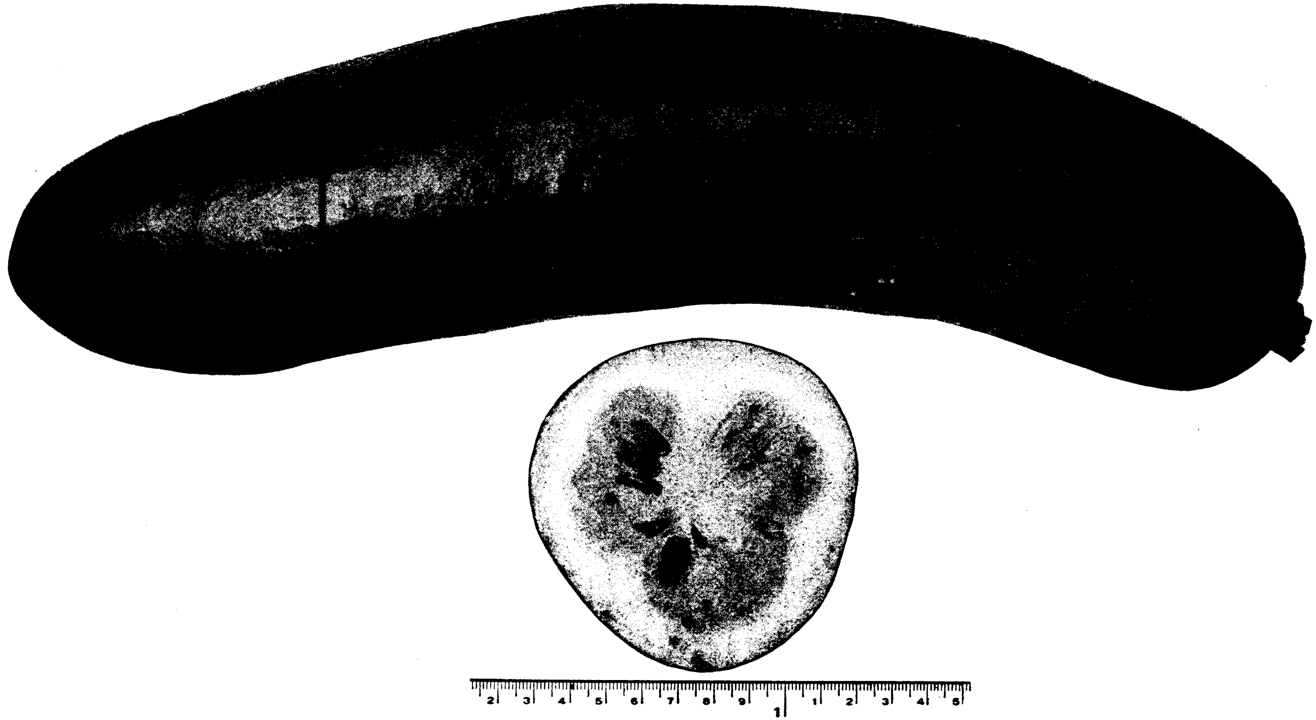
An annual plant, a native of Europe, with a top very similar to that of the rutabaga but more vigorous and without a fleshy root. Ordinarily grown for its seed from which oil is expressed, but recently found to make good "greens" for the table, eaten like turnip greens or spinach. Has been introduced and grown successfully as a vegetable in Palawan but is almost unknown in general culture.

SEMBU. *Canna edulis* KG.

A perennial, robust herb of upright growth, attaining a height of 2 meters or more, with large, broad leaves and dark-red flowers; a native of tropical America. Cultivated as an annual for its fleshy, starchy tubers, eaten like potatoes or made into starch. Introduced from Hawaii in 1918.

SUNFLOWER. *Helianthus annuus* L.

A coarse, annual herb, attaining a height of 2 meters or more, large, rough leaves and a large, solitary disk-like head of yellow flowers, 20 centimeters or more in diameter; native of Western United States. The seeds may be eaten roasted like peanuts, and a good cooking oil is expressed from them. They also make a good poultry food. Has been repeatedly imported since 1900, and probably previously by the Spaniards, but is rarely seen, though well adapted to the country.



The Curuba, *Sicana odorifera*, grown at Lamao Experiment Station.

Libato, *Basella rubra*, showing method of trellising. Lamao Experiment Station.

THE CULTIVATION AND USES OF ROSELLE

By P. J. WESTER, *Agricultural Advisor*

INTRODUCTION

The roselle was first introduced into the Philippines in 1905 and within the last nine years it has been widely distributed in the Archipelago. No plant that has ever been brought into the Philippines is more at home and few grow with so little care as the roselle, or are so productive. Still, like so many other new introductions, the roselle has been slow to gain hold in the popular taste though here and there it is now found in the provincial markets. Because of the agreeable, refreshing flavor of all preparations made from it, because of their wholesomeness, and because of its easy culture the roselle deserves to be more widely grown. The plant itself is so ornamental that it might well be cultivated just on its decorative merits.

The fleshy calyx or "fruit" and the immature leaves and stems of the roselle may all be prepared in various ways for human consumption. The stem itself furnishes a strong fiber of good quality. The seed makes a good poultry food.

The utilization of the herbage of the roselle for the wholesale manufacture of a wholesome, cheap wine was conceived by the writer several years ago before prohibition was enacted in the United States. This aspect of the wholesale culture of the roselle cannot of course be considered within the jurisdiction of the United States at present. On the other hand the prohibition wave has produced a greatly increased demand for soft drinks, and roselle sirup as a flavoring extract might well be considered for introduction to the public by the dispensers of soft drinks, which could be produced at a wholesale rate from the herbage unparalleled in the history of similar products.

As to the desirability of the culture of the roselle for home use there is, of course, only one answer. Whether or not the plant might be grown for export is a question of the demand and price paid for the product abroad.

To planters who might consider the growing of the roselle for export there are two avenues of disposal of their products.

The sirup, jelly, and sauce could be put up in a cannery near the plantation ready for export, the usual procedure with products of this kind, but the fruit and the herbage might also be evaporated and compressed, and then exported abroad for further elaboration. With the fruit this has been done in Hawaii, and it might be duplicated in these Islands both with the fruit and the tender herbage.

The following paper is a recapitulation of the practical data relative to the roselle of interest to the grower of the plant, the manufacturer of roselle products and the housewife, accumulated to date, previously published from time to time in this *Review*.

THE PLANT

The roselle, *Hibiscus sabdariffa* L., is an upright growing, much-branched, bushy, annual herb, attaining a height of one to sometimes exceeding two meters in the culinary varieties. Those that are grown strictly for their fiber are tall, and less inclined to branch, sometimes exceeding 3.5 meters in height. On the young plant the leaves are entire but change to palmately five-parted as the plant grows older; then, as the plant comes into the blossoming stage the leaves in the axils of which the flowers appear again change to three-parted or entire. The flowers are large, pale yellow, almost sessile, and are usually borne singly in the leaf axils.

Roselle is a native to the Old World Tropics but it is now well introduced into most tropical countries.

VARIETIES

The economic value of the roselle has been known for a long time, but the plant can scarcely as yet be said to be extensively grown anywhere, and consequently very few varieties are known. Four varieties, the Rico, Victor, Archer, and Altissima are at present being grown in the Philippines.

Rico (Plates XI and XII–*a*).—The plants of this variety are not as tall, but are proportionately more spreading than those of the other varieties, the leaves retain their unifoliolate character longer, and later are mostly tripartite instead of five-parted. The stems and calyces are dark red, and the leaves are dark green with reddish veins. The full grown calyx is about 40 to 50 millimeters long, and 28 to 32 millimeters in diameter; the fleshy spines subtending the calyx lobes are stout, and stand at nearly a straight angle from the axis of the fruit. The "eye" of the flower is dark red and the pollen is golden yellow.

"Victor" roselle coming into bloom. Singalong Experiment Station.

The Rico is somewhat more productive than the Victor and Archer.

Victor (Plates VIII and XII–*a*).—The plants of the Victor are 1.5 to sometimes exceeding 2 meters in height, somewhat taller, of more upright growth and are more robust than those of the Rico. The stems and calyces are reddish. The calyces are of about the same length as in Rico but they are more slender and tapering toward the end. The calyx lobes are frequently convolute, and the fleshy spines subtending the calyx lobes are longer and more slender than in the Rico and are curved upward. The "eye" of the flower is dark red and the pollen is golden brown. The fruiting is a somewhat earlier than in the Rico.

All foods and drinks made from the calyces of the Rico and Victor are a brilliant red and the juice from the herbage is also red.

Archer (Plates X and XII–*b*).—The plant is robust and of the same habit as the Victor; all parts of the plant are greenish or whitish. The flower is smaller than in the Rico and Victor, the "eye" is yellowish, the pollen pale yellow and the stigma green. The fullgrown calyx is greenish white, somewhat smaller than in the previously described varieties.

The plant is very prolific.

All products made from the Archer are whitish or amber colored.

Temprano is an early fruiting variety which originated at Lamao experiment station. Of value in subtropical countries having early frosts, being of weaker growth and less productive than the varieties mentioned above, its cultivation here has been discontinued.

Altissima (Plates XI and XII–*c*).—The plant is of upright habit, robust, and attains a height of more than 3.5 meters, branching sparsely or not at all. The flowers are normal. The calyx is small, thin and fibrous and covered with short, stiff bristles. The plants are red or intermediate between red and green.

The fruit is inedible, but an exceptionally long, strong and silky fiber may be extracted from the stem.

CLIMATE AND SOIL

The roselle does the best and is most productive where the annual rainfall is ample; say, 1,800 millimeters, well distributed during the growing season, but the plant also succeeds exceedingly well under irrigation. Altitudinally it flourishes best from sea level to an elevation of 900 meters.

The roselle thrives well on any reasonably fertile soil. The plant is of rapid growth and requires abundant moisture for its best development, but well-drained land is essential for its well being. It is very much a subject to the root-knot nematode, *Heterodera radicicola,* and therefore should not be planted in land infested with this pest.

PLANTING AND CULTIVATION

The roselle has a more deep-going root system than most annual crops and the land should therefore be deeply plowed or spaded and the soil well pulverized preparatory to planting.

The seed may be sown any time of the year but for maximum production of large, fleshy fruit it should be sown in the month of May up to not later than the 25th of the month.

The seed may be sown thinly in a seed bed, and the seedlings transplanted to the field when they are 8 to 10 centimeters high, but the best plan is to sow the seed directly in the field as in planting corn. Four to six seeds should then be planted in each hill, the hills 1 to 2.5 meters apart, in rows 1.5 to 3 meters apart, depending upon the fertility of the land, the abundance of moisture, and the time of the year when the seed is sown. The earlier in the year the seed is sown the wider apart should be the spacing.

When 2 or 3 ordinary leaves have developed the plants should be thinned to 2 or 3 to each hill and the missing hills should be reset by thinnings made from hills having more than two plants. Subsequently the land should be cultivated from time to time to keep down the weeds until the plants are large enough to shade the ground, when cultivation may be discontinued.

These directions apply where the plant is grown for the calyces alone.

If it is desired to grow roselle for the manufacture of wine, flavoring extract or jelly from the herbage, the seed should be sown thinly in drills 60 centimeters apart during the first half of March. In dry districts the land should be irrigated as needed, and the field should, of course, be cultivated to suppress the weeds according to need. Within 6 weeks the first cutting of the herbage may be made, which should be made so as to leave the stubble 6 to 10 centimeters high. A month later a second cutting of herbage may be made and a third cutting about July

PLATE IX

A fruiting plant of "Rico" roselle. Lamao Experiment Station.

1. Two out of every three rows of stubble should then be plowed up, leaving the rows 1.8 meters apart, the land should be given a thorough cultivation and weeding, and the remaining stubble rows allowed to grow up and set fruit.

Experiments conducted by the writer at the Lamao Experiment Station have shown that treated as recommended in the above paragraph roselle will yield, within 9 months, over 17,000 kilos of herbage in the three cuttings and subsequently 6,300 kilos of calyces from the plants that are allowed to grow up and mature from the stubble.

In districts with evenly distributed rainfall probably four cuttings of herbage can be obtained before the stubble is allowed to grow up and set fruit.

Grown for fiber the roselle should be sown thinly in drills 40 to 60 centimeters apart.

HARVESTING AND YIELD

Except when planted from September to March when the growth of the plant is abnormally small and few fruits produced, roselle is peculiar in that no matter when the seed is planted the plant blooms late in September and October, and the harvest is usually over by the end of December. The calyces mature very rapidly and are ready to harvest within 15 days after blossoming. If the calyces are picked promptly after attaining their full size, while the calyx stems are still so brittle and tender that they snap on breaking, the plants continue to bloom longer, and the harvest is prolonged and the yield is materially increased.

From a planting in May a good variety will easily yield 6,500 to 8,000 kilos of fruit per hectare, and under favorable conditions the yield may be nearly doubled. In Hawaii, grown as an intercrop with rubber, roselle has yielded 16,800 kilos of fruit per hectare, or at the rate of 19,000 kilos per hectare had the entire field been devoted to roselle.

COMPOSITION AND USES

The roselle has practically no food value but it is of value as an aid to digestion of other foods because of its pleasant appetizing flavor. Drinks prepared from roselle are cooling and of agreeable taste.

Because of the similar uses and the similar flavor of the roselle products and the cranberry a comparison of their analysis is of interest.

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TABLE I.—*Analysis of Roselle and Cranberry.*

Constituents	Roselle grown in the Philippines	Roselle grown in Florida U. S. A.	Cranberry
	Per cent	*Per cent*	*Per cent*
Water	82.49	88.91	88.53
Solids	17.51	11.09	11.47
Ash	1.26	0.89	0.25
Marc (insoluble matter)	7.39	6.67	4.60
Acid (as malic)	3.31	2.77	2.74
Reducing sugar as invert	0.82	0.33	1.90
Sucrose	0.24	0.03	0.10
Benzoic acid	Absent	Absent	Present

The above analysis of the roselle refers to the calyx, after the refuse, which is about 50 per cent of the weight of the calyx, consisting of the seed pod and the stem end of the calyx, has been cut away. The leaves analyze about 1.25 per cent acid and the stems about 0.6 per cent, more or less depending upon their age at the time of cutting.

Uses of the calyx.—The calyx or "fruit" may be employed

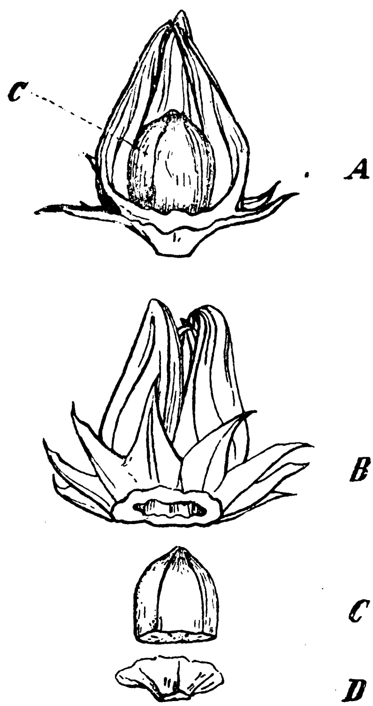


FIG. 1.—The "Fruit" of the Roselle illustrating the edible part and the refuse: *A* calyx with two calyx lobes removed showing seedpod *C*; *B* calyx, the edible part, ready for cooking; the refuse, consisting of seedpod *C* and base of calyx *D*.

Typical plant of "Archer" roselle at the Lamao Experiment Station.

in making a sauce eaten with meat, similar to cranberry sauce in color and flavor, or as a filler for short cakes and pies.

The calyx may also be employed for the manufacture of jelly, sirup or flavoring extract and wine. More definite directions relative to the preparation of these products are given under "Roselle Recipes."

Except in making sauce or jam or fillers for pies and cakes it is not necessary to remove the stem-end and seed pod of the calyx.

Uses of the herbage.—The tender leaves and stem may be used in preparing jelly, flavoring extract, sirup and wine, which resemble those preparations when made from the calyces in everything except that the color is less brilliant. Boiled, the leaves make good "greens" far better than those made from camotes and *kankong.*

About 100 kilos of herbage and 75 kilos of sugar make 300 liters of wine, and an equal amount of herbage makes approximately 200 liters of sirup, depending upon the quality of the herbage at the time of the cutting. The tender, succulent leaves and stems are rich in acid, but there is only a little acid in the over-ripe and fibrous herbage.

All preparations from roselle should be made in earthenware, porcelain, enameled or glassware or wood containers. *Metal containers should never be used as the acid in the roselle attacks the metal and poisons the contents.*

ROSELLE RECIPES

Baked pudding.—Take 1 cup flour, 2 teaspoons baking powder, $\frac{1}{4}$ teaspoon salt, 2 tablespoons butter or other shortening and sufficient milk to make soft dough. Pour $1\frac{1}{2}$ cups roselle sauce into an enamel-ware or porcelain dish, cover with dough, and bake 30 minutes in moderate oven.

Serve with hard sauce flavored with roselle sirup or jelly.

Cake.—Take 1 cup sugar, 1 rounding tablespoon butter, 2 eggs, $\frac{1}{2}$ cup milk, $\frac{1}{4}$ teaspoon salt, $1\frac{3}{4}$ cups flour, $2\frac{1}{2}$ teaspoons baking powder. Mix in order given. Bake in buttered and floured round layer-cake pans 15 to 20 minutes in a moderate oven. Put frosting between layers and on top of cake.

FROSTING.—Boil 1 cup sugar with $\frac{1}{3}$ cup water until sirup will thread from tip of spoon. Pour sirup gradually on stiffly beaten white of an egg. Beat until of right consistency to spread. Spread evenly over cake and dot with bits of roselle jelly with the frosting, or mix with the frosting, and also dot with bits of the jelly.

Cottage pudding.—Mix batter as for roselle cake. Place in a small dripping pan and bake 20 to 30 minutes in moderate oven. Cut in squares and serve with roselle pudding sauce.

PUDDING SAUCE.—One half cup sugar, 1 tablespoon corn starch, 1 tablespoon butter, $\frac{1}{3}$ teaspoon salt. Mix well. Add 1 cup boiling water, stirring constantly. Boil 5 minutes. Remove from fire and add $\frac{1}{2}$ cup roselle sirup. Serve hot.

"Duff."—Make a boiled roselle pudding and serve with hard sauce.

Gingerbread.—Take $\frac{1}{3}$ cup crisco, $\frac{2}{3}$ cup boiling water, 1 cup molasses, 1 egg, $2\frac{2}{3}$ cups flour, $\frac{1}{2}$ teaspoon soda, 1 teaspoon baking powder, $\frac{1}{2}$ teaspoon salt, 1 teaspoon cinnamon, 1 teaspoon ginger, $\frac{1}{4}$ teaspoon cloves. Mix well and pour into a well greased, shallow pan and bake 30 minutes in a moderate oven. Cut in squares and serve hot with roselle pudding sauce.

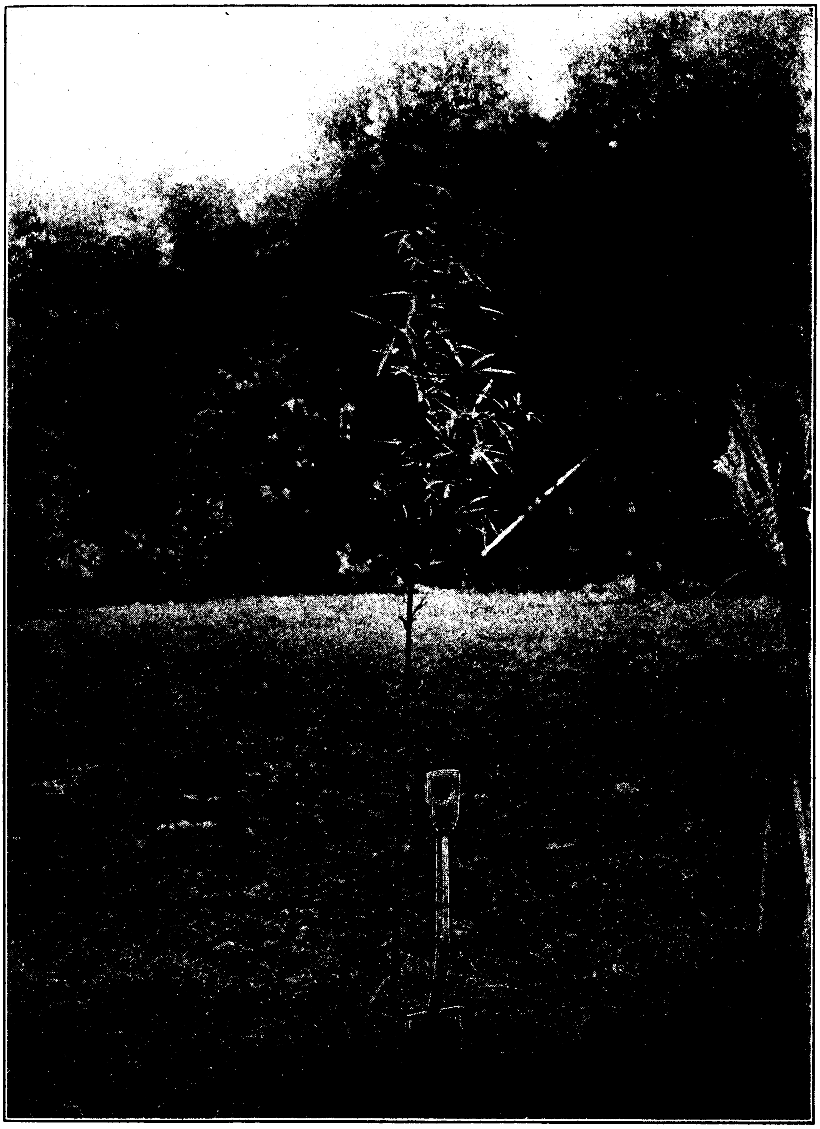
Gulaman.—Cut in small pieces sufficient gelatin (*gulaman*) to fill 1 cup. Wash thoroughly into 3 cups boiling water, boil until dissolved. Add $\frac{1}{2}$ cup sugar and 1 cup roselle sirup. Remove from fire and add sufficient hot water to make $3\frac{1}{2}$ cups (more or less water may be used depending upon how hard the product is desired), strain into mold and let stand 30 minutes to harden. When partly cool, cubes of fruit or nuts may be added if desired. Serve with whipped and sweetened cream or with cream and sugar.

NOTE.—This recipe may be used where ice is not available.

Jelly (from calyces).—Rinse the calyces well, put in pan with just enough water to cover the calyces, boil until soft, strain the mass through a cloth bag, measure the juice and add an equal amount of sugar, liquid measure, and boil until jelly is formed, from ten to twenty minutes.

Jelly (from herbage).—Cut tender leaves and stems of the plants and rinse well. Chop the material so that it will go into the pan easily, pour on boiling water until the stems are barely covered with water after they have wilted, and boil from 3 to 5 minutes; pour off juice, strain, measure and return it to the boiler and boil until the juice is reduced to about one-third; then add sugar, liquid measure, equal to the amount of juice before its reduction and boil until jelly is formed. If desired lemon or lime juice may be added, one lemon to about 6 glasses of jelly.

By heating the sugar to the point of melting and then pouring it into the boiling juice, a harder jelly is obtained than if the sugar is not heated.



Typical plant of "Altissima" roselle at the Lamao Experiment Station.

The roselle is deficient in pectin and therefore sometimes jellies with difficulty and afterward dissolves into a thick sirup. This may be corrected by adding pectin or a fruit rich in this substance such as genipa, *Genipa americana*, or apples when the jelly is made.

Jelly cake.—Use butter as for roselle cake. Bake in round layers and spread with roselle jelly. Sprinkle top of cake with granulated or powdered sugar. Serve warm or cold.

Pie.—Line a pie tin with puff or plain paste. Fill with roselle sauce, sprinkle with sugar, cover with lattice work or pastry. Bake 30 minutes in a moderate oven. Serve cold.

Pottage.—Take tender leaves of roselle, rinse well and boil until tender. Serve hot with meat.

Punch.—One pint roselle sirup, 1 quart finely cracked ice, ½ cup sugar, juice of two oranges.

Roly-poly.—Make dough as for roselle short cake. Roll ¼ inch thick, spread with roselle sauce, sprinkle with sugar. Roll up and place in a well greased, deep pan. Bake 30 minutes in moderate oven and serve with hard or vanilla sauce.

Roselleade.—Rinse well calyces or tender stems and leaves and place in pan, pour in enough water to cover, boil for 3 to 5 minutes, strain juice, cool, and dilute with water and sugar to taste. Serve cold.

Sauce.—Cut off the stem-ends and remove the seedpods from the calyces, rinse well in clean water, chop if desired, place equal parts of seeded calyces and water, liquid measure, in a pan and boil until tender, add sugar to taste. Serve cold with meat, or use in other ways as directed in the recipes.

Sherbet.—One pint roselle sirup, 1 cup sugar, 1 quart water. Mix and after putting in freezer add stiffly beaten white of one egg and freeze.

Shortcake.—Take 2 cups flour, 3 teaspoons baking powder, ½ teaspoon salt, 2 tablespoons sugar, 2 tablespoons butter, and sufficient milk to mix. Place in a round pan and bake 20 minutes in quick oven. When done split, spread with butter, and then with roselle sauce. Serve warm or cold.

Sirup.—Follow directions for making jelly, but boil the juice to a sirup instead of a jelly or, after rinsing put the herbage in a keg or earthern-ware jar. Pour in sufficient boiling water to cover the herbage and place a cover on the keg to exclude dirt; allow to stand for 24 hours to extract the acid, then filter through cloth. Boil the liquid until reduced to one-third of its volume and add sugar to suit the taste, about equal volumes of sugar and concentrated juice. Continue the boiling with constant stirring until the sugar is completely dissolved. Bottle while hot.

NOTE.—The sirup may be used as a flavoring extract in making ice cream, sherbet and soda water or in other ways as directed in the recipes.

Wine.—Treat the herbage as in making sirup. After filtering place the juice in a clean cask, previously scalded out with boiling water. For every four liters of juice add 1 kilo of sugar, made into a thick sirup by adding boiling water, poured into the juice. Then dissolve yeast in a little warm water, pour into the cask and mix the contents thoroughly by stirring. Set the cask aside to remain undisturbed during fermentation which will take place within a week.

If a sparkling wine is desired the juice should be drawn off and bottled before fermentation is complete. If a still wine is wanted delay the bottling until fermentation has ceased. Ageing improves the flavor and bouquet, but young wine is very satisfactory. Wine made from herbage or calyces of Rico and Victor is red, while that made from Archer is amber colored, resembling champagne.

ROSELLE AS AN AUXILIARY CROP AND A FIBER PLANT

Roselle is a crop that lends itself readily for use as an auxiliary crop in young rubber and coconut plantations and orchards where labor and other facilities are available to handle it.

A few years ago when Ceara rubber was being planted in Hawaii, roselle was successfully grown as an intercrop between the young rubber trees and the calyces were dried in fruit evaporators and shipped to the United States. On a coconut plantation where artificial driers are already installed for the drying of copra, these could be employed in drying roselle without it being necessary to install evaporators. Of course, the limit of the demand for dried roselle products would preclude the extensive planting of roselle for this purpose.

On the other hand the roselle might be extensively grown as an auxiliary crop between rubber and coconuts for its fiber for the manufacture of jute fabrics which otherwise will have to be imported in increasingly great quantities from abroad as the Philippine production of rice, sugar, coffee, and other products increases in volume.

In India the roselle is grown to some extent for its long, strong, silky fiber which is used in the manufacture of bags and other jute fabrics. When grown for this purpose the plants are cut when they are in full bloom and the stems are retted in water for the extraction of the fiber.

(*a*) "Rico" (at left) and "Victor" (at right), grown at the Lamao Experiment Station.

(*b*) "Temprano" (at left) and "Archer" (at right), grown at the Lamao Experiment Station.

(*c*) "Altissima" roselle (intermediate type at left and red type at right), grown at the Lamao Experiment Station.

ROSELLE VARIETIES.

DISEASES

The only disease so far reported on the roselle in the Philippines is *Phoma sabdariffae* Sacc., but apparently it is not a serious pest. Another unidentified disease causing the leaves to turn soft as if scalded with hot water and then shriveling, is more serious, but fortunately, so far as observed, it appears late in the season after the blossoming and fruiting is well advanced. Young plants have never been noted to be affected by this trouble.

In Florida the roselle is attacked by a mildew, *Oidium* sp., which appears during the fruiting season. It is, however, easily controlled by dusting dry sulphur over the plants. So far this disease has not appeared in the Philippines.

INSECT PESTS

The most serious insect enemy of roselle is the root-knot nematode, *Heterodera radicicola.* A cheap and effective remedy for this pest has not yet been found, and infested lands should not be planted to the roselle as it cripples the plants very severely.

The cotton stainer, *Dysdercus suturellus,* sometimes makes its appearance on the ripening calyces but seems to be rather harmless.

Aphids, *Aphis* sp., sometimes attack the young plants but they are readily controlled by the application of tobacco dust.

Two scales, *Coccus hesperidum* and *Hemichionaspis aspidistrae,* have been recorded on the roselle but are not important. Mealy bugs are more serious. Affected plants should be torn up and burned with the insects if they appear early in the season, in order to prevent their spread, which is usually effected by ants.

In Queensland the three following beetles recently have been found destructive to the leaves of the roselle: *Nisotra breweri* Jarv., *Lagris cyanea* Macl., and *Rhyparida discopunctulata* Lea. They can be combatted by spraying the plants with arsenical spray mixtures.

AGUSAN: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

Agusan Province (Plate XIII) is located between 8° and 9° 31′ north latitude and between 125° 7′ and 126° 15′ east longitude, and is bounded on the north by Butuan Bay and Surigao Province, on the east by Surigao, on the south by Davao Province and on the west by the Provinces of Bukidnon and Misamis on the Island of Mindanao. It has an area of 4,294 square miles, a population of 44,183 inhabitants, and comes within 696 square miles of being equal to the State of Connecticut in area.

Mountain chains, with here and there peaks rising to an elevation of from 1,000 to nearly 2,000 meters, form the east and west boundaries, from which there is a more or less rapid descent to the Agusan Valley, which occupies the larger part of the province. In the north eastern part of Agusan another, smaller valley is formed by the Tubay River, which rises in Lake Mainit on the Surigao border.

According to the latest estimates and surveys by the Bureau of Forestry, out of a total area of 1,112,146 hectares, only 57,935 hectares or 5.2 per cent are under cultivation. The swamps and lakes in the interior are estimated at 50,000 hectares, or 4.26 per cent of the total area, while the salt water swamp along the coast covers an area of 4,400 hectares. Most of the land, or 961,830 hectares, 86.5 per cent, is covered by commercial forests.

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[1] The writer wishes to acknowledge his indebtedness to Coloned Ole Waloe, Philippine Constabulary, for access to the Constabulary Monograph of Agusan in the course of the preparation of this article. The Bureau of Forestry Circular No. 5, *Memoria Descriptiva de la Provincia de Agusan* has also been consulted. Plate XIII has been traced from a map furnished by Mr. H. E. Neibert, supervising surveyor, Bureau of Lands. Plate XIV has been obtained through the courtesy of the Director of the Coast and Geodetic Survey, Manila. Plates XV, XVI, XVII and XVIII have been made from photographs owned by the Bureau of Science.

Oversized Foldout

The Agusan River is the central feature of the province which it has given its name. With a total length of 386 kilometers (240 miles)—of which 12 kilometers are navigable for interisland steamers with a draft of 8 to 9 feet, except during the driest part of the year, and for smaller river craft to Patrocinio, located on the boundary between Agusan and Davao, for a distance of about 250 kilometers—the Agusan is one of the three largest rivers in the Philippine Archipelago. The river has its source in Davao near the Pacific coast west of Karaga, south of the head of the Davao Gulf and flows with many turns and windings in a northerly direction to empty into Butuan Bay. At the mouth the Agusan is over a mile wide (1.65 kilometers) and the effect of the tide is felt some 25 kilometers up the river. At San Vicente the river is still 200 meters wide and at its exit from the lake region it is 120 meters broad.

The "Lower Agusan" is rather sluggish, while the current farther south ordinarily is but moderately rapid and the ascent is easily made by launch (Plate XVIII). In flood times the current is more rapid, the river overflows its banks and inundates the surrounding country, the current carrying with it numerous logs, trees and other débris that render navigation difficult and dangerous. Among the numerous tributaries of the Agusan the Wawa, Hibung, Simulao, Ohot, Umayam, Adgaoan and the Ihawan Rivers are the largest and the most important. These rivers in turn receive the water of numerous smaller streams making the province a veritable network of water courses.

The Wawa rises north of Mount Hilonghilong and flows in a southerly direction until it enters the Agusan at Esperanza. Ordinarily the Wawa is navigable for barotos to Verdu only owing to the rapid current of the river.

The Hibung River, quite deep and of moderate current, and with numerous tributaries, flows with many windings in a southerly direction until it turns westward and enters the Agusan opposite the Adgaoan River. Except in periods of droughts the Hibung is navigable to Prosperidad for river craft having a draft of 4 to 5 feet.

The Simulao River, which rises in Davao near Kateel Bay flows northwest and enters the Agusan a short distance south of the confluence of that river and the Hibung. The lower end of Simulao is navigable for small launches to Bunawan, up to which point it is also commonly known as the Katgasan River.

The Umayam River rises on the slopes of Mount Babaon on the Bukidnon boundary. Through a mountain district it flows southward for a distance of about 35 kilometers, turns east and then northward and after passing the Pigduktan falls, winds its way to the Agusan River. The lower course of the Umayam is navigable for launches drawing 5 feet of water to Loreto, and from there to Waloe by barotos.

The Adgaoan rises near the source of the Umayam but flows in the opposite direction, then proceeds on its tortuous course in an easterly direction until it joins the Agusan opposite the mouth of the Hibung River. The Adgaoan is navigable for launches of 5 feet draft to La Paz and thence for barotos to Sagunto.

The Tubay River, which forms the outlet for the water in Lake Mainit, about 50 square miles in extent and 25 meters above sea level, is navigable for launches for a distance of 20 kilometers from Lake Mainit to Lake Pagusĭ below which the rapids and the swift current render navigation impracticable except for barotos.

While in volume they do not compare with the Maria Christina falls in Lanao Province, the Pigduktan falls of the Umayam River, 150 meters high, greatly exceed them in height, being in fact, the highest falls of any considerable size in the Philippines. The Kolilokon falls, 45 meters high, of the Tigbauan River are very beautiful and interesting as are its many grottoes and caves.

The more noteworthy mountains are the Urdaneta, south east of Lake Mainit near the Surigao boundary, 1,750 meters high; Mabaho of about the same height, a little farther south on the same mountain range; and Hilonghilong, still farther south, about 1,900 meters high. In the southwestern part of the province, Kinabalian, attaining a height of 1,350 meters, is the most prominent. Mayapay, southeast of Nasipit harbor, is approximately 700 meters in height.

In the interest of the tourist, it is a pity that the Agusan is so far from Manila, for no other river in the Philippines so typifies the river of the tropics as pictured by the imagination quickened by reading the accounts of travelers and explorers, and it still retains its primeval beauty.

From the mouth of the river to Butuan the land is low, barely above tide water and the vegetation consists largely of mangrove and other salt water plants, a few coconuts appear from time to time, and here and there clumps of sago palms further inland beyond the influence of the salt water. At Butuan the land begins to rise slowly and is at considerable elevation above the river all the way to Talakogon. It is forested to the river

Oversized
Foldout

banks, the trees overhanging the river frequently being draped to the mirroring water with climbing plants, mostly leguminous or convolvulaceaus, in the greatest profusion, presenting a charming effect. A motor launch going up the river passes small clearings planted to corn, abacá and rice, and primitive houses or huts from time to time, into which timid women and children scurry at its approach while curiosity gets the better of the bolder male population, and they stand their ground to inspect the stranger. Round a turn in the river it may meet a native on a raft of bamboo loaded with supplies probably obtained by barter at some settlement farther inland. Clumsy crocodiles, agile iguanas and deliberately moving monkeys are a common sight. The slender, climbing rattans which gracefully rear their heads above the other, more opulent vegetation, and here and there a fish tail palm or "palma brava" tend to relieve the effect of the heavy vegetative luxuriance that at last becomes almost monotonous.

Talakogon, the gateway, so to speak, to the "lake region" is said to be a trifle more than 30 meters above sea level. If this statement is accurate the drainage of the vast swamps to the south should not present any very great engineering difficulties. The lake region is intersected by a bewildering number of streams, canals and rivers running in every direction, and woe to him who ignorant of the routes of travel guideless dares to enter the maze. Here and there the river bank is quite high though rapidly sloping downward into the impenetrable swamp beyond. Then again, the launch passes through narrow channels between seas of aquatic, floating grasses, in which now and then rise islands supporting a luxuriant vegetation among which attractive pandans with slender, tree-like trunks add to the picturesqueness of the landscape (Plates XV and XVI). Absent nearer the coast, bamboos again make their appearance in the lake region, but it is a dwarf, bushy, slender species that is of but little value. Epiphytes of many kinds are common. Two species of *Vanilla* grow wild in Loreto and probably at other points.

The district usually called the "Lake Country" of Agusan extends from Talakogon in the north to Veruela in the south for a distance of some 55 kilometers. At its greatest width it is about 25 kilometers broad.

It is said that during a heavy flood in 1860 one of the branches of the Agusan was closed by the accumulation of debris floating down the river and that this was the beginning of the inundation of the lake country. In 1905 seismic disturbances caused a still further subsidence which is believed to be still in progress.

Of the many "lakes," in this region, which are mostly small and very shallow, Lumao is the largest.

The land around Lake Mainit, the Tubay River and its tributaries forms another, smaller and very attractive valley in the northeast of Agusan Province. The land here is well drained and the country is more exposed to the sea; the climate is cooler and less oppressive than in the Agusan valley. The soil is fertile and well adapted to abacá, coconuts, coffee, rice, corn, and the variuos minor food crops.

CLIMATE

Among Americans the climate of Agusan does not enjoy a very good reputation. During the day it is hot, still and sultry, and the nights are cool and damp, and heavy fogs settle over the valley and swamps.

This climate is due to the peculiar topographical features of the Agusan valley, on all sides hemmed in by mountains shutting off the refreshing breeze from the sea except over a narrow stretch in the north. Then, too, the heavily forested valley retains more humidity than it would if the forest was cleared away—even were it not for the presence of the vast swamps and lakes. Earthquakes are frequent, though rarely destructive. Storms and typhoons seldom do much damage because of the protection afforded by the surrounding mountains. In the south of the province they are, as a matter of fact, of rare occurrence.

The mean monthly and annual rainfall of Butuan is as follows, according to the Weather Bureau:

	Millimeters.
January	181.5
February	244.1
March	147.6
April	122.0
June	151.1
July	129.6
August	98.9
September	136.2
October	162.9
November	287.9
December	317.5
Total	2,105.8

The rainy days average 188 in number.

Thus it will be seen that the rainfall here is of fairly even distribution throughout the year with most of the rain falling from November to March. Destructive droughts are unknown.

Scene on upper Agusan in the lake region.

The precipitation is very much greater in the interior of the province and there, especially on the mountain slopes east of Agusan River, the annual rainfall probably does not fall much short of 4,000 millimeters. Floods are an annual occurrence in the upper Agusan Valley during the rainy period, but the swamps and lakes act as a natural reservoir and absorb the surplus water so that the lower or northern part of the valley as a rule is not affected by these inundations.

Floods usually are associated with destruction. But the regularly recurring annual floods of Agusan are more like those of the Nile in that as they retreat the muddy waters leave on the fields a thick deposit of the fertile soil they have washed down from the mountain slopes in the interior, annually renewing the fertility of the land.

POPULATION

As previously stated, according to the Census of 1918 the population of Agusan numbers 44,183 souls, of whom approximately 25,000 are "non-Christians." The remainder are Christianized. A few Chinese traders live in the largest towns on the coast and rivers. There are very few Caucasians in the province.

The Christians are mostly Visayans, who live along the coasts and in the principal settlements along Agusan River and its tributaries. Of the non-Christian inhabitants the Manobos predominate, inhabiting the country along the Agusan and its tributaries. They are of a strong and well developed physique and would undoubtedly make good plantation laborers. However, all told they do not number more than about 20,000. The Mandayas are but a few thousand in number and live in the upper Agusan valley near the Davao boundary. They are of light complexion and well developed physically. While otherwise desirable because of their limited number these tribes cannot be considered as a possible factor in development work on a large scale for which labor must be imported.

The Mamanuas, a nomadic negroid race, believed to be the aborigines in this part of Mindanao, have been rapidly diminishing in numbers for many years and are probably doomed to early extinction. At present there are some 2,000 of them.

HISTORICAL REVIEW

One of the least developed of all the provinces in the Philippines the authentic history of Agusan is equally scant notwithstanding that Magellan made his first landing in the Philippines at the mouth of Agusan River in 1521 and took possession of the Archipelago for the crown of Spain. A concrete monument which is still standing in a small barrio called Magallanes, located to the left of Agusan River, was erected by the Spaniards in 1872 at the point of landing to commemorate the discovery. In 1709–10 the Spaniards first attempted to penetrate into the interior of Agusan, an ambition which appears to have been achieved without much resistance from the native inhabitants. Small settlements were made here and there along the rivers though the Spaniards never exercised practically any control over the natives.

Butuan has been the capital of Agusan for about 100 years. It was first located at the point of landing by Magellan, but because of its exposure to the floods of the Agusan the town was in 1868 removed to Banza barrio, about 5 kilometers above Magallanes. For the same reason it was again transferred in 1878 to its present site on the right side of Agusan River, about 6 kilometers inland. At present Butuan and Kabadbaran are the only two towns in Agusan where interisland steamers call regularly. While settlements were made and missions started by the Jesuits in the interior prior to that date, it does not appear that any organized attempt to civilize the native inhabitants was made until in 1873, when several villages or towns were first organized both on the coast and in the interior of the province. In 1885 there were 24 organized settlements. The occupation by Americans was effected without notable incident, and under the name of Butuan the province was administered by the Secretary of the Interior as one of the "Non-Christian provinces" until 1914 when the present organization took effect, and Agusan became a province in the Department of Mindanao and Sulu.

AGRICULTURE AND FOOD CROPS

Mountainous in the east and west, the soil has been carried from the higher elevation by the water in the innumerable rivers and streams and deposited in the central part of the province thus making extraordinarily fertile a broad valley of which but an infinitesimal area has as yet been brought under cultivation.

Agriculture in Agusan is in a primitive stage. Abacá and copra are the principal crops. The abacá is produced mostly along the Agusan, its tributaries and the Tubay River. The coconuts are found on the coast and up to Butuan on the river. Few coconut palms are seen in the interior of the province. A comparatively large area is devoted to corn, a more prominent crop

Another view in the lake region, upper Agusan River.

in Agusan than rice, which is still an import item of this province. A small amount of tobacco is grown for home consumption.

According to the statistics furnished by Mr. Antonio Peña, chief, division of statistics of this Bureau, the agricultural industries of Agusan rank as follows:

TABLE I.—*Agricultural Statistics of Agusan, 1918.*[1]

Crop	Area	Yield	Value
	Hectares		*Pesos*
Coconuts	3,179		612,615
Abacá	2,513	[b]897.8	601,105
Corn	2,930	[a]40,037	256,083
Rice	1,471	[a]26,337	107,568
Tobacco	25	[b]12.5	11,750

[a] Hectoliters. [b] Metric tons.

Other, more common food crops are sugar cane, camotes, gabi, cassava, peanuts, squash, mungos, eggplants, tomatoes and chili. The sago palm is also a source of food.

The sago palm, *Metroxylon sago* Rottb., flourishes over a considerable part of Agusan but the total area in sago swamps is apparently much smaller than in Cotabato, and it is doubtful whether the material is present in sufficient abundance to sustain a sago industry of any considerable magnitude. Here it may not be inopportune to recall that the sago palm has never been accorded the attention it deserves from civilized man. Yet, no starch producing plant will grow with so little care; it flourishes on land on which most other crops fail, once established the sago palm is established for many generations for unlike most other palms it suckers freely from the base and the creeping stems. The sago palm furnishes a wholesome, nourishing and cheap food whose extraction and preparation requires no very expensive or intricate machinery. Easily as the plant is propagated, it would appear that the Government agencies with jurisdiction in Agusan might well consider the systematic extension of the Agusan sago swamps with a view of insuring an

[1] Since this was written the statistics for the year 1919, have become available as shown below.

Crop	Area	Quantity	Value
	Hectares		*Pesos*
Coconuts	3,234	[a]4,304	[d]499,402
Abacá	2,625	[b]1,339	552,868
Corn	1,616	[c]25,128	230,413
Rice	2,218	[c]34,986	195,234
Tobacco	28		7,286

[a] Copra, metric tons. [b] Metric tons. [c] Hectoliters. [d] Value of all coconut products.

easily procurable local food in times of famine, also looking forward to the manufacture and export of sago sometime in the future which now is one of the import items in the Philippine Archipelago.

Among the fruits the durian, bauno, lanzon, banana, papaya, guava, pineapple, and jak are the most prominent. There are durian trees, *Durio zibethinus*, of enormous size and unquestionably very old all along the Agusan in the various settlements up to the Davao boundary, and large baunos, *Mangifera caesia*, of excellent quality are obtainable at Butuan when they are in season. South of Talakogon, at which point there are many large baunos, this tree has not been noted. On the right side of the river as one approaches Butuan there is a small forest of this excellent fruit and next to Jolo, Butuan is no doubt one of the best fields for selection work with a view of establishing standard superior varieties of the bauno. Here, too, it might be mentioned that near Momungan, Lanao, there is also said to exist a forest of baunos. Dillenias are common in the upper Agusan valley, and the kamingi, *Litchi philippinensis*, is common around Lake Mainit. This latter species is a very handsome tree with a fruit of fairly good quality though much inferior to the litchi.

At present there are no large plantations in this province.

FOREST RESOURCES

According to the latest compilations made by the Philippine Bureau of Forestry, Agusan Province has 961,830 hectares of commercial forests, 86.5 per cent of the total area of the province, an area exceeded only by Cotabato, Davao, Zamboanga and Palawan.

The forests include among others the following timber trees: apitong, *Dipterocarpus* sp.; mayapis, *Shorea squamata;* white lauan, *Pentacma contorta;* molave, *Vitex* sp.; amamanit, *Eucalyptus naudiniana;* toog, *Terminalia quadrialata;* tanguile, *Shorea* sp.; mancono, *Xanthostemon verdugonianus;* pagatpat, *Sonneratia pagatpat;* bagtikan, *Parashorea plicata;* dao, *Dracontomelum dao;* ipil, *Intsia bijuga;* narra, *Pterocarpus indicus;* camagon, *Diospyros discolor* and guijo, *Shorea guiso.* Teak, *Tectonia grandis*, is also found but not in commercial quantities.

So far there are no saw mills in operation in Agusan, though in general the province is considered to present good opportunities for lumbering on a large scale (Plate XVI). According to Mr. Rafael Medina, assistant director of Forestry, who made a survey of the forests of the province in 1915, the best site for

Virgin timber forest on the lower Agusan River.

a large central saw mill is on the Agusan River between San Vicente and Vitus. The large number of water courses could to great advantage be utilized in the transportation of logs from the forests to the mill.

Large quantities of rattans are obtainable from the forests. Beeswax and almaciga may also be gathered. The large mangrove swamps on the coast could sustain a cutch industry of considerable proportions.

RESOURCES OTHER THAN AGRICULTURE AND FORESTS

Agusan Province is not sufficiently explored to warrant definite statements relative to the mineral resources within its boundaries. Gold has been found in nearly all the rivers that originate east of Agusan but the extent of these deposits is unknown. Platinum finds have been made together with the gold. There is coal near San Vicente but no survey of the deposit nor quality tests have been made. Natural gas which burns readily has been discovered in Magallanes, and there are hot mineral springs in the Lake Mainit region and near Noveli in upper Agusan.

As elsewhere in the Philippines, there is an abundance of fish of all kinds in Butuan bay and Lake Mainit is well stocked also. Fresh water fish in large quantities are caught in the lake country during the "dry" season.

COMMERCE AND COMMUNICATIONS

Abacá, copra and bejuco constitute practically all the exports of Agusan.

Practically all interprovincial communication is by water on the Agusan River and its tributaries and on the Tubay. The province operates a small launch on the Agusan which makes regular trips between Butuan and Talakogon. The mileage of good roads is insignificant. The principal municipalities are connected by a local telephone system, and Butuan has cable communications with Manila and other points via Cebu.

Several inter-island steamers call at Butuan and Kabadbaran regularly and now and then at Tubay and Nasipit. One hundred and fifty-five steamers called at Butuan during 1918.

The value of the rivers and streams for navigation has already been indicated on page 101 in addition to which many smaller streams are navigable for barotos for longer or shorter distances depending upon the season and the flow of water.

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PROSPECTIVE INDUSTRIES AND FUTURE DEVELOPMENT

At present one of the least known and least advanced provinces in the Philippines, when the broad valley of marvelously fertile soil, its abundant and evenly distributed rainfall, and its protected situation and vast forests are considered; it would seem that one is justified in the prediction that in Agusan capital and labor are all that are required to transform the wilderness into an enormously productive country. Harnessed, the rivers and streams would be capable of furnishing more power than ever will be required either for industrial or transportation purposes, and once they are dredged and straightened they would furnish a cheap mode of transportation for much of the produce. They would provide a never failing water supply for irrigation purposes were that needed, but that is unlikely, however, in a region where the rainfall is so remarkably well distributed and so abundant as in Agusan. Lastly, at Nasipit, Agusan possesses the finest harbor on the north coast of the island of Mindanao, which some day will unquestionably become one of the principal terminals of the future railroad system of Mindanao and the outlet for the products of Agusan and northern Davao. The Agusan river affords good protection for shipping but because of the bar formed by the silt and accumulated debris at the mouth of the river it is approachable only at high tide. With sufficient shipping to justify the expense a passage could, of course, be kept open by dredging. (See Plate XIV.)

At present practically the only means of communication and routes of travel are along the Agusan River and its tributaries, and the casual traveler who does not have the time or the inclination to penetrate inland from the rivers is apt to carry with him the impression that Agusan is divided between swamps and a network of sluggish rivers. True, Cotabato perhaps excepted, Agusan has a larger area of swamp lands than any other province in the Philippines, and the climate is considered depressive. However, this condition applies to the low and swampy areas near the rivers and on the coast and there is no reason why the more elevated areas removed from the swamps and rivers should not be desirable land for settlers. It is true, of course, that this land is less accessible than other, equally good farming land in other parts of the islands, and for that reason Agusan valley will probably remain an unsettled region for many years unless a corporation with ample capital should obtain concessions for development on a very large scale. On the other hand, the valley around the Tubay river and Lake Mainit in the northeastern corner of the province and the well drained lands along the coast

Typical river view on lower Agusan.

afford a large area of fertile land eminently adapted to colonization by settlers of small means who might wish to make their home in Agusan.

As may already have been noted the development of Agusan all lies in the future, and to the promoter and pioneer with sufficient capital and imagination the province with its unusual opportunities for development, presents a fascinating aspect. Here is an opportunity to shape the future history of a province as large as some states in the American Union and to predetermine its industries and the routes of its highways, within certain limits to predicate even its future inhabitants.

An enterprise conceived on sufficiently broad lines would naturally devote a large share of its energies to lumbering, especially in the beginning, but hand in hand could and should follow the development of big estates planted to coconut palms, Para rubber, abacá, coffee, cassava, roselle, and jute, for all of which crops the region is preeminently suited. Extensive sago palm plantations might be established. It would be necessary to straighten out the Agusan river and some of its tributaries to more rapidly drain off an excess of water during the rainy period and to shorten the distances for transportation.

The rafting of the logs on the rivers would require supplementary logging railroads. Then, the opening of the interior of the province and the need for overland rapid transportation and connections with Davao and Cotabato would demand the construction of a railway from Nasipit to the Davao Gulf. From Azpitia a branch line to Lianga Bay on the Pacific coast might be found desirable.

For an enterprise of this magnitude, Nasipit with its excellent, well protected harbor would be a convenient and attractive center of administration and an excellent site for mills, factories and warehouses, as it would become also not only the principal port of Agusan but probably the largest export center on the north coast of Mindanao.

ON THE EVOLUTION OF THE CORN EAR

By NEMESIO B. MENDIOLA, Ph. D., *University of the Philippines*

In 1906 Montgomery published the theory that the ear of corn originated directly from the central spike of some tassel-like structure similar to the corn tassel. Before this time it was the general belief that the ear evolved through the fusion of a number of two-rowed spikes. In support of his theory Montgomery presented illustrations showing some of the steps of the supposed mode of evolution of a normal tassel into a perfect ear. [1]

The evidence he presented seems, to the writer at least, to be so exhaustive that it would require some surprisingly new findings to make any addition to that given. This completeness is perhaps responsible in part for the absence of any additional evidence presented either in support or against the theory.

It must be admitted, however, that for evidence to be highly valuable, it needs to be supported by corroborative facts. In writing this article, therefore, and in presenting the accompanying illustrations, the author's only object is to offer a confirmation of several of Montgomery's observations.

With one exception, and this is figure 1 of Plate XXII–*b*, all of the illustrations were taken from plants of Mexican June corn which were grown in only one field and belonged to a single generation. The College number of the culture is 357. F_5. The field showed a case of a population exhibiting many of the stages of the supposed manner in which the corn ear evolved. It is considered by many evolutionists that ontogeny is but a repetition of phylogeny. In connection with the field of corn under discussion, it may be said that the development of a generation may exhibit an abbreviated repetition of the evolution of the species or of its characters. Of the nearly 3,000 plants in the field, 31 per cent bore husks with unsuppressed, though not normal, blades. There were 116 plants in which central spikes of tassels were more or less developed into small ears. Heavy tillering was a characteristic of the field.

[1] Montgomery, E. G. *What is an ear of corn? Pop. Sci. Monthly* (1906), **68**, 55.

Many more illustrations than are given in this paper could have been shown, but the expense of publication forbade this. Otherwise, intermediate stages between those shown by the plates as well as earlier and later ones could have been published, and the steps from a normal tassel up to a perfect ear could have been shown without important breaks.

Plate XIX–*a* shows the free end of the central spike already developed into the beginning of an imperfect ear. While the tassel shows a normal number of lateral branches, there were cases observed in which the development of the central spike was accompanied by the absence of a number of the lateral ones. That lateral spikes, together with the central spike, may develop into ears, is seen from Plate *M,* which shows pistillate flowers on several of these organs. Moreover, we have a case shown in Plate XX–*a* in which only the lateral spikes, were developed into ears.

The development of the leaf sheaths into the corn husks and the dwindling and later the disappearance of the leaf blades, are processes which may be inferred from the theory of Montgomery. As has already been stated, thirty-one per cent of the plants of the field observed bore normal ears with husk leaves, which varied in length from very short to about one-half of a meter in length. Including the leaves which formed a sort of covering for the ear-like structures at the tassels of many plants, there were individuals which could be so arranged as to form a series showing a perfect gradation from absence of rudimentary blade to normal corn leaves. Plate XXI–*a* shows well developed rudimentary husk leaves and Plate XX–*b*, normal leaves the sheaths of which serve as husks to an imperfect ear.

It is assumed by Montgomery that the lateral branch, which originally bore the spike that was later evolved into a corn ear, was shortened or telescoped into the leaf sheaths [2] by a decrease in the length of the internodes. Possible reversions, as are shown in Plates XXI–*b*, XXII–*a* and XXII–*b*, suggest such an evolution. Plate XXI–*b* shows a structure which is practically a corn branch. The latter is borne high enough on the stalk not to be a "sucker." Figure 2 of Plate XXII–*b* shows an ear with fairly long stem; while in Plate XXII–*a* the ear shown with an extraordinarily long stem constitutes a branch with a normal ear at the terminal end.

[2] Montgomery, E. G. *The Corn Crops.* The MacMillan Co., New York (1915), 18.

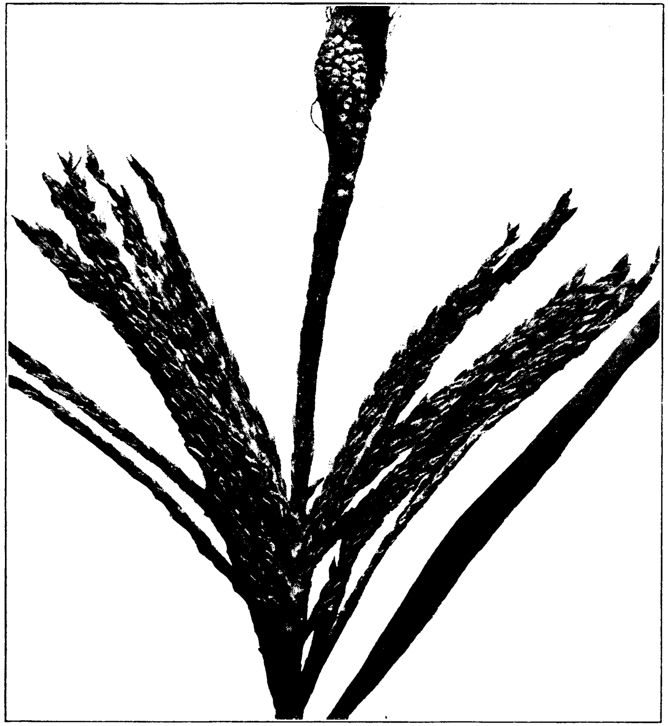
It is to be concluded from the above account that there were at least three processes involved in the evolution of the corn ear: the development of the spike into the cob and the ear proper; the shortening of the branch bearing the spike; and the development of the sheaths into the ear husks and the suppression of the leaf blades.

From the viewpoint of gradual isolation of the best adapted, there are certain facts which support an explanation of the evolution of the corn ear by this process. A lateral spike is less adapted to bear the weight of an ear than is a central one. Moreover, a long corn branch either is unable to bear its terminal load or must bear an ear with the silks pointing downward, thereby decreasing the chances of proper pollination. The disappearance of the blades from the corn husks could of course be explained by Weismann's theory of germinal selection, but there are no facts in this case to support this theory. On the other hand, from the viewpoint again of the isolation of the best adapted, the fact which Collins and Kempton found in connection with their work on breeding sweet corn for resistance against the corn ear worm may be cited. They observed that the husk leaves attracted the months or at least furnished a location for the eggs, and that while these organs tended on the average to reduce the damage done by each larva, this advantage was so outweighed by the increased number of larvæ introduced into the ear that they concluded that husk leaves are to be avoided in breeding worm-resistant strains.[3]

The writer desires to acknowledge indebtedness to Mr. L. B. Uichanco for help rendered in photographic work.

[3] Collins, G. N. and Kempton, J. H. *Breeding sweet corn resistant to the corn ear worm.* *Jour. Agr. Res.* (1917), 11, 565–566.

PLATE XIX

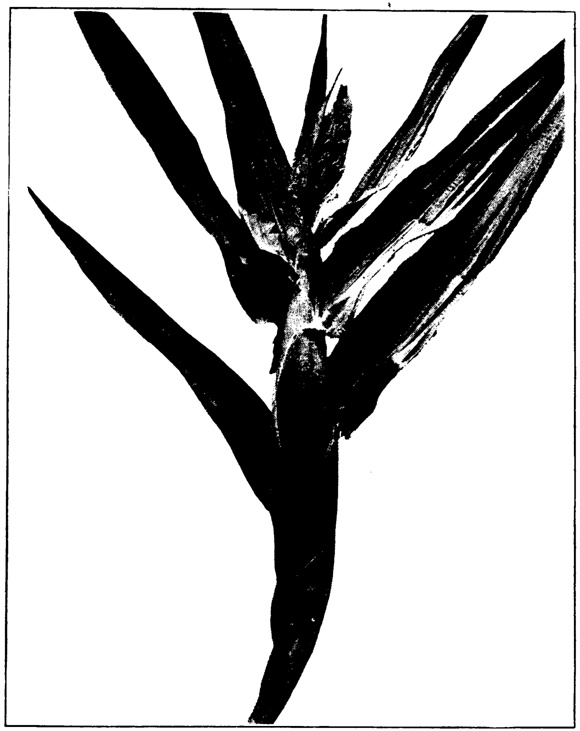


(*a*) Corn tassel with central spike showing the beginning of the development into a small ear.

(*b*) A central spike of a corn tassel fairly developed into an ear. A number of lateral branches also show tendency to develop into ear-like structures.

(*a*) The central spike has been developed into an almost perfect ear, the lower part of which is enclosed in leaf sheaths.

(*b*) The lateral spikes are absent. The central branch, well developed into an ear, is completely enclosed in leaf sheaths.



(*a*) A normal corn ear. The leaf sheaths have been developed into corn husks, the leaf blades showing signs of being suppressed.

(*b*) Lower portion of a corn plant showing a corn branch with unexposed tassel.

(*a*) A normal corn ear showing a fairly long stem. The husks on the exposed part of the stem were removed.

(*b*) In (1) a central spike is surrounded by several ears, the ears and spike being attached at the same node.

In (2) a normal corn ear is shown with a long stem. Two earlike structures are attached at two different nodes of the ear stem.

THE DISTRIBUTION OF PINK DISEASE

By H. ATHERTON LEE, *Plant Disease Laboratories, Bureau of Agriculture and Bureau of Science,* and HARRY S. YATES, *U. S. Department of Agriculture*

In the Philippine Journal of Science, Vol. XIV, No. 6, June, 1919, the present writers have described pink disease of citrus hosts and have discussed its distribution seriousness and methods of control. On page 660 the following statement was made:

Corticium salmonicolor B. & Br. has been found only recently in the Philippines and the supposition seems justified that it is of recent introduction here. It was first collected in the fall of 1917 at Novaliches, near Manila, on *Annona* sp. Since that time it has been found at Los Baños, Laguna Province, and abundantly at Lamao, Bataan Province. The Lamao Experiment Station is the center of plant introduction and distribution in the Philippines, and plant materials are known to have been shipped from Lamao to both Novaliches and Los Baños. It seems very likely that *Corticium salmonicolor* B. & Br. was brought to Lamao on some plant from another part of the Orient; for, while the fungus flora of the Philippines is far from being fully known, it seems very unlikely that botanical collectors and agricultural inspectors would have overlooked so conspicuous and destructive a fungus as *Corticium*—one likely to occur upon a veery large number of hosts—had it existed in the Philippines for any considerable period.

The writers feel that this statement must be retracted in the light of accumulated observations at the present time. Pink disease was found in Tanawan, Batangas, in 1918; in several localities of Manila, also in 1918; and in the Mindanao region, on a rubber plantation on the Island of Basilan, in 1919. In this latter instance a single case was found on a Para rubber tree about six years old. The tree was near the edge of the plantation where it adjoined the forest and no other cases were found on the estate. There is no record of any plant introduction to this place within recent years.

Mr. P. J. Wester [1], Agricultural Advisor of the Philippine Bureau of Agriculture also reports a case of the disease on a lime tree, *Citrus aurantifolia* (Christman) Swingle, from Mailag,

[1] Wester, P. J. *Notes on Philippine Citrus Fruits. Phil. Agr. Rev.*, Vol. XII, No. 1, First Quarter, 1919, pp. 69–70.

Bukidnon, and on *Gliricidia sepium* (Jacq.) Steud., at Dalirig, Bukidnon; both instances being at isolated inland points.

From the two isolated cases mentioned above, it appears probable that the organism causing pink disease is not a recent introduction in the Philippine Islands. The sporadic occurrence of the disease in the Philipines seems very difficult of explanation, in the light of the present state of knowledge of the life history and distribution of the organism.

THE IMPORTANCE OF PLANT QUARANTINE SERVICE IN THE PHILIPPINES

By GONZALO MERINO, *Chief, Plant Pests Control Division.*

The importance of plant quarantine is thoroughly realized by most civilized countries, due to the fact that they have lost, through the introduction of plant pests and diseases, billions of dollars worth of plant products.

By plant inspection, we mean the inspection of all plant materials that are brought into a country from foreign countries. Such materials as are found infected or suspected to be infected with pests and diseases are treated so as to kill the insects or fungus diseases on them or else entirely destroyed or returned to the sender.

By plant materials we mean all living plants, seeds for reproduction purposes, cuttings, bulbs, grafts, leaves, scions and fruit pits. The inspections are made by plant inspectors who are appointed by the Director of Agriculture. When these plant materials are found to be free from parasitic fungi or injurious insects, a certificate is given by the plant inspector to the exporter or importer. When plant materials are infested or infected they are treated or fumigated or disinfected, as the case may require, and are put under observation until they are supposed to be free from injurious pests and diseases. The holding of plant materials by plant inspectors is termed plant quarantine. Today the country that most carefully observes the necessity of quarantining plant materials is the United States, and since June 1, 1919, regulations have been made by the Department of Agriculture of that country providing that all plant materials shall be prohibited entrance into the United States except certain species with are wanted for plant breeding, and these must be submitted to the Federal Horticultural Board, in order that they may be quarantined before being allowed to enter.

The functions of the plant inspection service are highly specialized and stand in importance second to none in the scheme of our agricultural economy. The control of native plant pests and diseases covers a vast field.

By injurious insects and plant diseases we can mean those that by their depredations cause great economic losses to man; that is, depredations which are widespread. They may affect field crops, economic products, manufactured goods, tobacco, furniture, etc., timber and even man himself. It is a well established fact that there is but one way to prevent the coming of these dangerous insect pests and plant diseases, and that is to rigidly inspect all incoming plant materials and prohibit the entry of plant materials which are infested or infected or suspected of being so.

LOSSES DUE TO INSECT PESTS

The economic losses due to insects pests are computed to be 10 per cent at the least. Allowing also 10 per cent for losses due to fungus diseases, we have right here a loss of 20 per cent. Figuring that the marketable value of most of the principal crops, which are rice, tobacco, sugar cane, coconut, abaca, corn (maguey, cacao and coffee) runs up to about ₱462,000,000 the total loss would be about ₱92,400,000 and this is the lowest estimated average per cent of crop. The loss to rice and corn in the provinces, due to the attacks of two species of the army worm, *Prodemia litoralis* and *Spodoptera mauritia,* runs to from 15 to 30 per cent. The losses in the coconut crop due to red and black bettles runs up to 23 per cent of the attacked groves and bud-rot is similarly doing great damage. About 10 per cent of the coconut groves were affected with this fatal disease last year. The attacks of "Pagui-pagui" (Thosea cinereamarginata) and of the leaf miner (Promecotheca cumingi) in some cases reduced the production of coconuts as much as 60 per cent. The former defoliates the coconut trees and the latter causes the coconut leaves to dry up.

In the absence of a plant inspection service, many countries suffer great losses, as did America, with the introduction of the white pine blister rust from Germany. The citrus canker, which was introduced a few years ago, has caused the loss of about $30,000,000 worth of Florida citrus trees. In the Philippines we have the coffee blight which was introduced from Arabia about the year 1885. This disease since its introduction into the Philippines has caused millions of pesos worth of damage to the once thriving coffee industry of Lipa. Previous to the year 1889, this town sold coffee not only to other provinces but to other countries as well. The coffee industry there is now almost entirely wiped out and the disease is all over the Islands. The citrus canker is also one of the diseases which was recently introduced and is liable to cause great economic losses to this country.

The necessity of guarding the importation of plant material into any country is very great. Once a disease or pest becomes established its control is very difficult, expensive and often impossible. A part of a plant brought over unnoticed, containing some plant pests or disease may do incalculable damage to our crops. Fruits from aboard incoming vessels which are found to be wormy and incapable of being eaten are thrown into buckets and taken ashore and from these fruits dumped into the garbage might emerge a fruit fly, which if it happened to be a new species to this country might have a devastating effect on our fruit industry.

It is a fact that introduced plant pests are very prolific in their new habitat due to the absence of the natural enemies and parasites that control them at home. Surrounded as we are by other countries in the Orient having commercial relations with us, and as Manila is considered to be the central commercial port of the Orient, the possibility for bringing into this country new plant pests and diseases is great. There are boats direct from America, China, Java, Sumatra, Singapore, British North Borneo, and French Indo-China to Cebu and Iloilo, steamers from America, Australia, Japan, touch at the port of Zamboanga, as do boats from Singapore and British North Borneo. Besides some boats have direct connections from British North Borneo, to Jolo and Balabac.

In order to be on the safe side, we must detail plant inspectors to the ports of Cebu, Iloilo and Zamboanga providing them with the necessary assistants, fumigation houses, and apparatus for the proper carrying on of their work. Manila was at first the only port where plants were properly inspected, but later the work was also extended to the port of Zamboanga. This year, we expect to have inspection not only in the port of Zamboanga but also to declare the ports of Cebu and Iloilo ports of entry for plant materials. By ports of entry we mean ports where plants are inspected or allowed to come in after inspection or quarantine.

COMPARISON OF THE ORGANIZATION OF THE PLANT INSPECTION SERVICE IN THE PHILIPPINE ISLANDS AND THAT OF JAPAN

At the request of the U. S. Department of Agriculture, the Governor-General of the Philippine Islands issued an Executive Order authorizing the inauguration of a plant inspection service about the middle of the year 1915. In the same year a bill was presented in the Philippine Legislature (Act No. 2515) and was finally approved, prohibiting the exportation from, and the importation into, the Philippine Islands of diseased plant materials. With this authority the Department of Agriculture issued permits for plant materials that were imported into the Philippines. A plant inspection service was finally inaugurated during the latter part of 1915 for the Philippines.

In the Philippine Islands, the plant inspection was originally a small section of the Bureau of Agriculture, under the Plant Industry Division. Recently it was reorganized into a real Division. The personnel of this Division consisted of a Chief and three plant inspectors until lately, when we were able to secure the services of four more graduates from the College of Agriculture who are working now in the Laboratories of the Bureau of Science on plant diseases; and four assistant plant inspectors, and three junior plant inspectors. Other employees are appointed as laborers and their work is to assist the inspectors. Due to lack of technical personnel, only the port of Manila was formerly considered to be the port of entry. We are going to gradually stop the introduction of plant pests in other ports. This work will be done by employees who have been specially trained along this line of work.

This division, beside the plant inspection work, is charged with the work of controlling serious plant pests and diseases reported from all over the Philippine Islands. When first organized as a section, the personnel attended only to the eradication of locusts, which were then causing tremendous losses to agriculture.

When plant materials arrive at the port of Manila, the pest control division is notified by the custom house officials. The inspector from the office goes to the custom house and there examines the plant materials, and if he finds them infested with pests or infected with disease, seizes them; and either fumigates or disinfects them, as the case may require, before the material is turned over the owner and certified to be free from plant pests and diseases. Badly infected or infested plants are destroyed. Some plant materials are not allowed to come into the Philippines under any conditions. Sugar cane, due to the presence of insect pests and diseases in Hawaii, which are not as yet found in the Philippines is prohibited entrance, except in small quantities for plant breeding purposes and the material must then be consigned to the Bureau of Agriculture. The bamboo, due to a dangerous disease found in China and Japan, a disease known as *Ustilago Shiraiana,* is also prohibited entrance. Of late we have added to the list of prohibited plants the banana, coconut, rice, and tobacco, these being the principal crops of the Philippines.

All persons who intend to export plant material from the Philippines to another country are required to submit such plants together with the packing materials for inspection by the plant inspector not less than 24 hours before they are to leave the Islands. Also an application must be made out on Form No. 144 which is furnished by the Bureau of Agriculture. If the plants in the course of inspection are found to be free from insect pests and plant diseases, a certificate is given by the plant inspector and the package is tagged so that the materials can be allowed to go out. Plants which show the presence of insects or disease are either returned to the exporter, destroyed or treated. Great caution is used in issuing certificates. These are only given after careful investigation and plants that are quarantined in other countries will not be certified. Importations of plants are also allowed when due application is received in the Bureau of Agriculture. In case the plant inspector destroys plant materials by fire or causes them to undergo treatment of any nature, the person or persons who have presented Form 144 or 146 are so notified, as is also the custom house or post-office official concerned. Certificates which are issued by other countries for the imported articles are to be presented to the plant quarantine officials in this country. The inspection of incoming and outgoing materials is to be made at the ports of Manila, Cebu, Iloilo, and Zamboanga only. Plant materials entering the Philippines through the post-office must be inspected also, upon notification by the post-office officials of the presence of such materials. In this case the inspection is made in the presence of either the consignee or a post-office official or both.

The Administrative Code, section 2746, provides the penalty of a fine not to exceed ₱200 or imprisonment for not to exceed 30 days, or both for those who violate any section of Act No. 2515, the law which regulates the importation and exportation of plant materials into the Philippines.

At present the organization of the plant quarantine service of the Philippines is almost perfected, due to some innovations introduced by the Bureau of Science, and an advisory plant quarantine board has been formed. The members of this board are appointed by the Director of Agriculture to take up questions arising through the plant quarantine service. The members are the Assistant Director of Agriculture, as chairman; the

Chief of the Plant Pests Control Division; and the Chief, Plant Industry Division; the Entomologist and the Mycologist of the Bureau of Science.

As to the organization of the plant inspection service in Japan, this can be considered perfect and its success is remarkable. The Imperial Plant Quarantine Station of Japan is one of the Bureaus of the Department of Agriculture and Commerce. It was organized in the year 1914 by Prof. Kuwana, the present director, and Mr. Ito, now chief of the Plant Industry Division of the Bureau of Agriculture of Japan.

The central station is located at Yokohama in the Prefecture of Kanagawa and there are five substations, located at Kobe, Hiyogo Prefecture; Moji Fukuaka Prefecture; Nagasaki, Nagasaki Prefecture; Ysuraga, Fakiu Prefecture; and Yokkaishi in the Miyo Prefecture; and fourteen small stations distributed as follows: Otaru and Hakodate on the Island of Hokkaido, Shimizu, Taketoyo, Nagoya, Osaka, Zina, Hakata, and Shimonoseki on the mainland of Japan, Karatsu, Miike and Kagoshima on the island of Kyushu, Isuhara on a small island northwest of the island of Kyushu, and one small office in the city of Tokyo at the Ministry of Agriculture and Commerce.

The inspections conducted at the main station and the five substations are exhaustive. The inspectors here inspect all kinds of incoming and outgoing plant materials sent as mail matter, in passengers' baggage and in any other way. Citrus fruits and Irish potatoes are also inspected for dangerous insects and bacteria. At Osaka and Shiminoseki stations, only incoming plant materials, including citrus fruits and Irish potatoes, are inspected. At the twelve other stations, only incoming packages containing plant materials are inspected, at the Tokyo Station only mailed plant materials are inspected.

The personnel of the Imperial Plant Quarantine Station of Japan consists of a director who is the head of this organization, four plant inspectors who are senior officials and charged with the duties of supervising the inspection and the investigation of plant pests or diseases. Twenty-four assistant plant inspectors who are junior officials are charged with the duties of assisting plant inspectors in the inspection and investigation of plant diseases and plant pests at the main station and at the substation of Kobe and Moji and as inspectors in charge at the remaining substation and all small stations. There are 25 junior assistant plant inspectors whose duties are to assist the assistant plant inspectors and plant inspectors in the station of Yokohama, Kobe, Moji, Nagasaki, Tsuruga, Yokkaichi and Shimonoseki engaged in the inspection of plants, investigation of plant diseases; preparation of samples and preservation of specimens and of diseased plant materials and of plant pests, rearing of insects, either beneficial for propagation, or injurious for scientific study, identification of same for specimens; and all work that the immediate chief may order done, as prescribed by the Ministry of Agriculture and Commerce.

Incoming plant materials from foreign countries which are inspected consist of the following:

1. Either the whole or a part of a plant to be cultivated or used.
2. Seeds, bulbs and roots which are intended for propagation.
3. Citrus fruits.
4. Potatoes.

For outgoing plant materials inspections are made of bulbs, rose stocks, fruit tree stocks, palm seeds and other seeds intended for propagation going into the United States of America only in so far as that country requires Japan to certify plant products exported by that country to the United States. Fruit tree stocks and cherry stocks going to Korea are also certified to be free from pests and diseases before they can be exported.

The law on importation and exportation provides inspection not only for incoming but also for outgoing plants. A clause is added, however, providing that inspection will be made only if the inspector deems it necessary.

The plant inspector may inspect articles whether prescribed or not when he thinks any danger may occur if same is to be allowed to pass unnoticed. All importations of plant materials must be entered only in the ports and places where there are quarantine offices designated by the Minister of Agriculture and Commerce. When the materials so inspected are found to be infested or infected by plant pests or diseases, the inspector disinfects or destroys them by fire, or prohibits the importation or exportation of such articles.

The plant inspectors may inspect ships when they suspect that there are plant materials either coming in or going out on board and may either allow such materials to be landed or not, or suspend the exportation or not, should they find such articles on board subject to inspection according to the laws and regulations.

In case it seems necessary to take special precautions against infection, the Minister of Agriculture and Commerce may order the articles to be exported through a specified place and may prohibit or limit the import or transfer in or receiving of plants or any articles suspected of bearing dangerous insects or bacteria.

The penalties provided by the law for violators of the quarantine regulations in Japan range from 300 or 500 to 1,000 yen, but do not exceed these amounts.

When any person desires to import or is to receive an importation of potatoes, he must file an application with the Plant Quarantine Station denoting thereon the type and name of vessel in which the potatoes are to come, date of arrival at port, ports where exported, name and residence of consignor and the consignee, and number of cases.

When sending out plants the exporter must also submit a similar application to the above mentioned station at least one day before the sailing of the boat on which articles transferred are to go. The same procedure is gone through with materials to be imported. An application is submitted denoting the kind and class of materials, the addresses of consignor and consignee and the name and date of arrival of the boat or ship. Another form of application is submitted when the consignee receives the materials through the mail. He must file with the Imperial Plant Quarantine Station or any branch office of said station an application showing date of receipt, class of mail, name and address of senior, and remarks, should the package concerned need to be opened or changed.

Certification by the Plant Inspector in every case of exportation or importation is provided if the materials so mined are found to be free from diseases and pests. The plant inspector carries with him a pass stamps or pass tags to stamp packages should he find the materials free from pests or diseases. White tags are attached when the materials need no inspection and there are two kinds of red tags—one to be attached when materials are found infested or infected and are to be carried to the quarantine station for disinfection or fumigation, and the other when the material is found infested or infected and is to be destroyed by fire or sent back to the country of origin, if refused landing.

The work of controlling of plant pests and diseases in the country and of devising means of control is not done by the plant quarantine service inspectors at all, although they send out inspectors to investigate certain outbreaks of plant pests and diseases. It is done by the Central Experiment Station of Japan which forms another Bureau under the Department of Agriculture and Commerce; besides each province or prefecture of Japan has its own prefectural experiment station and this prefectural station is authorized by law to enforce rules and regulations.

The necessity for enlarging the personnel of the Pests Control Division of the Philippines for the management and enforcement of all effective measures of plant pests and diseases is very apparent. This phase or the work urgently demands extension and to accomplish this larger appropriations are absolutely necessary.

The U. S. Department of Agriculture has its thousands of well-paid, trained, experienced specialists, second to none in point of efficiency. What woud happen to agriculture in that country without this means of protection? The money so spent is money well invested for pests control and plant quarantine work is the most effective form of insurance known to agriculture.

The Philippines as far as its resources will permit must adopt this system to protect its chief industry in agriculture.

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THE PREVENTION OF THE IMPORTATION OF INJURIOUS INSECTS AND PARASITIC FUNGI ON ECONOMIC CROPS FROM FOREIGN COUNTRIES

By H. ATHERTON LEE, *of the Plant Disease Laboratories, Bureau of Agriculture and Bureau of Science*

There are known to exist in foreign countries, insects injurious to economic plants and fungi also parasitic on economic plants. Examples of such insects in foreign countries are the sugar cane borer in the Hawaiian Islands, and the cane leaf hopper also in the Hawaiian Islands. Both of these insects have been very destructive at different periods in that country. The Mediterranean fruit fly, found in Australia, Mediterranean countries, and Hawaii has also caused heavy financial loss, especially in Hawaii. We do not have this insect in the Philippines yet.

In the case of parasitic fungi, there is the trouble of sugar cane known as the Lahiana disease not yet reported from this country but said to be the worst disease of sugar cane in Hawaii. There is also what is called the leaf splitting fungus on sugar cane in the Hawaiian Islands which has not yet been found in this country.

A fungus disease known as banana wilt has been described from the Hawaiian Islands, Porto Rico and Central America causing a great deal of loss in those countries. It has not yet been reported from the Philippines. If introduced into this country this disease might spread on to the closely related abaca plants.

A disease known as the Dumbara disease of tobacco, said to be caused by a fungus is known in India. It causes the tobacco plants to wilt and die, rather extensively according to the report. It has not yet been found in this country. There is also a nematode, which is a very microscopical small worm, known to exist in India on rice plants. It is said to be very destructive in certain localities of India in their wet season and is gradually spreading. We do not yet have it in the Philippines.

These are a few of the insects and fungi which are known to exist in foreign countries and of which we have no knowledge in this country. Even in the case of the least injurious of these troubles, crops when affected, lose an appreciable percentage from the normal, or maximum yield, and such percentage of losses even if but 5 per cent or 10 per cent, when applied to the whole output of the country and repeated year after year amounts to extensive damage. These injurious insects and parasitic fungi can be kept out of this country very easily by a careful inspection of all incoming plants.

Instances of great losses from insects or fungi introduced into new countries are quite numerous. The Hessian fly which is said to cause more damage to the wheat crop in the United States than any other insect is supposed to have been introduced into America from Europe by the Hessian soldiers about the year 1779. Americans who come from New York State or Pennsylvania will remember the destruction of the chesnut trees in those states in the last years due to a fungus which was introduced into America from Japan.

Here at home in the Philippines we have the instance of the blight of rust of Arabian coffee which was introduced about 1885. The once prosperous coffee industry centered around Lipa has become entirely wiped out because of the destructiveness of that fungus.

It is possible by examining all living plants, seeds and fruits which entered these Islands to intercept any affected fungi or infested insects from foreign countries. Such a course has been adopted in the United States, in Holland, in Japan, and several other countries.

Mr. Hernandez, Director of the Bureau of Agriculture, is taking steps to put such inspection of plant materials into effect here. An organization is being perfected, with the coöperation of the Bureau of Science, which is to be known as the plant quarantine service, with specialists stationed at Zamboanga, Cebu and Iloilo as well as Manila, to inspect all plants for insects and fungi.

An advisory board of experts has also been appointed by Director Hernandez to take up questions arising in the plant quarantine service. This board will consist of the Assistant Director of the Bureau of Agriculture, as chairman, G. Merino, Chief of the Plant Pest Control Division, M. Cruz, Chief of the Plant Industry Division, of the Bureau of Agriculture; Dr. Banks, Entomologist, and A. Lee, Plant Pathologist, of the Bureau of Science.

The board requests that persons arriving in Manila with their hamper of fruit from Honolulu or pet pine trees from Japan be not offended if they are detained for a short while. The inspection of such plants is for the protection of the agricultural interests of the country and the many people directly and indirectly dependent on the agricultural success of the country.

BANANA WILT IN THE PHILIPPINES

By H. Atherton Lee and Felicisimo B. Serrano *of the Plant Disease Laboratories of the Bureau of Agriculture and Bureau of Science*

Plants of the Latundan variety of the banana, *Musa sapientum*, have been observed affected with banana wilt at Los Baños and Calamba in Laguna Province, and San Luis, Lemery and Taal in Batangas Province. This is a disease which has attracted much attention in Porto Rico and an excellent paper has been presented on the subject by Brandes in "Phytopathology" Vol. 9, No. 9, September, 1919. The disease is reported from Porto Rico, Cuba, Trinidad, Barbados, the northern countries of South America, Central America, Mexico, and the Hawaiian Islands. Doubtful cases have been reported from India and Java. Isolation and inoculation experiments by Brandes have shown the diease to be due to the fungus *Fusarium cubense* E. F. Smith. We have isolated a species of *Fusarium* uniformly from the affected plants in Laguna, which agrees closely with the description of *Fusarium cubense*. We have inoculated this fungus with a needle into the pseudostems of healthy banana plants and have caused the characteristic discoloration which results in typical cases of banana wilt. Inoculations with a needle without the fungus have resulted negatively. The evidence is therefore conclusive that we have in Laguna and Batangas Provinces the same disease which is known in the West Indies as banana wilt.

The disease has been reported as very serious in Porto Rico and other countries of the western tropics. Brandes quotes McKenney as stating that in 1910, in Panama, at least 15,000 to 20,000 acres of banana plantations had been abandoned and many thousands more were seriously affected, while in Costa Rica the damage was greater. Other West Indian countries are stated to have suffered severely also.

Growers of this country need not be greatly alarmed in as much as several of our common varieties appear to be resistant to this disease. The Latundan variety in our experience has been the only variety susceptible as yet. Although this variety is very popular, there are other varieties equally desirable, which are apparently resistant. Prevention of the disease will therefore be based upon the distribution of resistant varieties to affected localities. A further report will appear upon this subject very shortly.

Some apprehension has been expressed that abaca plants may be affected with this trouble. We already have results from inoculations with *Fusarium cubense* upon abaca plants, which indicate that abaca is resistant to this disease.

CURRENT NOTES—SECOND QUARTER

NOTES By P. J. WESTER, Agricultural Advisor

A NEGLECTED OPPORTUNITY.

The Philippines have an ideal climate and soil for coffee, which was in fact, once an important industry in the Archipelago. The United States is importing coffee at the rate of 600 million pesos annually and yet no one in the Philippines seems to realize the market opportunities for this staple in America.

We quote from the *Literary Digest* (New York): "According to a statement sent out by the National City Bank of New York, the people of the United States are paying over a million dollars a day for their coffee. The import valuation of coffee coming during the fiscal year just ended is over $300,000,000. Adding to this the cost of freight, roasting, and distribution, we have a total of $365,000,000, making the average for the year more than a million dollars a day against about one-third that sum two years ago. The bank's statement continues:

While the average import price of coffee brought into the United States in the fiscal year 1920 is double that during the war-period and higher than in any year in the history of the import trade, the quantity imported has also gone on increasing. The total coffee imports in the year will approximate 1,500,000,000 pounds against the former high record of 1,322,000,000 pounds in 1917, when the average import price was less than half that of 1920.

Most of this increase in the sums which we are paying for coffee has gone to the benefit of our neighbors in Latin America. Of the $236,000,000 sent out of the country to buy coffee in the nine months ending with March, 1920, $222,000,000 went to Latin America as a whole, and the remainder chiefly to the Dutch East Indies. To South America the total was $195,000,000, of which $148,000,000 went to Brazil against $47,000,000 in the same months of last year, $30,000,000 to Colombia against $13,000,000 in the corresponding months of last year, and $17,000,000 to Venezuela against a little less than $9,000,000 in the corresponding months of last year. The average import price of the coffee brought from Brazil in the nine months ending with March, 1920, was 22.7 cents per pound against 11.8 cents per pound in the same months of last year."

Is it not about time to start a movement for increased coffee production in the Philippines?

NOTES ON AGRICULTURE IN TRINIDAD VALLEY.[1]

The Trinidad Valley is said to encompass about one square mile. Perhaps one-fourth or a trifle more of this area is planted to lowland rice at present. A somewhat smaller area is devoted to vegetables of the temperate zone. Much of the land was formerly too wet and swampy for tillage but the blasting away of the rocks at the outlet of the river, and the canal which is being dug at the initiative of the Bureau of Education, will result in the reclamation of practically the entire swamp, which then will become the most fertile part of the whole valley.

The Trinidad Valley is located near Baguio, Mountain Province, at an approximate elevation of 1,400 meters. The climate is agreeable especially during the dry season; the temperature is cool and pleasant. The rainfall is heavy but the rainy season is short and is followed by a prolonged dry period.

As to the probabilities for success with the various fruits in the Mountain Province, there is virtually no hope of raising currents, gooseberries, cherries, plums and walnuts. The conditions for apples are somewhat more favorable. The trees will make a fair growth though the fruit can probably never be sold in competition with foreign fruit. This is also true of the pears. country that more importations of trees for experiment would not be worth while.

The outlook for peaches is better and all Peento peach varieties are recommended for introduction from Florida and Japan. Peach varieties especially worth trying are the Angell, Hall's Yellow, Jewell, Miami, Red Ceylon, and Waldo.

Certain grapes might do here. The Isabela, which has been so successful in Hawaii, is especially recommended for trial. The Muscadine grapes are also worth trying out.

The fruits that are decidedly worthy of a more extensive and thorough trial include the Chestnut, *Castanea sativa;* Loquat, *Eriobotrya japonica;* Kaki, *Diospyros kaki;* Persimmon, *Diospyros virginiana;* Cherimoya, *Annona cherimolia;* Cyndra, *Cyphomandra calycina;* Damia, *Macadamia ternifolia;* Bunya,

[1] Extracts from a Report to the Director of Agriculture, made in July, 1920.

Araucaria bidwilli; strawberries, *Fragraria chiloensis;* and the various raspberry, Loganberry, mulberry, blackberry and dewberry varieties growing in California and Florida.

The strawberries grown in Baguio and Trinidad are of rather indifferent quality and small in size, and the importation of several of the best varieties grown in the United States cannot be too strongly recommended. Especially the following everbearing varieties: Francis, Americus, Progressive, Productive, Ideal and Peerless.

A few plants of the native species of *Rubus* have already been planted in the nursery by Mr. Santos. This is highly commendable and should be continued until all the native species are brought under cultivation. If a systematic search is made among the wild plants it is certain that individuals well worthy of culture will be found. I have eaten fruits of the Atibu, *Rubus pectinellus,* Pilay, *Rubus niveus,* and Rolfeia, *Rubus rolfei,* collected in the wild state which were of very good quality and quite equal in marketability to the mulberries now sold in Baguio.

Then, the *Rubus* varieties grown on the Pacific coast, especially in California, and *those* that are native of Florida have a good chance of succeeding in Trinidad, and should by all means be introduced there. Species grown in the eastern United States north of Florida are less likely to succeed. The best types of the native species of *Rubus* having been assembled they could be easily crossed with the American imported kinds and thus superior new hybrids of great value to the Philippines might be originated.

There are two species of huckleberries, *Vaccinium villari* and *V. whitfordi,* native to the Philippines. These berries are remarkably good keepers and could be shipped to Manila with far less loss of fruit than strawberries. They are of good eating quality, and the search for, and the domestication of, the superior individual plants that certainly are to be found in the Mountain Province is eminently worth the while.

The mulberry flourishes in Trinidad but the fruit is of poor quality. The large fruited sweet kinds growth in northern Florida, such as "Stubbs" and "Hicks" should be imported without delay.

The Cyndra, *Cyphomandra calycina,* introduced about 3 years ago, has been quite successful and only needs wider dissemination to become of greater usefulness. According to the nurseryman at the Bureau of Forestry nursery this plant is readily propagated by cuttings.

Because of climate and elevation Trinidad and Baguio are totally unsuited to the cultivation of the blight-resistant coffees from Java. The dry season is too prolonged even for the Arabian coffee, which for this reason may be expected to succeed *only if it is cultivated rationally* and leguminous cover crops are grown between the plants and worked into the soil. By the use of heavy vegetable mulches on the land during the dry season, fair crops might be obtained without irrigation, but in lieu of a good mulch irrigation is absolutely necessary if good results are to be obtained.

Tea was introduced in Baguio many years ago, but the climate is too unfavorable for this plant to make it worth while to attempt to establish a tea industry in Benguet, especially in the face of the superior tea lands in Mindanao. The same is true of cinchona.

Camphor has also been found to grow, but so slowly that it is highly questionable whether the culture of this tree would pay. The culture of this tree also is more likely to succeed as a commercial enterprise in the highlands of Mindanao than in Benguet.

The successful outcome of all plant introduction work, in Trinidad as elsewhere, all other conditions being equal, depends upon the judicious selection for importation of species and varieties which are adapted to the soil and climate where they are to grow. If they are chosen injudiciously without proper regard for their climatic requirements the money and labor expended is apt to be a total loss. Indeed, the loss is double when the accomplishment that might have been made with the same money with other successful plant immigrants is considered.

Baguio itself is not a good agricultural country but the Trinidad Valley is a splendid body of land sufficient for the production of the temperate vegetables demanded by the Manila market for a long time to come. The production of various other kinds might be greatly increased by variety tests, but the importation and testing of potato varieties would be of special value. Such trials might to advantage be made in coöperation with the Trinidad Agricultural School, the garden of which is very efficiently managed.

The cabbage is one of the principal vegetable crops and the daily wastage from the outer leaves as the heads are prepared for shipment to Manila is very great. This wastage in combination with other garden refuse could be used in feeding fish (as is being done in Java where fish of excellent quality are bred and kept in concrete tanks and fed with succulent greens), which could be disposed of to the annually increasing number of residents in Baguio. At present nearly all fish is brought there from the coast. Reservoirs or ponds for fish culture should not be difficult or expensive to construct, considering that the river flowing through the Trinidad Valley is now well under control and never dries up.

"THE CUSTARD APPLE IN QUEENSLAND"

This is the name of the latest publication about Annonaceous fruits to arrive, written by Mr. William Leslie, and will be welcomed by all who are interested in the fruits in question as the first comprehensive account of the Annonas in Queensland.

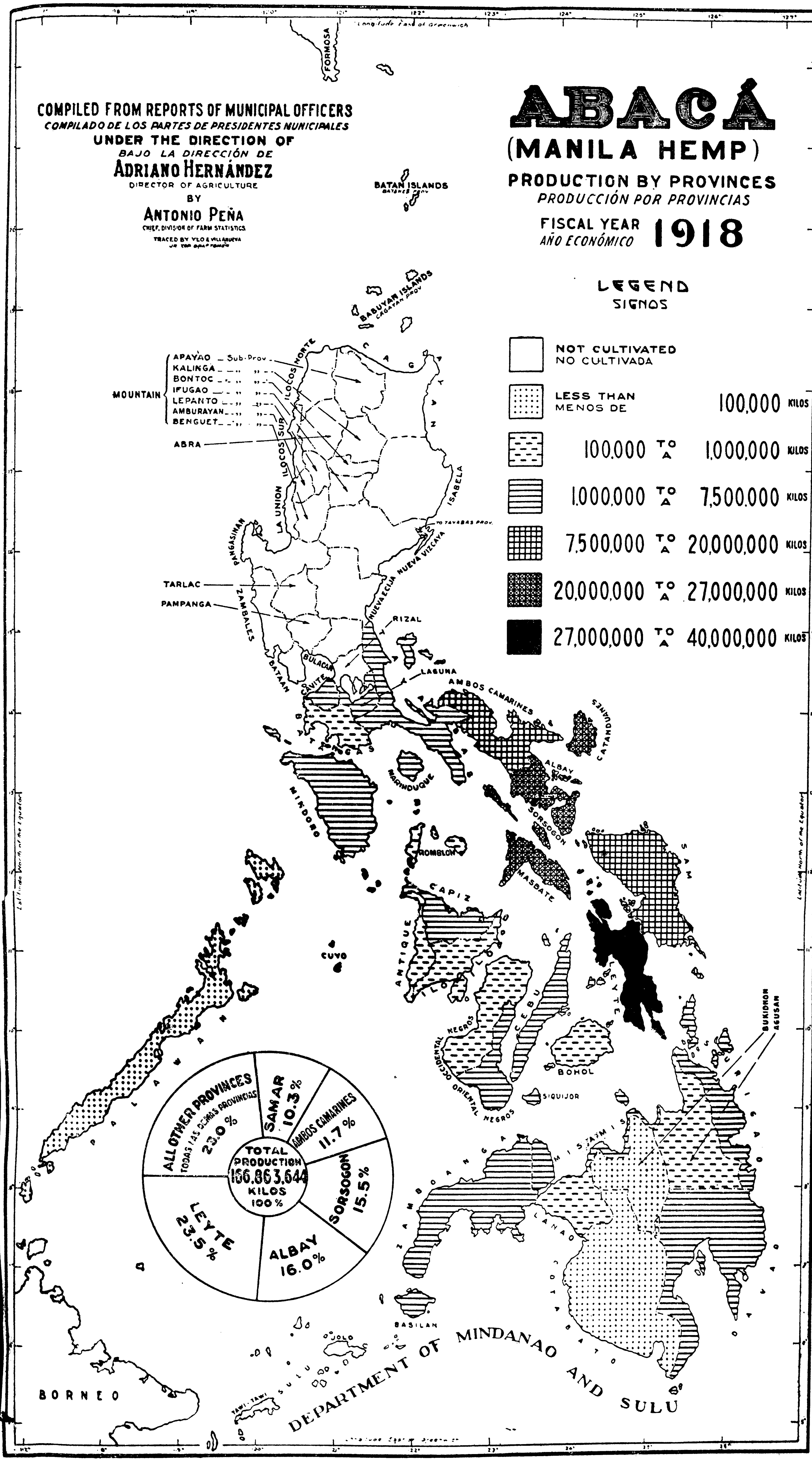
Several species of *Annona* have been introduced into Queensland but apparently only one, *Annona cherimolia,* has become of commercial importance, and it is in Queensland known under the name custard apple; sixty-four hectares of this tree was under cultivation in 1918, yielding 20,000 cases of fruits, valued at from ₱50,000 to ₱70,000.

Apparently Queensland has taken the lead among all countries which have introduced the cherimoya from its homeland in the culture of this delicious fruits, the orchards being set out with grafted varieties, of which several are described and illustrated in the bulletin in question.

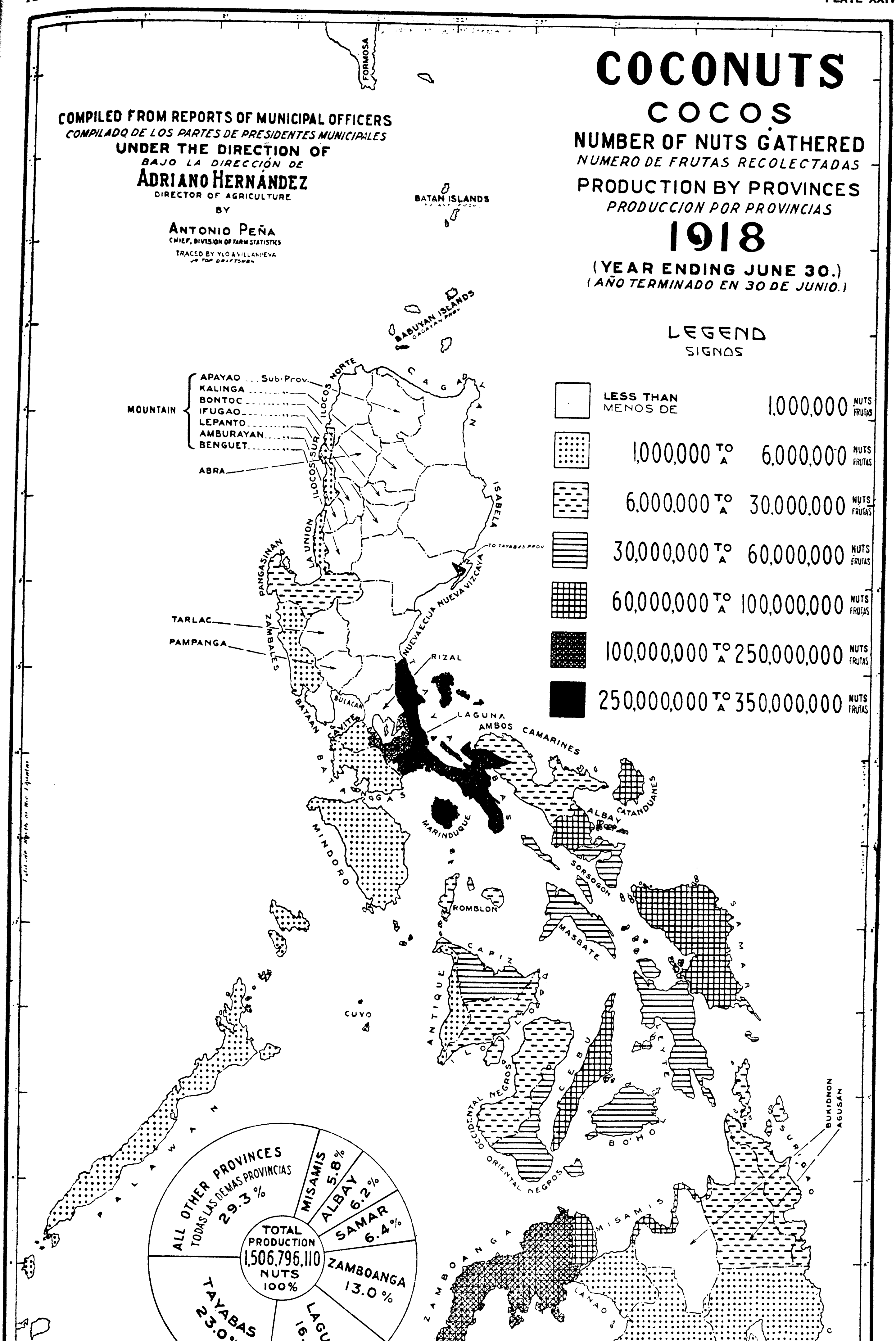
In Queensland whip and cleft-grafting is generally employed instead of budding. Here it might not be inopportune to remark that for good results in shield budding, other conditions being equal, the buds should be cut large, with an ample budshield, as small buds are easily smothered by the rapidly growing callus. The cherimoya is used as stock in Queensland.

The tremendous variation in the fruit shown in the many varieties illustrated argues strongly for the contention that some of the Australian cherimoyas are really hybrids between the true cherimoya and the sugar apple, *A. squamosa,* for they appear to be very similar to the hybrids between these species made by the writer in Florida and the Philippines. In fact, certain of the species of Annona described within the past few years from Mexico and Central America seem to combine the features of other species to such a high degree that when the ease with which some Annonas hybridize is considered it seems highly probable that they are natural hybrids.

In the Philippines the cherimoya has at last been established in the Mountain Province and it is hoped that this (one of the most delicious of the tropical fruits) will eventually become one of the staple fruits in the Philippine market.



MAP SHOWING ABACA PRODUCTION FOR THE YEAR 1918.



MAP SHOWING COCONUT PRODUCTION FOR THE YEAR 1918.

PUBLICATIONS OF THE BUREAU OF AGRICULTURE.

BULLETINS.

No. 11. Press Bulletin: Part I, Seed Distribution; Part II, Need of Diversified Farming; Part III, The Avocado; and Part IV, Publications of the Bureau of Agriculture. (English and Spanish.)
No. 12. Abaca (Manila Hemp), Revised. (English and Spanish.)
No. 13. The Cultivation of Maguey. (Spanish.)
No. 14. El Cultivo del Sésamo en las Islas Filipinas. (Spanish.)
No. 16. El Cultivo del Tabaco en las Islas Filipinas. (Spanish.)
No. 17. Cultivo del Cocotero. (Spanish.)
No. 27. Citriculture in the Philippines. (English.)
No. 28. The Mechanical Transmission of Surra by Tabanus Striatus. (English.)
No. 29. Duration of Infectiveness of Virulent Rinderpest Blood in the Water Leech, Hirudo Boyntoni Wharton. (English.)
No. 30. Experiments upon the Transmission of Rinderpest. (English.)
No. 31. An Atypical Case of Rinderpest in a Carabao. (English.)
No. 32. Plant Propagation in the Tropics. (English and Spanish.) (See price below.)
No. 33. Cane Production and Sugar Manufacture in the P. I. (English.) (See price below.)
No. 34. Tobacco Growing in the Philippines. (English.)
No. 35. Coconut Palm: Its Culture and Uses. (English.) (See price below.)

CIRCULARS.

No. 7. Coconuts. (English and Spanish.)
No. 12. Plant Pests and Remedies Therefor. (English and Spanish.)
No. 14. Maize Leaf Fodder. (Spanish.)
No. 15. The Mango. (English and Spanish.)
No. 16. Pineapple Culture. (English and Spanish.)
No. 17. Maize Culture. (English.)
No. 20. The Mango Bark Borer. (English and Spanish.)
No. 21. Kapok Culture. (English and Spanish.)
No. 22. Maguey (Cantala) and Sisal Culture. (English and Spanish.)
No. 23. Locust Pest. (Spanish.)
No. 24. Citrus Growing in the Philippines. (English and Spanish.)
No. 25. Cultural Directions for Vegetables and Flowers. (Spanish.)
No. 26. Cacao Culture. (English and Spanish.)
No. 27. Banana Culture. (English and Spanish.)
No. 28. Propagation of the Seedless Breadfruit. (English and Spanish.)
No. 29. Guinea Grass. (English and Spanish.)
No. 30. Cultural Directions for the Papaya. (English and Spanish.)
No. 32. Sugar-cane Cultivation. (English and Spanish.)
No. 33. La Fabricación de Azúcar Mascabado. (Spanish.)
No. 34. Peanuts. (English.)
No. 35. Cultural Directions for Para Rubber. (English.)
No. 36. The Vegetable Garden. (English and Spanish.)
No. 37. Some Observations on Rats and Their Control. (English.)
No. 38. Coconut Culture. (English.)
No. 39. Cultural Directions for Banana. (English and Spanish.)
No. 40. Suggestions for Selection and Saving of Garden Seed. (English and Spanish.)
No. 41. Increasing Rice Crop by Seed Selection. (English and Spanish.)
No. 42. Instructions for Planting Vegetables. (English and Spanish.)
No. 43. Instructions for Irish Potato Growing. (English and Spanish.)
No. 44. Propagation of Pili Nuts. (English.)
No. 45. Instructions for Planting Lawns to Bermuda Grass. (English.)
No. 46. Instructions for Planting Upland Palay. (English and Spanish.)
No. 47. Instructions for Planting Lowland Palay. (English and Spanish.)
No. 48. Propagation of Sweet Potatoes. (English.)
No. 49. Propagation of Cacao. (English.)
No. 50. Valuable Forage Crops for the Philippines. (English.)
No. 51. Propagation of Lumbang. (English.)
No. 52. Propagation of Peanuts. (English.)
No. 53. Propagation of Chico. (English.)
No. 54. Culture and Uses of Cowpeas. (English.)
No. 55. Use Corn for Food. (English.)
No. 56. Propagation of Guinea Grass. (English.)
No. 57. Propagation of Lanzones. (English.)
No. 58. How to Select and Store Seed Corn by "Halayhay" Method. (English.)
No. 59. Cultivation of Ilang-Ilang. (English.)
No. 60. Indigo. (English.)
No. 61. Green Manure, Soiling and Cover Crops. (English.)

CIRCULARS—Continued.

No. 62. "Dapog" Method in the Culture of Rice. (English and Spanish.)
No. 63. Roselle. (English.)
No. 64. Propagation of Violetas, (Barleria cristate). (English.)
No. 65. Propagation of Coffee. (English.)
No. 66. Mungo on Rice Land. (English.)
No. 67. Castor Oil Beans. (English and Spanish.)
No. 68. The Camote and Cassava. (English.)
No. 69. Saving and Investing (Rural Credit). (Spanish.)
No. 70. Saving and Investing (Rural Credit). (Pangasinan.)
No. 71. Saving and Investing (Rural Credit). (Bicol.)
No. 72. Saving and Investing (Rural Credit). (Visayan-Samar.)
No. 73. Saving and Investing (Rural Credit). (Visayan-Cebu.)
No. 74. Saving and Investing (Rural Credit). (Tagalog.)
No. 75. Saving and Investing (Rural Credit). (Visayan-Iloilo.)
No. 76. Saving and Investing (Rural Credit). (Pampango.)
No. 77. Saving and Investing (Rural Credit). (English.)
No. 78. Saving and Investing (Rural Credit). (Ilocano.)
No. 79. Directions for Budding. (English.)
No. 80. Bud-Rot of Coconut. (English and Spanish.)
No. 81. Method of Determining Whether or Not a Coconut Tree is Attacked by Bud-Rot. (English and Spanish.)
No. 82. Why not eliminate the "uang" of Coconut. (English and Spanish.)
No. 83. Instructions for the Control of Rice Cut-Worms. (English and Spanish.)
No. 84. Pests of Maize. (English and Spanish.)
No. 85. Tobacco Pests. (English.)
No. 86. Method of Controlling Maya. (English and Spanish.)
No. 87. Instructions for Combating the Rat Pest. (English and Spanish.)
No. 88. Abacá Root Weevil. (English and Spanish.)
No. 89. Control of Rice Bug, "atangia." (English and Spanish.)
No. 90. Rubber Culture. (English.)
No. 91. Coffee Culture. (English.)
No. 92. Brief Instructions for Running an Incubator. (English.)
No. 93. Practical Instructions for the Control of Tomato Turtle, Leaf-feeding Beetle. (English.)
No. 94. Poultry Notes. (English and Spanish.)
No. 95. Method of Controlling Certain Pests and Diseases of Maize. (English and Spanish.)
No. 96. Notes on Swine Breeding in the Philippines. (English and Spanish.)
No. 97. Planting Instructions for Abacá. (English.)
No. 98. Planting Instructions for Maguey and Sisal. (English.)
No. 99. Preparation of Maguey and Sisal Fibers by Retting. (English.)
No. 100. The Panama Hat Palm-Carludovica Palmata. (English.)
No. 101. Suggestions Re Process of Castration. (English.)
No. 102. Foot-and-Mouth Diseases. (English and Spanish.)
No. 103. Rinderpest and Its Prevention. (English.)
No. 104. Raising Ducks. (English and Spanish.)
No. 105. Preparation of Papain. (English.)
No. 106. Propagation of Mulberry Cuttings. (English.)
No. 107. The Culture and Uses of the Castor Oil Beans. (English.)
No. 108. Instructions for Planting Patani Beans. (English.)
No. 109. Propagation of Ates. (English.)
No. 110. Ates (Sugarapple). (English.)
No. 111. Vegetable Growing. (English.)
No. 112. Soy Beans. (English.)
No. 113. Wampee. (English.)
No. 114. Bordeaux Paste for Gummosis of Citrus Trees. (English.)
No. 115. Yam Culture. (English.)
No. 116. The Four Spotted Corn Silk Beatle. (English.)
No. 117. Rice Farming. (English and Spanish.)

PUBLICATIONS FOR SALE.

Bulletin No. 32, "Plant Propagation and Fruit Culture in the Tropics," English and Spanish, ₱1 or ₱1.40 postpaid.
Bulletin No. 33, entitled "Cane Production and Sugar Manufacture in the Philippine Islands," paper cover, ₱1 or ₱1.40 postpaid; bound, ₱3 or ₱3.45 postpaid.
Bulletin No. 35, "The Coconut Palm; Its Culture and Uses," ₱1 or ₱1.20 postpaid.
Manual de la Industria Azucarera de las Islas Filipinas, ₱4 or ₱4.50 postpaid.

All communications should be addressed to the Director of Agriculture, Manila, P. I.

(*a*) View of abacá (Manila hemp) in the plantation of the Culaman Plantation Company, Malita, Davao.

(*b*) Road through the abacá plantation of the Ohta Development Company, Malita, Davao.

THE PHILIPPINE

Agricultural Review

VOL. XIII THIRD QUARTER, 1920 NO. 3

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ILLUSTRATIONS

DAVAO: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

The Province of Davao (Plate II) is located between 125° and 126° 40′ east longitude, and between 5° 20′ and 8° north latitude, in the southeast corner of the Island of Mindanao. It is bounded on the north by Agusan Province, on the east by the Pacific Ocean, on the south by the Celebes Sea and on the west by Cotabato and Bukidnon, and has a coast line of more than 600 kilometers. With an area of 7,486 square miles Davao nearly approximates in size the State of New Jersey, which has an area of 7,815 square miles, and it has a population of about 101,000 inhabitants according to the census of 1918.

According to the most recent surveys and estimates of the Bureau of Forestry, Manila, 90.2 per cent, or 1,749,420 hectares of the area of Davao is still commercial forest, a greater area of woodland than that in any other province in the Philippines, Cotabato excepted. The land in cultivation includes but 30,730 hectares or 1.6 per cent of the total area. The open land and cogonales is probably not less than 50,000 hectares. These figures may require some readjustment, since there is an unexplored area of 6.1 per cent, or 117,564 hectares. There are quite extensive mangrove swamps at the head of the Gulf.

In addition to the mainland Davao includes four fairly large islands, Samal and Talikud, near the head of the Davao Gulf, Bulat and Sarangani off the southernmost point of the Island of Mindanao, and several smaller ones scattered along the coast here and there.

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[1] The writer wishes to acknowledge his indebtedness to Col. Ole Waloe, Philippine Constabulary, for access to the Constabulary Monograph of Davao, and to Mr. Carl M. Moore, Superintendent of schools in Mindanao, for access to a report on agriculture in Davao by Mr. W. F. L. Asimont. The map of Davao has been traced from a map of Mindanao furnished by Mr. H. E. Neibert, supervising surveyor, Bureau of Lands. The map of the Malalag Bay has been traced from a map furnished by the Director of the U. S. Coast and Geodetic Survey, Manila.

Geographically Davao Gulf is the central feature of Davao Province and practically all plantations in the province extend inland from its shores. Few people realize that here in the southeast of the Philippine Archipelago there is a bay more than three times as large as the Bay of Manila.

The province itself is constituted of the eastern slope of the mountain chain that, roughly speaking, extends from north to south, west of Davao Gulf, the Agusan Valley south of the eight parallel, and the large peninsula to the southeast, terminating at Cape San Agustin.

The topography of Davao is varied. There are large level or undulating plains, there are gently rising mountain slopes and rugged, precipitous mountains. The country is everywhere well watered by numerous streams and rivers, which, thanks to an evenly distributed rainfall, rarely or never run dry.

In a general way, the great bodies of agricultural land in Davao might be considered in two large regions. (1) The country in northern Davao drained by the Agusan River and its tributaries. This spacious, fertile country belongs topograpically to the Agusan Valley and it is one of the finest bodies of virgin agricultural land in Mindanao. The present great drawback to this district is the absence of transportation facilities; and as yet the entire tract is lying idle, barring a few isolated patches of semicultivated land occupied by the native inhabitants. (2) The water-shed of the Saug, Libuganon, Tagum and Hijo Rivers at the head of Davao Gulf and the country to the west and south thereof to Mount Apo and Malalag Bay west of the Gulf, and east of the Gulf to Mapanga Bay.

There are other valleys of greater or less dimensions of equally fertile land in the remainder of Davao, for instance, the country around Lais and Malita, at Kuabo, and north of Mati, but these areas are not comparable in size with those of the two large regions first mentioned. In the other coast districts, even where the mountains approach the coast, when the streams come within sight of the sea, as a rule the surrounding country spreads out in alluvial valleys of great fertility, sometimes small, not more than a few hundred hectares, to larger plains, sometimes exceeding a thousand hectares in area. Several of the Davao plantations are situated in such valleys. Though most of the better agricultural land in Davao is below this elevation, the Guianga plain to the northwest of the town of Davao ascends from 300 to over 600 meters altitude.

Oversized Foldout

The southern part of Davao west of the Gulf, from Sarangani Channel to Malalag Bay, is mountainous and forested from the Cotabato border to the coast. It is a rugged country, rich in timber but relatively unimportant from an agricultural point of view. Still, notable plantations are located here, such as those of the Culaman Plantation Company at Malita, one of the largest and most successful estates in Davao, and the Lais Development Company in Lais; and it is about Malita and Lais that the cultivation of rubber (Para and Castilloa) and Robusta coffee is concentrated in Davao.

From Malalag Bay and northward the country assumes a different aspect. The mountain ranges recede from the seashore and give room for broad, undulating plains, gradually rising as one travels westward, partly in virgin forest, in part cleared and overgrown with cogon, *Imperata cylindrica,* a tall, perennial grass. This is, in fact, a section of one of the large agricultural regions of Davao.

The narrow peninsula east of the gulf, from Kuabo southward, is a rough, mountainous land covered with virgin forests. The agricultural areas are small and located on the west coast of the peninsula.

The land from Mati to Manay for some distance inland is the principal cattle district in Davao.

In the river valleys the soil is, as a rule, a friable, rich alluvium, free from boulders and stones and frequently of great depth. Lands with good agricultural soil 3 to 4 meters deep are by no means uncommon. Now and then a sandy loam is encountered. Heavy clay soils are the exception. On the higher slopes of the mountain range facing Cotabato much of the soil is of volcanic origin and is exceedingly fertile.

The long coast line is indented by several large bays, such as Mapanga, Kuabo, Puhada, Mayo, Karaga, and Kateel.

Good anchorage and harbors for motor boats are located at the following points: Astorga, a few kilometers north of Santa Cruz; Butulan, north of the Sarangani Channel; Kalian just north of Kalian Point; Kuabo, on the bay of the same name; Mapanga on the bay of the same name; Patulangan, on the east coast of Davao Gulf just north of Santa Cruz; Tagabuli, a few kilometers south of Santa Cruz, at the mouth of the river of the same name; and Tubalan, on the east coast of Davao Gulf north of Malita.

Patoko and Tumanao, on the west coast of Sarangani Island afford good anchorage for steamers and motorboats. Mati, at the head of Puhada Bay has a good harbor for ocean-going steamers. This is also true of Monserrat, located some distance south of Kuabo Bay on the west coast of Davao Gulf.

The best harbor in the province is Malalag Bay, inside Kolapsin Point on the eastern shore of Davao Gulf.

Davao has a large number of streams and rivers of which the following are the largest and the most important:

The *Agusan* River, which originates west of Karaga and flows first westward and then in a northerly direction until it enters Agusan at Patrocinio and empties into Butuan Bay, on the north coast of Mindanao (See *Agusan: Its Natural Resources and Opportunities for Development,* in the previous issue of this REVIEW). The Agusan is navigable for motor boats to Veruela in Agusan Province and thence by baroto to Compostela, Davao.

The *Kateel,* emptying at Kateel, has a considerable volume of water but the current is too rapid to permit navigation.

The *Davao* River, emptying at Davao, the provincial capital, is navigable for small motor boats for about 10 miles inland.

The *Lasang* River is navigable for barotos for about 4 miles.

The *Libuganon* rises in the mountains in the northwestern corner of Davao and joins the Saug River at Pagsabangan. Thence to the sea it is known as Tagum River which is said to be navigable for small boats for about 25 miles inland.

The *Saug* River, already mentioned, is navigable for barotos to Macgum.

The *Tagum* River, formed by the confluence of Saug and Libuganon Rivers at Pagsabangan is navigable to this point by motor boats drawing 5 feet of water. On a much smaller scale the Tagum River and its valley is very smiliar to the wooded banks of the Agusan on the north coast of Mindanao.

Padada, Hijo, Sumlug, Bitangan, Karaga and *Honoon,* are other somewhat less important rivers with a smaller volume of water, in addition to which there are innumerable small short streams and water courses that wind their way from the mountains to the sea all along the coast.

With the exception of Tagum the rivers in Davao are of little value for transportation purposes. On the other hand the numerous falls and rapids afford rich opportunities for the construction of power plants for plantations, for industrial and lighting purposes and for transportation.

The highest mountain is Apo, 2,883 meters high, located near the Cotabato boundary, southwest of Davao; Hamihitan on the narrow peninsula south of Puhada Bay ascends to an eleva-

(*a*) Near view of abacá. Davao.

(*b*) Abacá ready for harvesting. Mintal, Davao.

tion of 1,607 meters, and Latian southwest of Lais is 1,586 meters high. Several other mountains reach an altitude of 600 to exceeding 1,000 meters.

CLIMATE.

In a territory so large and having the topographical formation characteristic of Davao naturally there is considerable variation in the precipitation in the various districts, but in the main Davao has a very evenly distributed and ample rainfall. In fact, the capital of the province has a more equal distribution of rainfall than any other point in the Philippines where observations are made at present and it is fairly typical of the province as a whole. The following table shows the rainfall at Davao on the gulf and in Karaga on the Pacific coast as recorded by the Philippine Weather Bureau, Manila.

TABLE I.—*Mean monthly and annual rainfall of Davao.*

Months	Davao	Karaga
	Rainfall	Rainfall
	mm	*mm*
January	110.2	294.8
February	141.6	402.4
March	164.2	270.3
April	190.3	148.5
May	252.8	203.7
June	234.2	103.6
July	208.9	142.7
August	207.4	75.7
September	203.6	67.4
October	242.3	128.4
November	176.4	171.9
December	208.8	422.6
Total	2,340.7	2,432.0

The temperature varies, of course, with the elevation. On the lowlands it is rather warm and sultry during the day but the nights are always cool and pleasant. Further inland on the mountain slopes above 300 meters the heat is never oppressive.

POPULATION

The population of Davao is about 101,000, divided into Filipinos, (the majority of whom belong to tribes peculiar to Mindanao, including the Bagobos, Bilans, Mandayans, Tagacaolos, Atas, Culamans and Moros), about 10,000 Japanese and some 300 Chinese. One hundred Americans, perhaps, are living in the province, mostly planters.

Of the native tribes the Bagobos occupy the east coast of Davao Gulf from Digos to Talomo, including the mountain slopes to Cotabato and the Guianga plain. The Tagacaolos inhabit the country from Digos to Lais, and furnish most of the native plantation labor in the province. The Culamans are scattered from Padada to Sarangani on the east coast and from Kuabo to Cape San Agustin on the west coast of Davao Gulf. The Bilans occupy Sarangani Island and the country immediately to the north thereof, and there are some also here and there in the mountains north of Cape San Agustin. The Mandayans occupy the mountain range from Cape San Agustin to Agusan and the valleys of Agusan, Hijo and Tagum Rivers, north of the Gulf. The Atas live in the interior between Davao and Libuganon Rivers. Remnants of the invading Moros are settled on Samal and Sarangani Islands, at the mouths of the Tagum, Hijo, Lasang and Sumlug Rivers, and in some villages on the Pacific coast between Manay and Mati.

The Japanese are occupied in growing abacá and coconuts both as owners of and laborers on plantations. The Chinese are traders.

On the face of it, from the above statement, it would appear that labor is fairly plentiful in Davao, whereas the opposite is true. The natives are either caring for their own small farms or they are occupied in other pursuits, and new estates that are opened in the future must needs import labor from the Visayas or Luzon.

HISTORICAL REVIEW

Davao is the "youngest" province in the Philippines. Its history is recent and scant and is rather in the making and in the future. But little is known of Davao prior to about 1823, until which year the Bagobos inhabited the coasts. Moro pirates then arrived and drove the Bagobos to the hills, who sent emissaries overland to the Spanish military post at Cagayan, Misamis, for aid against the Moros. As a result the Spaniards dispatched an expedition by sea to Davao, which, aided by the native inhabitants, drove out the Moros and hoisted the Spanish flag. Davao was occupied by the American army in 1900. The military government continued in force until 1914, when civil government was established and Davao was made a province in the Department of Mindanao and Sulu.

AGRICULTURAL INDUSTRIES

Reliable export figures for Davao are not available but in part may be surmised from the following table showing the areas planted to agricultural crops, furnished by Mr. Antonio Peña,

(*a*) Hydro-electric and ice plant of the Ohta Development Company, Mintal, Davao.

(*b*) Hospital for plantation laborers operated by the Ohta Development Company, Mintal, Davao.

Chief, Division of Statistics of this Bureau.[1] Of the below named products only abacá and copra are exported.

TABLE II.—*Agricultural crops in Davao, 1918.*

Crops	Area	Quantity	Value
	Hectares		*Pesos*
Abacá	17,983	7,085	4,550,728
Coconuts	[b] 1,014,742	[a] 542	[d] 96,839
Rice	7,470	[c] 76,891	361,108
Corn	468	[c] 3,705	14,879
Tobacco	41	[a] 19	7,586
Coffee (est)		9	4,200

[a] Metric tons. [b] Trees. [c] Hectoliters. [d] Total value of all products.

According to these figures, if we reduce the number of coconut trees to area, calculating 204 to the hectare, or 7 meters apart, there are 45,200 hectares planted to coconut palms in Davao, one-third of which are estimated to be in bearing. The coconut ranks first if area is considered; if crop values are the index abacá is by far the leading crop. In fact, notwithstanding its recent development Davao already ranks sixth among all the provinces in the Archipelago in abacá production, and in quality Davao abacá outranks the product of all the major abacá districts in the Philippines. By far most of the abacá is produced on plantations located around the gulf. In value of the product rice ranks second among the agricultural crops of Davao, but a large quantity of rice is still annually imported. Kateel is the most prominent rice district in the province.

The production of other crops is insignificant.

The vegetables in Davao do not differ very materially from those grown in other parts of the Philippines except that fewer kinds and smaller quantities are grown.

Sago palms, *Metroxylon sagu* Rottb., are common along the rivers and furnish a wholesome food (Plate V–*b*).

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[1] Since this was written the following statistics for the year 1919 have become available.

Crops	Area	Quantity	Value
	Hectares		*Pesos*
Abacá	19,789	[a] 6,699	3,642,475
Coconuts	43,791	[d] 620	[c] 163,087
Rice	7,000	[b] 70,956	576,504
Corn	1,170	[b] 15,318	165,061
Tobacco	80	[a] 32	18,205
Coffee			5,029

[a] Metric tons. [b] Hectoliters. [c] Value of all coconut products. [d] Copra, metric tons.

The following varieties of food plants and abacá have been recorded in Davao by Mr. Santiago Festin, deputy governor of the province:

RICE VARIETIES

Baka-nang-hau-an	u-ng-w [1]	Kapunit	u-ng-w
Balanay	l-ng-w	Karangkang	u-ng-w
Bandera	u-ng-w	Kayinti	l-ng-w
Banogo	l and u-ng-w	Laag	u-ng-w
Batukan	u-ng-w	Landang	u-ng-w
Binagaybay	u-ng-w	Lansiyau	u-ng-w
Binogka	u-ng-w	Lumban	u-ng-w
Bisliganon	u-ng-w	Lupa	u-ng-w
Boyokot	u-ng-w	Mahosay	u-ng-w
Buakan	u-ng-w	Malagkit	u-gl-w
Bula-ing	u-ng-w	Mandaya	u-ng-w
Dayogo	u-ng-w	Manobang	u-ng-w
Gomon	u-ng-w	Manombay	u-ng-w
Kabo-ong	u-ng-w	Sugila	u-ng-w
Kabovod	l-ng-w	Sug-ñgi	u-ng-w
Kalimbato	u-ng-w	Tadokan	u-ng-w
Kalobid	u-ng-w	Tapo	u-ng-c
Kandoyogo	u-ng-w		

CORN VARIETIES

Bagobo	Lawa-an	Pongko
Cebuano	Malagkit	Romblon
Loma-og		

SUGAR-CANE VARIETIES

Balatino	Binay	Lubagon
Bambowawan	Bu-ok	Ma-hó
Bantolinao	Hali-hali	Tinigbao
Batakan	Kambagon	Tumanan

CAMOTE VARIETIES

Amondong	Lagang	Sagonot
Baling	Manila	Ta-bon
Bina-ay	Okayon	Timbolosan
Gapas	Oyop	Ubi-ubi
Gomansing		

GABI VARIETIES

Cabodiau	Lagan	Somolod.
Initlog	Pinoyó	

UBI VARIETIES

Ba-ay	Binaue	Sinaua
Binansan	Bitay	Tinampay

COCONUT VARIETIES

Ba-ongan	Limba	Mamis
Binauauan	Lingkoranay	Tinadayao
Dahili	Makapuno	

[1] u=upland, l=lowland, ng=non-glutinous, w=white, c=colored.

(*a*) Coconut in bearing. Mati, Davao.

(*b*) There are no extensive sago, *Metroxylon sagu*, swamps in Davao but the palm is common and grows luxuriantly in many parts of the province. Sigaboy, Davao.

BANANA VARIETIES

Binaleng	Inambak	Paitan
Binañgay	Inusa	Pitogo
Bina-oy	Kamis	Pudikit
Biongkaras	Kolikut baguio	Puti-an
Bungulan	Kuagi	Sab-a
Butulan	Litondan	Señora
Dak-dakon	Lononsing	Taba
Dang-dañgon	Lumbaga	Taokan
Do-o	Lupit	Tindok
Garo	Masikampo	Tinogon Baguio
Goyodon	Obispo	Tudling biya
Inaluan		

EDIBLE MUSHROOMS

Amag	Kolopan	Taliñga-nang-Amag
Darogdogan	Kopan	Tinibo
Kaupas	Labgos	

ABACÁ VARIETIES

Agutay	Lakig	Poti-an
Apid	Lawa-an	Sab-a
Baguisanon	Libotong	Sawayo
Bato	Maguindanao	Sinapi
Boñgolanon	Polahan	Tangongon
Buntot Kabayo	Ponokan	Tuigon

Cultivated fruits are very scare, but many wild or naturalized fruit trees, such as the Bauno, Durian and Marang grow luxuriantly in the forest and are gathered and marketed. Citrus trees succed well. *Citrus excelsa* var. *davaoensis* West., produces especially large and juicy fruits in great abundance.

The following wild and cultivated fruits have been noted in Davao by the writer:

Banana, *Musa sapientum* L.
Bauno, *Mangifera caesia*, Jack.
Barobo, *Diplodiscus paniculatus* Turcz.
Bignay, *Antidesma bunius* Spreng.
Breadfruit, *Artocarpus communis* Forst.
Buol, *Ximenia americana* L.
Cacao, *Theobroma cacao* L.
Carambola, *Averrhoa carambola* L.
Coffee, Arabian, *Coffea arabica* L.
Cashew, *Anacardium occidentale* L.
Citron, *Citrus medica* L.
Coconut, *Cocos nucifera* L.
Custardapple, *Annona reticulata* L.
Dao, *Dracontomelum dao* M. & R.
Duhat, *Eugenia jambolana* L.
Durian, *Durio zibethinus* L.
Guanabano, *Annona muricata* L.

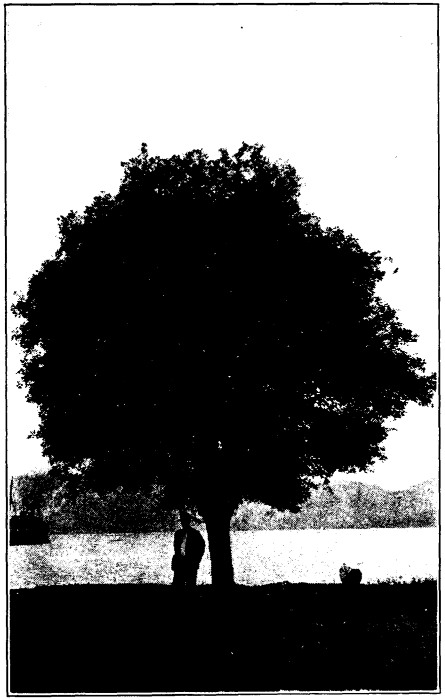
Fig, *Ficus carica* L.
Guava, *Psidium guajava* L.
Huani, *Mangifera odorata* Griff.
Inyam, *Antidesma ghaesembilla* Gaert.
Jak, *Artocarpus integra* L.
Kabuyao, *Citrus hystrix* DC.
Kalamondin, *Citrus mitis* Bco.
Kalpi, *Citrus webberi* West.
Kamia, *Averrhoa bilimbi* L.
Kamanchile, *Pithecolobium dulce* Bth.
Kandiis, *Garcinia* sp.
Lamio, *Dracontomelum edule* Skeels.
Lanno, *Spondias pinnata* Kurz.
Lanzon, *Lansium domesticum* Jack.
Lemoncito, *Triphasia trifolia* P. Wils.
Lime, *Citrus aurantifolia* Swg.
Maigang, *Eugenia garciae* Merr.
Macopa, *Eugenia javanica* L.
Mandarin, *Citrus nobilis* Lour.
Mango, *Mangifera indica* L.
Marang, *Artocarpus odoratissima* Bco.
Orange, *Citrus sinensis* Osb.
Papaya, *Carica papaya* L.
Pomelo, *Citrus maxima* Merr.
Pomegranate, *Punica granatum* L.
Pineapple, *Ananas sativus* Schult.
Santol, *Sandoricum koetjape* Merr.
Sugarapple, *Annona squamosa* L.
Talisay, *Terminalia catappa* L.
Tamarind, *Tamarindus indica* L.

Of the identified fruits, the Lamio, Buol, Dao, Inyam and Maigang, deserve mention as heretofore not having been recorded as food plants in the Philippines.

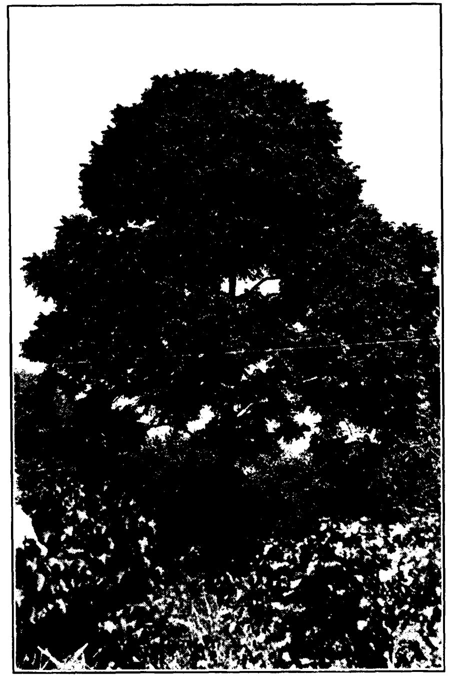
The Lamio, *Dracontomelum edule* Skeels,[1] (Plate VII–*b*) is a very handsome tree up to 20 meters in height, with a straight trunk and a well-shaped, rounded crown. The leaves are large and pinnate. The fruit is produced in loose clusters like the Hevi, *Spondias cytherea* Sonn., to which it is related. Not quite fullgrown fruits collected at the end of May, 1919, in Malalag, averaged 33 millimeters in cross-section, and were pronouncedly oblate with a large stone in the center containing up to 5 seeds. The flesh is said to be subacid and edible. The Lamio would make a very ornamental shade tree.

The Dao, *Dracontomelum dao,* is a large tree, with rather small, pinnate, glabrous leaves, and the fruits are said to be somewhat smaller than those of the Lamio, but otherwise similar

[1] The identification of this and the following species has courteously been made by Mr. E. D. Merrill, Director, Bureau of Science, Manila.



(*a*) A Kalpi tree, *Citrus webberi*, Mati, Davao. Trees of this species grown from material procured from Mati have been found highly resistant to citrus canker.



(*b*) Lamio, *Dracontomelum edule*, a native fruit tree. Malalag, Davao.

(*c*) Maigang, *Eugenia garciae*, a native fruit tree. Sigaboy, Davao.

in eating qualities. Several trees were noted in bloom in May. So far as observed this tree is of but little value for ornamental purposes.

The Buol, *Ximenia americana* L., (Plate VII–*a*) is a spiny shrub rather than a tree, attaining a height of 6 to 8 meters, growing on the seashore on the Davao Gulf, and in southern Cotabato. The stems, at first of upright growth, bend over and outward, until the plant eventually forms a large, spreading shrub. The flowers, which appear in small cymes in the axils of the leaves, are honey-bearing and pleasantly fragrant. The fruit is broadly ellipsoid, regular, up to 32 millimeters long, with shallow cavities at the base and apex; the surface is smooth and greenish yellow; the skin thin, peeling from the flesh like that in a ripe peach; the flesh is greenish next to the skin, fading to grayish white around the seed, with the texture of the cherry, juicy, pleasantly acid but scant, enclosing a large, smooth seed adhering to the pulp. The fruit is collected and eaten by the native inhabitants. The fruit is too acid for eating out of hand but would apparently make a good preserve.

The buol is especially abundant at Malalag Bay where many very productive plants were noted by the writer, the fruit ripening from May to June and July.

The Inyam, *Antidesma ghaesembilla* Gaert., is a small dioecious tree growing on open, grassy plains or hills, and commonly found on poor, gravelly and stony soils where most other trees refuse to grow. The fruits grow in short, compact racemes, and are of the size of a small currant, smooth, dark red to almost black, with scanty but pleasantly flavored subacid pulp containing a relatively large seed.

The Inyam is common throughout the Philippine Archipelago from sea level to at least 1,000 meters elevation, under the conditions noted.

The fruits are collected and eaten but rarely marketed, and may be eaten out of the hand and would probably make a good preserve.

The Maigang, *Eugenia garciae* Merr., (Plate VI–*c*) is a small tree of upright growth with young growth quadrangulate; the leaves are unusually long and broad, possibly the largest in the genus. The flowers grow in large compact panicles among or below the leaves, opening in May, the fruit ripening probably in July. The fruit, which was not seen by the writer, is said to be about 25 millimeters across, roundish, smooth and dark red; the flesh is said to be subacid, pronouncedly sweet and of good flavor, containing one seed.

Botanically, the Maigang would appear to be pretty much a more robust form of the Lipoti, *E. currani* C. B. R., formerly described and illustrated in this REVIEW, and the fruit is probably quite similar to the Lipoti. The Maigang makes a handsome ornamental shade tree.

The Kandiis, *Garcinia* sp., (Plate VII–*b*) would seem to be the same species as the Kadis described from Cotabato on another page and is apparently very closely related to *Garcinia binucao.*

In addition the following, unidentified fruits, of which no herbarium material has been obtained, are reported to grow in Davao:

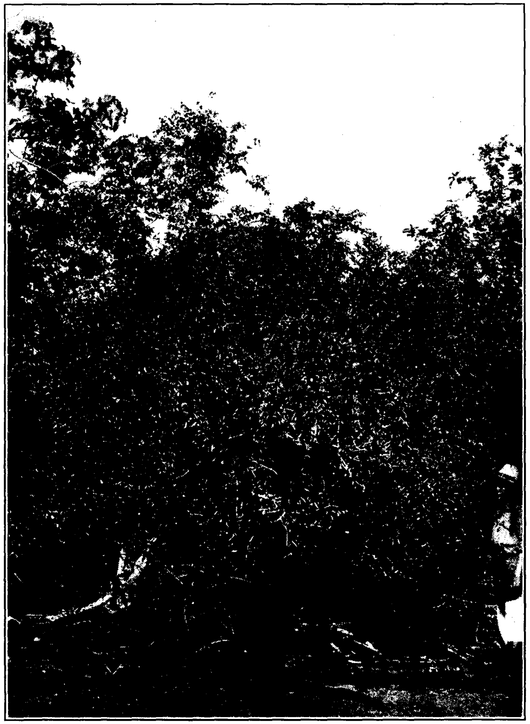
Angos	Katmon	Lowaw
Balangas	Kagokoo	Monane
Bunani	Kolotkolotan	Olingon
Kamapasiau	Langauisan	Parale
Kanobi	Lambog	Pili
Kape	Labno	Posdan
Kalapi	Labonao	Tapaok

It is but natural that abacá and coconuts should claim the attention above all other crops in Davao, and the province is unquestionably destined to become a country of large plantation ventures. Indeed, such large fortunes (For the Philippines) have been made in land speculation and abacá within such short a time that except coconuts, cattle, and to a limited extent rubber, other crops and business ventures seem to have been lost sight of.

Vegetables, fruits and poultry products command exorbitant prices, yet they are difficult, at times impossible, to obtain. Of course, the major staples are profitable, but it is confidently believed that the profits from well conducted vegetable, fruit and poultry farms in Davao would be even greater and it could be started with comparatively little capital. A business venture of this kind would also be of inestimable service to the community in that it would render an isolated locality more independent of the importation of foodstuff from outside sources.

While this is true of the towns, especially Davao, it is believed that the planters also could to great advantage grow a large part of their own foodstuffs.

Lowland rice can not be recommended since its cultivation would preclude the utilization of the land for other crops, but upland rice and corn could be grown as auxiliary crops in the young abacá and coconut plantations. Ragi, *Eleusine coracana,* one of the grain crops of India, could be used for the same purpose.



(*a*) The Buol, *Ximenia americana*. Malalag, Davao.

(*b*) Kandiis, *Garcinia* sp., a native unidentified fruit tree related to the mangosteen. Sigaboy, Davao.

Of the legumes cowpeas and anipay, *Phaseolus calcaratus,* would be suitable for planting on a larger scale, while as vegetables the seguidilla, marutong and patani are eminently worth while. Among the root crops cassava, ubi, tongo, yautia and camotes succeed very well, and would produce abundantly. Especially is it desired to call attention to the possibilities of cassava as a *table vegetable.* The general impression prevails that cassava is a plant grown for the manufacture of starch only, and that the roots are quite inedible. True, the roots of most cassava varieties *are* hard and fibrous even in their young stage and when old they are, of cource, not fit for the table. But the writer has in Bukidnon, Mindanao, eaten cassava roots boiled like white potatoes, which were entirely free from fiber, and in quality equal to "young" potatoes. They were greatly superior in eating quality to imported white potatoes.

Some day the Philippines, like Java, may grow her own white potatoes but in the meantime it would be eminently worth while to get familiar with the several root crops that succeed so well in these Islands, which are equally so or more palatable than the imported product, and which are readily produced.

PLANTATIONS

The rapid progress of the agricultural development of Davao may be surmised from the fact that whereas in 1917 69 corporations were engaged in agriculture on a fairly large scale, this number increased to 127 in 1918. Of these 82 were organized by Japanese, 20 by Americans and 19 by Filipinos.

Among these plantations those operated by the Ohta Development Company in Talomo and Mintal are the largest and are exceptionally well-organized and managed (Plates I-*a* and III). In Mintal this company has installed an irrigation system including 3 miles of main canals and 70 miles of laterals. Talomo is the center of administration of this company where it has a private wharf and large bodegas. A large, airy modern hospital of light material has been erected in Mintal and all buildings are lighted with electricity from a small hydro-electric plant at Mintal where ice is also manufactured for the needs of the plantations (Plate IV). The plantations, which consist of abacá and coconuts, are well managed and in excellent condition. Altogether, considering area, its general appointment and management and the excellent condition of the plantations, this enterprise reflects the greatest credit on its organizers and administrators and is well worth visiting by prospective planters who wish to see a model abacá and coconut plantation managed in line with the most advanced ideas in tropical agriculture.

The Culaman Plantation Company at Malita also has a large plantation of abacá and coconuts in excellent condition (Plate I–*a*).

Among the many other plantations that have come into existence and are well established the following are especially worthy of notice: The Piso Plantation Company at Piso on the west coast of the Gulf. The Madaum Plantation Company at Madaum, at the head of the Gulf. The Moro Improvement and Trading Company at Tagnanan, the Gulf Plantation Company at Pantukan, and the Southern Cross Plantation Company at Pangasinan; all of which are located on the west coast of the Gulf above Mapanga Bay. The Mindanao Plantation Company at Digos; the Padada Plantation Company at Padada; the Cumassie Plantation at Cumassie, the Basiaon Plantation Company at Basiaon Bay; the Lacaron Plantation Company at Lacaron and the Lais Development Company, Lais, are all located on the east coast of the gulf south of the town of Davao. These are but a few of the more prominent agricultural ventures in the province.

Nearly all the plantations in Davao are devoted to abacá or this is the principal crop, though coconuts are now being planted to an increasingly greater extent, and the indications are that very considerable areas now in abacá will be given over to coconuts. The violent fluctuations in the market price of abacá fiber coupled with the scarcity of labor is largely responsible for this movement.

At Lais and Malita some Castilloa rubber has been planted which is here considered quite promising, largely because the gathering of rubber is simple and can be performed by untrained labor. A small number of Para rubber trees have also been set out. Certainly the soil and climate appear to be very favorable for the growth of Hevea. Robusta coffee has been planted at Lais and found very successful but there are no large plantations in the province. Cattle are raised very successfully in connection with some plantations devoted to coconuts, especially near Mati.

Small areas have also been planted to lumbang or biao, *Aleurites moluccana,* for nut production by some planters, but it is very doubtful whether this crop will prove as profitable as the coconuts, abacá, rubber, and coffee, to which the province is well adapted.

(*a*) The Provincial government building, Davao.

(*b*) Native vegetation on the shore of Malalag Bay, Davao. (The palm-like plants are *Cycas circinalis*.)

RESOURCES AND PRODUCTS OTHER THAN AGRICULTURAL

The vast forests of Davao contain much the same timber trees that are found in the forests in other parts of the Philippines, such as camagon, *Diospyros discolor;* mancono, *Xanthostemon verdugonianus;* molave, *Vitex* spp., narra *Pterocarpus indicus;* tindalo, *Cassia javanica* and *Pahudia rhomboida;* ipil, *Intsia bijuga* and *Adenanthera intermedia;* guijo, *Shorea guiso;* agoho, *Casuarina equisetifolia,* and apitong, *Dipterocarpus* spp. Many other species might be mentioned.

As yet there are no saw mills to utilize the forest resources of the province.

Lumbang nuts are collected and marketed to a considerable extent. Almaciga and rattans are brought from the forest in small quantities. As yet nothing has been done to export tanbark from the mangrove swamps that are situated on the gulf.

The waters around Davao are rich in fish but the fishing industry is poorly developed.

Sulphur deposits are reliably reported to exist on Mount Apo, but no surveys have been made to determine their extent. There are hot sulphur springs at Point Baños about midway between Malita and Sarangani Channel.

TRADE AND COMMUNICATIONS

When the recent economic development of Davao is considered, coupled with the presence of an exceptionally long coastline, the reasons for the almost total lack of roads is easily perceived. The only first-class road in the province has been constructed from the town of Davao to its shipping point and dock, Santa Ana, a few kilometers away, which road now is being extended to Talomo. But the absence of land transportation is not such a hardship to the inhabitants as one might be lead to believe, considering that nearly all plantations are located on the Gulf and have water transportation.

Two wireless stations, one in Davao, the capital, and another in Kuabo, together with telephone lines that extend to all the more important municipalities even on the Pacific coast as far as Kateel, serve as means of communications within the province, and with the outside world.

The inter-island transportation facilities are confined to the steamers *Raritan, Fernandez Hermanos, Albay, Neil, MacLeod, Yazoo, Mindanao,* and *Tablas,* of which all but the last make regular trips to Manila. These steamers not only touch at Davao and Mati, the two principal ports, but depending upon the amount of cargo to or from each place, they call at several of the plantations or municipalities in the Gulf as well as on the Pacific coast as far as Kateel. These steamers also call at Zamboanga, Dumaguete and Cebu on their way to and from Manila.

FUTURE DEVELOPMENT

The two great future industries of Davao are lumbering and agriculture.

As in Agusan and Cotabato, aside from the timber for lumbering great quantities of almaciga and rattan can be gathered in the forest while tanning extracts can be obtained from the mangrove swamps on the Gulf.

The phenomenally rapid development of agricultural lands in Davao is a prophecy of the future, and this may be expected to proceed at a greatly accelerated pace. Here a word as to the development of the past may not be out of place. The progress of Davao during the last five years undeniably has been more rapid than that of any other province in the Philippines. Many (for the Philippines) big corporations have been organized and have set out plantations of abacá and coconuts. There has been a great stampede for plantation sites, and an impression has recently gained headway that the public land in Davao was fast becoming exhausted. This is not true. How erroneous this belief is may be seen by a glance at the figures on the first page of the within article, where it will be noted that less than 2 per cent of the lands of the province are claimed for agricultural crops. It is a fact, however, that the agricultural lands near the coast are rapidly being occupied and since there are practically no roads into the interior of the province, planters away from the coast naturally are at a great disadvantage. In fact large areas of the most fertile lands in the province away from the coast are practically inaccessible to planters who would unquestionably open up the lands if the communications with the coast was established. This brings to the fore the future transportation problem of Davao.

The long coastline will permit extensive employment of water transportation on the Gulf by small craft, for which there is good anchorage at many points. Good roads from these minor "ports of call" into the interior would do much to bring several of the inland districts within the region where agricultural development is feasible, but for the opening up of the great agricultural district in northern Davao and the establishment of communications with the neighboring provinces, railroads are

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imperative. With a view of serving the agricultural interests of Davao a harbor more centrally located would have been desirable, but all other advantages are so onesidedly possessed by Malalag Bay in contrast to other points that one may expect it to become the principal shipping port in Davao.

Malalag Bay (Plate IX) has not the uniquely favorable combined features of Parang, Cotabato, but:

(1) The bay is well protected; vessels would be safe there no matter how rough the Gulf, yet,

(2) It is large enough to accommodate a large fleet.

(3) The water is deep close to the shore and piers could be constructed at a comparatively slight expense.

(4) The topographical features of the country surrounding the bay are favorable to the growth of a large and attractive city under good sanitary conditions.

(5) An abundant supply of excellent water is obtainable from the Padada River when the port shall have expanded into a large city, and during its infancy the flow of the Malalag River will be more than ample.

(6) While Malalag is located at the lower end of one of the large agricultural regions of Davao, it is next door to another great agricultural section of the Cotabato Province.

A railway then, terminating at Malalag, (one branch turning westward and crossing the range of mountains would enter the Cotabato Valley) should run northward through the rich valleys of Padada, Digos and Santa Cruz in succession, then penetrate the Guianga Plain to turn in a northeasterly direction until it entered the Agusan Valley territory to connect with the railroad from Nasipit. For an outlet to the sea in the northern part of the Davao Gulf, Tagum would probably be the most desirable point, though low and swampy. A third roadstead at Mati on the Pacific coast will probably be established eventually for a branch line penetrating the interior of the peninsula to the north of this town.

Davao is well adapted to a wide range of crops. Coconuts and abacá are already so extensively planted and have proved so eminently successful as to require no further comment except that the area planted to the coconut palm is likely to increase at a much greater rate than that of abacá, especially until the present scarcity of labor is relieved or a practical hemp stripping machine is invented and placed the market. A successful mechanical hemp stripper would release a great number of laborers from the tedious process of stripping hemp by hand for other plantation work and would unquestionably do more to increase the acreage planted to abacá than any other event except the admission of foreign labor.

The quality of the soil and the rainfall indicate that large areas of land in Davao are well adapted to Para rubber. It is true that the earliest attempts to grow Para rubber in Davao failed, but this would appear to have been due to faulty seeds and plants, and to inexperience in handling rubber, for later plantings have done well. Also, one may expect Para rubber in time to become one of the principal products of Davao. Notwithstanding the progress made by Castilloa in Davao, in the light of the experience with this rubber in all other regions where it has been tried, it can not be recommended as a plantation crop where Para rubber will succeed.

While Arabian coffee is not recommendable anywhere in Davao, there is very reason to believe that the new blight resistant coffees would prove highly successful. More particularly on the Guianga plain tea culture on a large scale would appear feasible.

On some of the lighter soils tobacco of good quality might be produced. Other annual crops adapted to this regions are jute and roselle for fiber. Small quantities of anabo fiber are already produced from a native plant, *Abroma augusta,* and it is by no means impossible that this might become an important agricultural crop, for the fiber is of good quality and the plant is of rapid growth and easily grown. Cassava starch in large quantities might be produced. The production of the annual crops is largely a question of securing enough labor to handle them.

The food plants grown in other parts of the Philippines succeed well in Davao and with the proper organization of its agricultural industries the province could be self-supporting so far as foodstuffs are concerned.

COTABATO: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT[1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

The Province of Cotabato (Plate XI) is located between 123° 50′ and 125° 30′ east longitude and between 5° 30′ and 7° 40′ north latitude. Occupying the major part of the huge peninsula that lies between the Celebes sea on one side and is washed by the Davao Gulf and the Pacific Ocean on the other, it is bounded on the north by Lanao and Bukidnon, on the east by Davao, and on the south and west by the Celebes Sea, and contains an area of 9,620 square miles, being by far the largest province in the Philippines. In size it compares most nearly with Vermont in the United States, that state having an area of 9,565 square miles. Cotabato is three times as large as Porto Rico less 1,247 square miles, which has an area of only 3,604 square miles and it is about a third larger than the Hawaiian Islands, which contain 6,406 square miles.

Of this large territory, according to the latest survey of the Bureau of Forestry, Manila, 78.7 per cent, 1,960,530 hectares, is covered by commercial forest, 2.9 per cent, or 72,640 hectares is open grass lands; there is less than 2 per cent of the land in mangrove swamps and non-commercial forests, while 0.6 per cent, or less than 15,000 hectares are in cultivation. Some of these figures are subject to correction, since there are 16 per cent, or 402,880 hectares of land that still remains unexplored.

The more prominent mountains in Cotabato are Mount Matutum, 2,295 meters high, northwest of Sarangani Bay in the

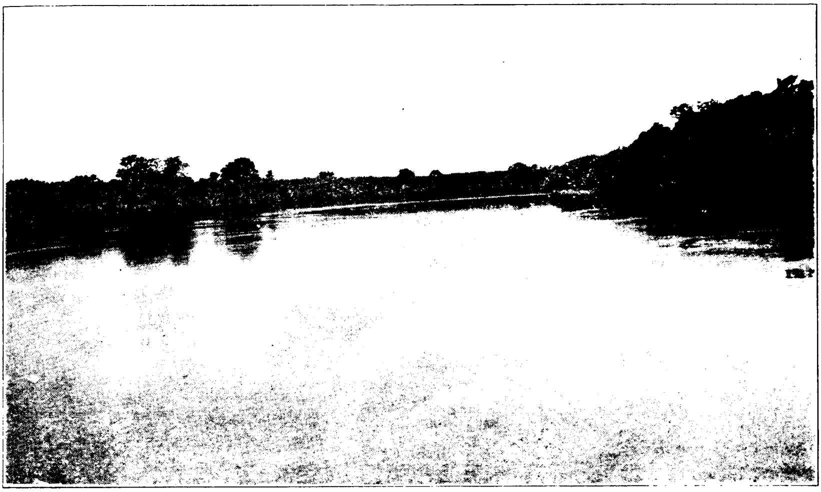
[1] In addition to his personal notes the writer has drawn upon the following sources of information: The Constabulary Monograph on Cotabato, loaned by Col. Ole Waloe, Philippine Constabulary, the Provincial Reports furnished by Governor F. W. Carpenter, Department of Mindanao and Sulu, and a Report on the Cotabato Valley by Mr. W. F. L. Asimont furnished by Mr. Carl M. Moore, Superintendent of Schools, Mindanao and Sulu. The map of Cotabato has been traced from a map furnished by Mr. N. E. Neibert, supervising surveyor, Bureau of Lands. The map of Parang harbor and the entrance of Cotabato River has been presented by the Director of the Coast and Geodetic Survey, Manila.

interior, and Arnold Hague, about 1,950 meters high, and Piapanayungan, 1,560 meters high, in the northwestern part of the province. Except the comparatively small area that drains into Sarangani Bay and the unexplored region on the southwest, the entire province is one vast basin of the Cotabato River and its numerous tributaries, of which the Alan, Libungan, Buluan, Maridagao, Kulaman, Kabakan, and Malitabug Rivers are the largest. The Cotabato River itself, under the name of Pulangi, originates in northern Bukidnon and is probably the longest river in the Philippines. This river is navigable for small steamers to Fort Pikit, 74 miles from the sea, nearly all the year around, and at medium high water to Kabakan, a distance of more than 100 miles from the coast.

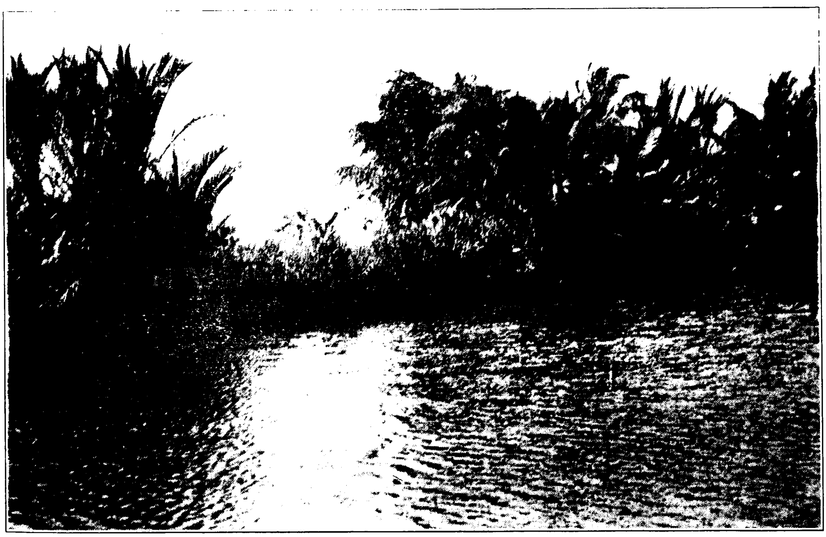
Owing to the fact that the several large tributaries of Cotabato originate and flow through widely separated localities in which the heaviest rainfall occurs at different times of the year, unlike the Agusan, the Cotabato River has no regular seasons of high and low water, the rise of the water is extremely irregular, and the inundations are unpredictable over a large area of land from Kabakan to the mouth of the river, with the consequent risk of destruction of the growing crops. Still, large as this area is, it is but a fraction of the total agricultural area of the province.

As one ascends the Cotabato River, at present the highway of the province, for several miles from the coast the banks, barely above tide water, support a vegetation of mangrove and other salt water plants. Further inland, as they rise to a higher level beyond the influence of salt water, the vegetation changes to tall grasses with here and there clumps of shrubby trees and sago palms. As the river leaves the fresh water swamps of the interior at Tumbao it branches into two arms and forms a delta country to the coast, penetrated by numerous cross channels.

Already before Cotabato, the capital of the province, is reached, a few tall coconut palms make their appearance on the low river banks and immobile, in the still air, they stand like sentinels on the river banks as if posted to challenge travelers all the way to Kabakan. Indeed, there is little else to relieve the monotony of the flat country. Here and there small Moro villages are passed clustering on the top of the river bank, the houses themselves scarcely visible through the thick growth of bananas and other fruit trees by which they are surrounded. Striking kapok and bangar trees meet the eye from time to time. The stately bauno is scarce, and so is the handsome,



(*a*) Typical view of Cotabato River between Cotabato and Fort Pikit.



(*b*) Sago palms, *Metroxylon sagu*, on the banks of Cotabato River near the town of Cotabato.

round topped, leafy inogug. Altogether, the lower part of the river is a flat, monotonous country of but little interest to the sight-seeing tourist. (Plates X and XIII).

Mango trees are common but they are not the clean-limbed, dark green, handsome trees of Cavite and Batangas, but gnarled, and sparse-leaved. They look out of their natural element, due perhaps to the high water table and the frequent inundations. The stiff Buri palm, *Corypha elata* Roxb., is quite a common feature in the landscape. The spiny bamboo, ***Bambusa spinosa*** Roxb. also is well introduced. To the duck hunter certain sections in the swamps are a paradise. Crocodiles are common in the rivers and swamps.

Cotabato might be considered in the following divisions:

(1) North Cotabato or the Parang District, including the country north of the lands overflowed by Cotabato River, the swamps of the interior and the Kabakan River.

From the coast this country is a series of plains, largely denuded of forest, between hills and mountains, gradually rising as one goes further inland to an elevation of 500 meters on the plateau about Buldun. Further eastward the country is more mountainous and perhaps more forested but its general character is much the same. East and north of the Libungan swamps and the Malitabug River lies a wide stretch of open country gently rising towards the north and east. The northeastern corner of Cotabato is said to be largely virgin forest.

(2) The Cotabato delta and the swamp lands in the interior, including the Libungan and the Liguasan swamps.

Actual surveys have never been made but it is conservatively estimated that the big Liguasan swamp covers an area of some 300 square miles. Including this and the Libungan swamp the marsh and delta lands probably do not fall much short of 700 square miles. Buluan is a shallow lake about 40 square miles in extent. There are several smaller, some very attractive lakes in the province, but none of importance.

(3) Eastern and central Cotabato, including the plains south of Kabakan River and east and south of the swamps to the Sarangani watershed.

(4) The Sarangani District, including the watershed around Sarangani Bay, and

(5) The unexplored mountain region along the southwest coast. Several of the small rivers which find their way to the sea on this coast flow through small valleys of great fertility.

The country between Sarangani Bay and Lake Buluan is a wide, open plain, rising so gradually from the lowlands in the interior on one hand, and from Sarangani Bay on the other that the divide of the watershed is scarcely noticeable. Other large plains lie to the north and east of Sarangani Bay. While there is some very good land in the northern part, about Lake Buluan, much of the plain extending from Sarangani Bay to the north and northwest is said to be of but little value agriculturally except for a cattle range.

CLIMATE

At the higher elevations and on the coast the climate is cool and pleasant, but in the interior it is warm and sultry though the nights are almost invariably cool and agreeable. Rainfall observations are all too scant over the large territory under discussion, but so far as they are available they show a well distributed and ample rainfall with no prolonged dry periods.

According to the Weather Bureau, Manila, Cotabato, the capital, has a mean monthly and annual precipitation as follows:

TABLE I.—*Mean monthly and annual rainfall, Cotabato.*

Month	Rainfall
	mm.
January	98.8
February	88.8
March	68.1
April	164.9
May	218.5
June	237.3
July	292.0
August	271.8
September	248.6
October	255.1
November	231.7
December	133.5
Total	2,309.1

The following table also has been published by the Weather Bureau.

TABLE II.—*Rainfall at Tamontaka, Cotabato.*

Month	1894	1895	1896
	mm.	*mm.*	*mm.*
January	----------	21.7	101.0
Febrauary	----------	30.5	70.0
March	----------	128.0	----------
April	----------	110.0	55.5
May	321.1	90.0	162.5
June	358.5	203.0	375.5
July	233.5	----------	216.0
August	195.7	----------	205.5
September	406.1	----------	181.5
October	194.5	----------	78.5
November	165.3	----------	137.0
December	114.3	----------	39.0
Total	----------	----------	----------

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The following tables have been made from rainfall records forwarded by Mr. J. E. McCall, industrial supervisor, Bureau of Education, Cotabato, to the writer:

TABLE III.—*Rainfall in Cotabato.*

Month	Kabakan			Kidapawan		
	1917	1918	1919	1917	1918	1919
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	252	196	69	86	294	48
February	97	289	81	73	275	137
March	178	302	124	166	277	75
April	110	226	80	312	220	138
May	204	344	194	269	446	383
June	676	421	265	318	551	296
July	235	58	184	220	208	295
August	60	147	55	265	127	195
September	115	99	340	273	142	307
October	103	175	235	413	227	326
November	113	107	97	283	104	216
December	112	114	118	240	68	255
Total	2,255	2,478	1,842	2,918	2,939	2,671

TABLE IV.—*Rainfall in Cotabato.*

Month	Ladtingan			Buluan		
	1917	1918	1919	1917	1918	1919
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	205	332	64	71	192	13
February	114	208	44	48	258	20
March	140	221	52	43	121	28
April	134	216	66	17	157	36
May	206	152	259	151	176	196
June	254	319	179	211	248	342
July	235	101	160	309	164	138
August	276	191	63	273	121	88
September	191	117	158	107	247	130
October	307	92	147	151	55	243
November	199	66	59	281	26	172
December	193	83	50	115	133	115
Total	2,454	2,098	1,301	1,777	1,898	1,521

TABLE V.—*Rainfall in Cotabato.*

Month	Kudurangan			Buldun		
	1917	1918	1919	1917	1918	1919
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
January	150	241	47	186	417	136
February	140	69	66	278	301	12
March	91	106	100	203	255	177
April	127	193	79	387	223	259
May	222	192	273	363	283	516
June	296	258	148	316	548	358
July	255	138	146	294	354	380
August	224	118	32	226	240	416
September	162	92	134	237	166	768
October	328	133	187	534	499	713
November	116	102	141	387	257	457
December	132	100	110	251	334	272
Total	2,243	1,742	1,463	3,662	3,877	4,464

POPULATION

The population of Cotabato numbers 154,270, divided among Moros, Manobos, Bilans, Tirurays, Tagabilis, Dulangans, and Christian Filipinos, and a few scattered Americans, Chinese and Japanese, but by far the greater number of the inhabitants in Cotabato are Moros, belonging to two tribes, the Maguindanaos and the Iranun's. These people are widely scattered through the Cotabato Valley, and are the most advanced in civilization among the native inhabitants. Next in importance are the Manobos, who have settlements here and there in the more remote districts. The Bilans and Tirurays comprise several thousand people also living in the remote parts of Cotabato. The Tagabilis and Dulangans are very few. The Christian Filipinos live around Parang Bay and about Cotabato. Then there are quite a number who have been settled in agricultural colonies from Fort Pikit to Silik and at Glan within the past few years.

At present labor is plentiful at the few plantations that have been started, but corporations initiating development work of any magnitude would almost immediately be confronted with the problem of importing labor.

HISTORICAL REVIEW

The Spaniards first attempted to take possession of Cotabato in 1596 but the conquest was not permanent. A second expedition was sent in 1637, followed by several others from time to time for nearly 200 years, during which there was much blood shed by both belligerents. The more permanent occupation of Cotabato by the Spaniards dates from 1851, when a fort was begun and a naval base established at Polloc. From then on until the American occupation of Cotabato in 1899, there was intermittent fighting between the Moros and the Spaniards who ascended the river and erected one fort after another as far as Fort Pikit, where a very strong fort, still in good condition, was constructed on the hill in 1885. The military régime continued in force until in 1914 when civil government was established in Cotabato, organized as a province in the Department of Mindanao and Sulu.

AGRICULTURAL INDUSTRIES

In an undeveloped country like Cotabato agriculture also necessarily remains in an undeveloped state. Americans who have lived in the interior say that much upland rice is grown by merely cutting down the native, wild grasses at the approach of the rainy season. Then, when the floods come and the river

PLATE XII

(*a*) Street in the town of Cotabato. Incidentally this photograph illustrates well the unsuitability of the "Fire tree," *Delonix regia*, as a shade tree.

(*b*) Street in the town of Cotabato. Bangar, *Sterculia foetida*, in the foreground.

inundates the land the cut vegetation decays, and when the waters subside the seed rice is sown. Harvesting is next in order. So rich is the soil and so favorable is the climate that the Moros get good rice crops by this primitive method of culture.

According to Mr. Antonio Peña, chief, division of statistics of this Bureau, the agricultural crops of Cotabato were in 1918 as follows:

TABLE VI.—*Agricultural statistics, Cotabato, 1918.*

Crop	Area	Quantity	Value
	Hectares		*Pesos*
Rice	559	[a] 9,070	45,259
Coconuts	350	[b] 321	[c] 36,660
Corn	13	[a] 123	739
Sugar cane	7	[b] 4	306
Abacá	2		306

[a] Hectoliters. [b] Copra, tons. [c] Value of all coconut products.

From these figures it is readily seen that Cotabato is at the very beginning of her agricultural development.[1]

Rice is, of course, by far the most important food crop grown in Cotabato, but other plants are also cultivated to supplement rice. Several varieties of corn are cultivated, among which are some dwarf varieties said to mature in 70 to 75 days after sowing the seed. At least three very distinct strains of edible adlay, *Coix lacryma-jobi*, have been recognized in a lot of this grain from Cotabato.

Many camote varieties are grown but generally are neither of good quality nor very productive. The Nito is a very early variety, said to mature in two months from the date of planting, and to be of good quality, and the Malukamba is reported to bear very large roots.

Several gabi varieties are also grown.

The vegetables grown include marutong, lyon beans, sincama, patani, mungo, anipay, cowpea, sitao, peanuts, camote, cassava,

[1] Since this was written the following crop figures for 1919 have become available:

Crop	Area	Quantity	Value
	Hectares		*Pesos*
Rice	672	[a] 11,328	90,624
Coconuts	360	[b] 168	[c] 31,633
Corn	47	[b] 494	4,900
Abacá	4	----------	105
Sugar cane	1	----------	120

[a] Hectoliters. [b] Copra, tons. [c] Value of all coconut products.

squash, gabi, ubi, onions, tomato, pepper, chili, ginger, batao, eggplant, patola, apalia, and mustard. Several of these species are very recent introductions and they are as yet but sparsely grown.

The seeds of the lotus, *Nelumbium speciosum* Willd., is a food of considerable importance in Cotabato, and are common in the markets.

The banana is the most important of the fruits grown in Cotabato and a very large number of varieties are cultivated.

The mango, *Mangifera indica* L., is second in importance and the following varieties are recognized by the Moros and said to be true mangos: Dudul, Titi, Solo, Libas and Tay. The writer, who visited Cotabato during the mango season in May, 1919, when there was an abundance of mangos in the market, was unable to secure specimens of any but the Dudul and Titi.

The Dudul is the variety most esteemed. The fruit is short-oblong, about 80 millimeters long and 60 millimeters across in its broadest dimension, and with full cheeks; the skin is yellowish green to greenish yellow with a faint blush on the sun-exposed side, thick and tough like the Pico mango grown in Luzon. The flesh is a shade darker yellow than in the Carabao mango, firm, with rather abundant fiber, turpentiny, yet very sweet and of good flavor, having the characteristic aroma of the Carabao. The seed is large.

The Titi mango is somewhat smaller than the Dudul and proportionately more slender; it is greenish yellow in color. The flesh is scant, but sweet, juicy and fine flavored, the fiber is abundant, and the seed large. The Titi is the most common mango in Cotabato.

If the other varieties mentioned are true mangos they probably come from a few scattered trees that differ from the ordinary mangos.

Mangos are the most common fruit trees along the banks of Cotabato, but the trees are old and gnarled, commonly with spreading tops, quite different in habit and character from the Carabao and Pico mango trees growing in Luzon, plainly indicating a different source of origin; and there can scarcely be any doubt but that these mangos were imported by the Moros when they arrived to introduced the Islamic faith many centuries ago.

The "Paua" mango is said to grow in the forest and is probably *Mangifera altissima* Blco.

Among the citrus fruits, though ordinarily poor, oranges and mandarins are occasionally produced of very good quality.

(*a*) Typical scene on Cotabato River between the town of Cotabato and Fort Pikit.

(*b*) Moro villages on the Cotabato River banks are usually surrounded by coconut palms, mangos, and other fruit trees.

Limes and dalayaps, *Citrus aurantifolia* var. *aromatica* West., of excellent quality, have been obtained. The most interesting citrus fruit noted is the "mangapug," which is a citron-yellow, oblate fruit up to 10 centimeters in diameter, thin skinned, with 13 to 15 locules separating from each other and the rind; the flesh is extremely acid and very juicy, and of fair quality for making ade. No trees have been seen but the mangapug is apparently an unusually large form of *Citrus webberi* West. The principal ripening season occurs in December, but ripe fruits are found on the trees during the greater part of the year.

Occasional trees of the Inogug are found here and there along the river. This is an unindentified species of *Eugenia,* indigenous in Cotabato and, so far as can be learned, not found elsewhere in the Islands. The tree is large, up to 18 meters tall and has a trunk at least 75 centimeters in diameter breast high, and a heavily foliated, round, handsome crown. The fruits grow 4 to 10 in axillary clusters among or just below the leaves, and are up to 33 millimeters long and 22 millimeters across, roundish oblong, smooth, shining, dark red to black when fully matured; the flesh is white, stained with red near the skin, of the texture of the apple, very acid but of pleasing flavor. The fruit is one-seeded. According to Mr. McCall, who first called the attention of the writer to the Inogug, the fruit makes an excellent jelly.

The trees are very prolific, the fruit ripening from September to January when it is common in the markets, but occasional ripe fruits are said to be found on the tree throughout the year. The wood is fine grained and hard and makes good, durable timber. Aside from its value as a fruit, the Inogug is worthy of planting as an ornamental shade tree along roads and streets, and the tree well deserves wide dissemination in other parts of the tropics.

The Kadis is an unidentified species of *Garcinia,* native of Cotabato, possibly indentical with the Kandiis of Davao and the Kariis in Bukidnon. The tree is small, with slender branches and small, thin leaves. The fruit grows in the axils of the leaves and is up to 6 centimeters in diameter, very distinctly oblate, apex a shallow cavity, surface smooth, light orange in color, pericarp soft, fleshy, acid and edible; flesh 6 to 8 free locules, light orange in color, semi-transparent, juicy, subacid and of good flavor. The seed with its adherent fibers resembles the mangosteen seed. The fruit ripens in December and January and can be eaten out of the hand, but could probably be best utilized for making jelly and preserves. The tree might be of service as a stock for the mangosteen, as seedlings are raised without difficulty and are of fairly rapid growth.

The kaubi is probably *Zalacca clemensiana* Becc., recently described from Davao. This palm is said to be abundant in the interior. The fruits are brownish, up to 5 centimeters across, growing in clusters, and the flesh is encased in a scaly, snake-like, thin skin from which it readily separates; the flesh, containing 3 large seeds, is scant, but said to be subacid and of very pleasant flavor in the fully ripe fruit. The fruit is reported by Mr. J. E. McCall, who forwarded specimens to the writer, to ripen at all seasons of the year.

The total absence of *Nepheliums* and *Euphorias* along the Cotabato River is particularly striking in comparison with the numerous species belonging to these genera found in Bukidnon and Lanao. Durians, marangs and baunos are quite rare. Numerous large kayam trees grow in Pangi.

It is rather interesting to note that the native name of the Custardapple is here as in Sulu, "Salikaya," indicating that this fruit has been introduced from the Dutch East Indies.

Quite a number of mushrooms are collected and used for food by the natives. One of these is reported to be remarkably large, over 20 centimeters across.

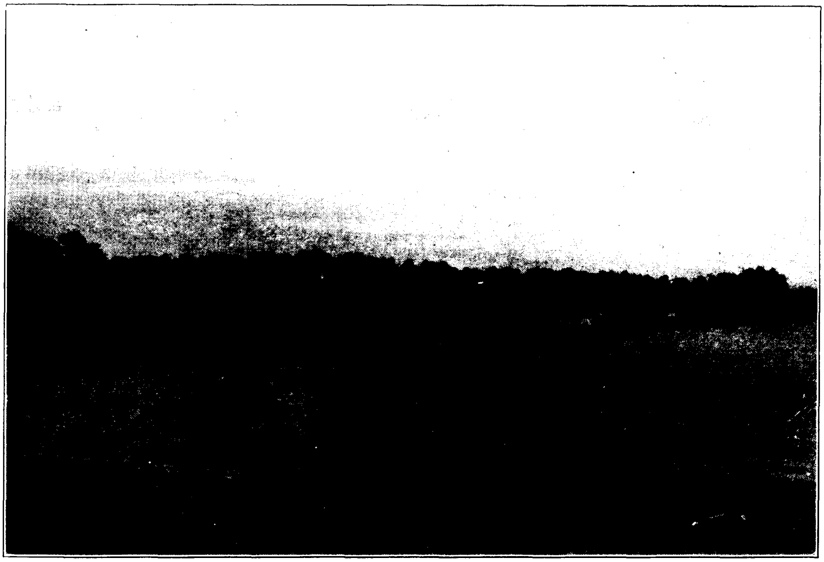
The following varieties of the principal food plants were recorded by the writer during visits to Cotabato in 1918 and 1919:

RICE VARIETIES

Baka	u-a-ng-c [1]
Buan	l-al-ng-c
Bulungkoy	u-al-ng-w
Bungatadatu	l-al-ng-w
Bungod	u-al-ng-w
Dabitun	u-al-ng-w
Dikakigulan	u-al-ng-w
Dikalagan	u-al-ng-c
Dilayaan	u-al-gl-c
Dimakenel	l-a-gl-w
Dimasimbil	u-a-ng-w
Duluman	u-al-gl-c
Gagatusan	l-al-ng-w
Gintauan	u-al-gl-w
Guyuden	l-al-ng-w
Kabangkalan	l-a-gl-c
Kabasalan	u-al-gl-w
Kabuyao	l-a-ng-w
Malu	l-al-ng-w. Grows 1.5 meters tall in very deep water; raised only in the swamp.
Mangad	l-al-gl-c
Manila	u-al-ng-c
Manili	l-a-ng-w
Mankasar	l-al-ng-w. The best rice in Cotabato.
Matanoyap	l-al-ng w
Mauilan	l-al-ng-w. Second best variety.
Mokel	u-a-gl-w
Pagagutan	l-al-ng-w

[1] u=upland; l=lowland; a=awned; al=awnless; gl=glutinous; ng=nonglutinous; w=white; c=colored.

(*a*) Entrance to Parang Bay. Bongo Island in the distance.



(*b*) The village of Parang, 1919.

RICE VARIETIES—continued.

Kakuak	u-gl-c	Pangi	u-al-gl-c
Kaliagan	l-a-ng-c	Patiar	l-al-gl-c
Kalipapa	u-al-ng-w	Pikit	u-a-gl-c
Kanoni	u-al-ng-w	Pudtad-salangit	u-al-ng-w
Kayopo	l-a-ng-c	Pulut-a-calabao	l-al-gl-w
Kilodan	u-a-ng-c	Rambayong	l-al-gl-c
Kinaban	u-a-ng-w	Salanay	l-al-gl-c
Kolangkang	l-al-ng-w	Salui	l-al-ng-c
Kolungkang	u-al-gl-w	Sankad	l-a-ng-c
Lambayong	l-a-ng-c	Sibuyon	u-al-gl-c
Lumaga	u-al-ng-c	Sindangan	l-a-gl-c
Maasim	u-al-ng-c	Taganunok	l-al-ng-w
Magalinalin	u-al-ng-c	Takilid	l-al-ng-w
Makagoba	l-al-gl-w	Talagad	u and l-al-ng-c
Makardit	l-al-gl-w	Tilili	u-al-ng-w
Makidatu	u-al-ng-c	Zamboangan	l-al-ng-c
Malok	l-a-gl-w		

CORN VARIETIES.[2]

Babelek
Balabed
Balaguayan
Balanak
Balgiasan
Balokiki
Banag
Banati
Bantolinay
Basagan
Bibilakura
Bulinak

Dalapig
Dalikan
Gading
Galuga
Garungan
Kalibogan
Kilala
Kinumis
Lagasan
Kladsom
Lambeng
Lemik

Libuted
Lumayong
Mantobang
Nimbukul
Payangan
Palikat
Sandad
Tagiguem
Takikem
Talagad
Tangkaasay

SUGAR CANE VARIETIES

Balagon
Gubo
Iramas. The best sugar cane in Cotabato; soft and sweet.
Magabong
Magka. Very good, sweet and soft.

Maitom
Mamasao
Olapongan
Pamogon
Pusedan

Sambolauan
Saruday
Sibayan
Suludabao
Tangungan

CAMOTE VARIETIES

Gandalusa
Kagamat
Kalusang
Kangkong
Kulikut
Krusao
Kulintangan

Labina
Malukamba
Mankag
Nato
Nito
Nukit
Pagulingen

Sagiket
Saolan
Takulab
Talingi
Talukambang

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[2] The list of corn varieties has been furnished by Mr. J. E. McCall.

GABI VARIETIES

Balaisan
Bubunalaga. Large, white.
Inampay
Kadel
Kapukao
Kisul
Nato
Pikit. The best variety in Cotabato.
Saka-kuden
Sandang
Sapanding
Sarot
Tanayan

COCONUT VARIETIES

Kapal
Kayomamis
Limba
Tundok. A sweet husked variety.

BANANA VARIETIES

Amas
Binankil
Buñgulan
Buñgulan-asu
Dapuso
Demangay
Dubpong
Dudsing
Duka
Gadung
Kagadungan
Kundong
Ligakuda
Malamangay
Malubung
Maman. Syn. Pitogo, Nilanzon.
Mangay-pakal
Mangay
Pagadatan. Very large bunches.
Pakal
Pamubpugen
Pandakan
Pugpugen
Putian
Salapang
Sulay-baguio
Tagiao
Timbangalan
Tindoro. Syn. Tudlodatu and Daliring senora.
Tumbaga
Tundok

IDENTIFIED FRUITS

Banana, *Musa paradisiaca* L.
Bangar, *Sterculia foetida* L.
Bauno, *Mangifera caesia* Jack.
Breadfruit, *Artocarpus communis* L.
Cashew, *Anacardium occidentale* L.
Custardapple, *Annona reticulata* L.
Dalayap, *Citrus aurantifolia* var. *aromatica* West.
Dao, *Dracontomelum dao* M. & R.
Durian, *Durio zibethinus* L.
Fig, *Ficus carica* L.
Guanabano, *Annona muricata* L.
Guava; *Psidium guajava* L.
Jak, *Artocarpus integra* L.
Huani, *Mangifera odorata* Griff.
Kabuyao, *Citrus hystrix* D. C.
Kamia, *Averrhoa bilimbi* L.
Kayam, *Inocarpus edulis* Forst.
Lanno, *Spondias pinnata* Kurz.
Lanson, *Lansium domesticum* Jack.
Lemon, *Citrus limonia* Osb.
Lime, *Citrus aurantifolia* Swg.
Mabolo, *Diospyros discolor* Willd.
Macopa, *Eugenia javanica* L.
Mandarin, *Citrus nobilis* Lour.
Mangapug, *Citrus webberi*, West., var.
Mango, *Mangifera indica* L.

IDENTIFIED FRUITS—continued.

Mangosteen, *Garcinia mangostana* L.
Marang, *Artocarpus odoratissima* Blco.
Ninur, *Antidesma ghaesembilla* Gaert.
Orange, *Citrus aurantium* L.
Paho, *Mangifera altissima* Blco.
Papaya, *Carica papaya* L.
Pineapple, *Ananas sativus* Schult.
Pomegranate, *Punica granatum* L.
Pomelo, *Citrus maxima* Merr.
Salak, *Zalacca edulis* Reinw.
Santol, *Sandoricum koetjape* Merr.
Sugarapple, *Annona squamosa* L.
Tamarind, *Tamarindus indica* L.

The following native fruits remain unidentified:

Bobonao, *Aglaia* sp. (?)	Kabalasileng	Kolumbug, *Dillenia* sp.
Bulungu	Kadis, *Garcinia* sp.	Konakon
Dawaling	Kagoko, *Eugenia* sp.	Lugisan, *Eugenia* sp. (?)
Inogug, *Eugenia* sp.	Kamundamunda	Tantong

EDIBLE MUSHROOMS

Bula
Banuayan
Dikaluluman—terrestrial.
Gantusan—terrestrial, large, said to be 25 cm. across.
Inumanamanok
Inumanoak
Kabalasi—terrestrial
Kalisig
Kamay
Kaupas—terrestrial
Korop
Tanguleg
Waloy—terrestrial, the most esteemed species.

PLANTATIONS

Several smaller plantation ventures have been started but the only large plantation in operation at present is the Rio Grande Rubber Company at Kabakan, which is 1,024 hectares in extent, with about 200 hectares planted to coconuts and Para rubber. The growth of the trees is good.

RESOURCES AND PRODUCTS OTHER THAN AGRICULTURAL

There are vague reports of the discovery of coal and gold in the north-eastern part of Cotabato, but these rumors have never been verified. Oil of good quality has been discovered at Kerusoy in the neighborhood of Kerupe. How extensive these deposits are is not known but if oil should be found in any considerable abundance, the development of oil wells will become of the greatest importance not only for Cotabato and Mindanao but for the entire Philippine Archipelago.

In her enormous forests Cotabato has a source of great wealth immediately available for development on a very large scale. Not speaking of the large forests in the interior, the large, almost entirely unexplored mountain range on the southwest coast from Mount Kabalatan to Sarangani Bay, a distance of some 200 kilometers, forms a solid, broad belt of commercial forests containing both hard and soft wood. Among other trees the following species of timber trees are found in the Cotabato forests: Bagtican, *Parashorea plicata* Brand; white lauan, *Pentacme contorta* M. and R.; guijo, *Shorea guiso* Bl.; lumbayao, *Tarrietia javanica* Bl.; calantas, *Toona calantas* M. & R.; camagon, *Diospyros discolor* Willd.; ipil, *Intsia bijuga* O. Ktze; narra, *Pterocarpus indicus* Willd.; acle, *Albizzia acle* Merr.; tindalo, *Pahudia rhomboida* Prain, and *Intsia acuminata* Merr.; kalamansanai, *Neonauclea* sp.; ebony, *Maba buxifolia* Pers.; kamuning, *Murraya exotica* L. and palomaria, *Calophyllum inophyllum* L.

At present three sawmills are in operation in the province, one large mill in Lebak and two smaller ones in the town of Cotabato.

Some almaciga, gutta percha, beeswax, lumbang nuts and bejuco are gathered in the forests and marketed, but the quantities obtained could be multiplied again and again, and tanbark in large quantities could be obtained for export from the mangrove swamps on the coast.

The hills south of Cotabato from Tamontaka to Awang contain a sticky, plastic clay which on investigation may be found of value for the manufacture of pottery, tiles and bricks.

The waters on the coast abound in fish of excellent quality.

COMMUNICATIONS AND TRANSPORTATION

The almost total lack of good roads is not the hardship one might suppose since the Cotabato River and its many tributaries are navigable for launches far into the interior and still farther inland are negotiable by barotos. For this reason most settlements are located on the rivers. Overland transportation is handled by means of pack animals.

Cotabato is connected with the outside world through the wireless station in Malabang, Lanao, and has a local telephone system connecting the principal towns in the province. The steamers *Fernandez Hermanos, Neil McLeod* and *Mindanao* from Manila, call at Lebak and Cotabato at irregular intervals, and the steamship *Tablas* makes monthly calls at both points. The river steamer *Hall* makes regular trips on the Cotabato River as far as Fort Pikit and Kabakan and makes occasional trips to Parang and Lebak. The *Research* makes irregular trips from Zamboanga to Cotabato.

TRADE

The following table shows the exports from Cotabato from 1914 to 1918. From this it may be seen that lumber and rice are the only products of importance.

	1914	1915	1916	1917	1918
Lumber	₱213,747	₱2,700	₱153,788	₱241,628	₱240,047
Rice	185,975	54,362	110,099	134,387	105,624
Copra	7,183	4,556	8,173	41,420	29,486
Carabaos					13,220
Mats		1,104		820	12,565
Abacá	3,268	766	1,280	18,162	7,196
Peanuts	554	1,487	3,659	4,291	6,160
Palay (rough rice)	43,691	11,660	5,521	6,595	4,41[illegible]
Fowls				12	4,328
Hides	324	742		240	2,244
Rice Bran	2,944	747	446	1,677	1,777
Lumbang nuts	1,438	1,455	1,482	1,628	1,094
Miscellaneous					
Total	514,785	99,425	296,247	463,448	448,800

Small quanties of coffee, cacao, beeswax, gutta percha, rubber, and rattans are also exported; in 1918 less than ₱1,000 for any one item. The largest in area of all the provinces in the Philippine Archipelago, Cotabato probably ranks lowest as a producer and exporter next to Bukidnon.

PROSPECTIVE INDUSTRIES AND FUTURE DEVELOPMENT

The different provinces in Mindanao each possess individual features that appeal to the prospective investor depending upon the industry in which he seeks to engage. But no other province equals Cotabato in potential wealth or in diversity of possible agricultural and other industries. Naturally this is to a large extent due to the size of the province, but is also in part due to its geographical and geological features and the vegetation.

With a larger area in commercial forests than any other province in the Philippines, as yet practically untouched, these will for a long period of years continue to yield great quantities of excellent timber. The mills alone are lacking. The more accessible forest is, of course, that on the coastal range from the mouth of the Cotabato to Sarangani Bay, but in the interior the Cotabato, Libungan, Maridigao, Malitabug and Kulaman Rivers all penetrate virgin, commercial forests and they have a sufficiently large volume of water to permit the rafting of logs incident to lumbering.

The mangrove swamps on the coast would furnish tanbark in large quantities. Rattans, almaciga and other forest products could be obtained from the interior in far greater amounts than at present.

The materialization of the hopes relative to the oil finds would be of the greatest significance in the development of the north-western part of the province, and would give great impetus to the development of Parang into a great shipping point.

On the big, open, grassy plains, between Sarangani Bay in the south to lake Buluan, and on the rich, hilly pastures in the north from Parang over Buldun, to Banisilan and Bukidnon there is room for large cattle ranches.

At the lower elevations the soil and climate are favorable for the production of abacá, coconuts, coffee, and rubber over very large areas. Wide stretches of country continue suitable for coffee as one ascends to the higher plains north of Cotabato River, and here tea would also undoubtedly succeed well in many districts. With tractor cultivation upland or unirrigated rice could unquestionably be produced in great quantities and sugar haciendas could be opened up that would dwarf all previous similar undertakings in the Philippines into insignificance.

Then, there is the delta country, the land subject to the overflow of the Cotabato River and its tributaries and the adjacent swamps, the soil of which is inexhaustively fertile.

Due to the ever present menace of inundation very little land can safely be farmed at present along the lower reaches of the Cotabato and Libungan. A region of exceptional potential wealth, it is at present a barren waste serving as a breeding ground for malarial fevers, it is a menace to health, and it bars the ready access to the more elevated, fertile country beyond. But it presents equally exceptionally vast opportunites for achievement and exploitation. The project might be financed by the National Government, but a concession granted to a large corporation would probably be preferable, as that would insure more rapid development. In any event the taming of this country with all that implies, fundamentally simple, would be one of the greatest engineering feast ever undertaken in these Islands. It would require the patient perseverance of a capable staff of administrators and engineers for many years. It is a project sufficiently vast to tax executive ability of a high order, and to fascinate the man of ambition, with a desire to achieve, aside from the mere monetary returns.

The project is a big one, but the problem is simple enough and would consist of the straightening of the rivers to induce a swifter flow of water, in the lower areas supplemented by the construction of dykes to prevent inundation during flood time. The drainage would also necessitate the dredging of a system of canals in the more depressed localities; but these

Oversized Foldout

would serve a triple purpose, as they would provide also a means of transportation and a source of water for irrigation in times of need. Thus, once the drainage and canal system was in working order, by the employment of tractors, on this great, level plain any of the important annual staple crops of the tropics such as rice, corn, sugar cane, tobacco, and jute, not to speak of indigo, cassava and peanuts, sesame and other crops, could be grown on a, for the Philippines, unprecedented scale.

Beside these greater products sago seems trifling, yet it is well to remember that the sago swamps of Cotabato exceed in area any others in the Philippines, those of Agusan not excepted, and they might well be systematically exploited and even extended.

No country can develop and prosper without a transportation system adequate to handle its traffic and afford good outlets for its trade.

In the development of the transportation system the several large rivers, and the canals in the present swamp region and delta, will unquestionably play a considerable rôle, but railways will be the greater arteries of trade. Railways are more or less urgently needed elsewhere incident to the development of Mindanao, but nowhere is the need so great, would the road meet less difficulties in construction, and would increased traffic follow quicker than on a railroad extending from Parang along the foothills of the mountains north of the Cotabato delta and the big swamps, over Kabakan and Kidapawan, terminating on Malalag Bay, on the Davao Gulf, with a branch line curving southward east of lake Buluan to Makár on Sarangani Bay. Excepting in the country south of lake Buluan such a road would penetrate during its entire length an agricultural land of unsurpassed fertility, which at present is practically uninhabited, and for all practical purposes is now inaccessible from the coast.

There are several good harbors on the Mindanao coast, but no other possesses so many advantages for the location of a great seaport and railroad terminus as Parang Bay. (Plates XIV and XV.) The points in its favor may be summarized as follows:

(1) The bay is large enough to shelter a large fleet of vessels.

(2) There is deep water and excellent anchorage close to the shore, and piers could be constructed at a low expenditure.

(3) The topographical features of the land around the bay for the planning of a large and attractive city are unusually

good, the land has perfect drainage and a good slope from inland to the sea.

(4) An excellent and abundant supply of water is procurable within a short distance.

(5) Parang is within 45 kilometers of the oil discoveries in Pidatan.

(6) Parang is by far the nearest good harbor of any prospective importance to the coal field of Malangas—150 kilometers sailing distance.

(7) The approach to Parang of a railroad from the interior of Mindanao does not present any topographical difficulties and it is within easy reach of a very large and fertile country adapted to rice, corn, coconuts, rubber and coffee, and stock raising.

Also, one may confidently look forward to the day when Parang will be the center of trade and shipping not only of Cotabato Province alone but quite possibly of the entire Island of Mindanao.

THE PRESERVATION OF TROPICAL FRUITS

By P. J. Wester, *Agricultural Advisor*

PRELIMINARY REMARKS

The large annual importations of fruits and pickles of various kinds from the Temperate Zone into the Tropics where fruits are, or at least are supposed to be, abundant at all seasons of the year, is quite remarkable. In the Philippines the preserve imports for 1915, 1916, 1917, and 1918 were ₱101,746, ₱75,896, ₱86,818, and ₱118,555 respectively.

The preserved fruit is imported, of course, mostly to supply the demand of the Caucasian element of the population, but no small amount is consumed also by the native population, showing that there is a demand that is not met by the Filipinos themselves by preserving their own fruits. There is, of course, a good reason for this. Glass jars have become rather expensive when they have reached their destination after toll has been taken by shippers, importers and middlemen, and all the breakage has been accounted for. Then, as yet the average Filipino does not realize the all important factor of sterilization in the preservation of fruits. No doubt repeated attempts have been made to preserve many of the fruits of the country, but the ever-present ferments have proved too discouraging.

Caucasians unfortunately all too frequently look with indifference if not downright disdain at most of the tropical fruits, and make little or no attempt to "get next" to the many excellent tidbits that the Tropics have to offer.

The banana and citrus fruits the American knows from home. As a rule it does not require much coaxing of the palate to become fond of the mango and the mangosteen; he masters the papaya, chico and the lanzon, and he may acquire even a fondness for the sugarapple. But the farther side of these fruits is usually a *terra incognita* to most Caucasians, to say nothing of tropical fruit preserves.

Speaking of the Tropics in general, the pineapple and orange are today the only tropical fruits preserved on any considerable scale. Some banana "figs" are made, but apparently the art of preserving them has not yet been well mastered. On the other hand shredded coconut, though hardly a preserve in the proper sense, is an article that has come to stay but is not yet produced on the scale it merits both because of palatability and wholesomeness. Poha jam, made of the fruit of *Physalis peruviana,* is gradually being more and more introduced, and the manufacture of roselle jam and preserves takes a spurt now and then, though strangely enough no permanent industry has yet been built up based on this fruit, than which there is none easier to cultivate, few as productive and for which everybody has nothing but praise on sight, or rather on taste. Lest we forget, jelly is made from the lowly guava in a small way and mangos are reported to be dried and preserved in India.

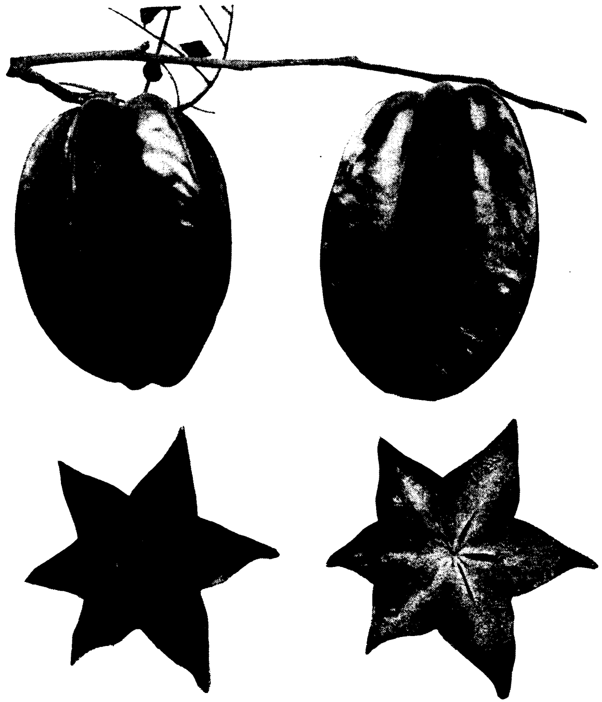
As a matter of fact the tropical fruits in their diversity of appearance, color, texture, quality, flavor, and aroma present a fascinating subject for the preserve maker that is not sufficiently appreciated.

Canned mangos and guavas are easily the equal of canned peaches, and many palates might prefer them. However prepared, preserves of the tamarind are equal to any preserve in the same class made from temperate fruits and superior to many. Santol jelly is so superior in flavor and so attractive in color as to be in a class all by itself, which is also true of mangosteen preserves, yet it is next to impossible to obtain either. Preserved ginger is a delicacy of unusual merit, still it is all but unknown to the Caucasian. Genipa jelly is another product that is unsurpassed in flavor and aroma yet few have tasted it. Equally good preserves of many other fruits might be enumerated.

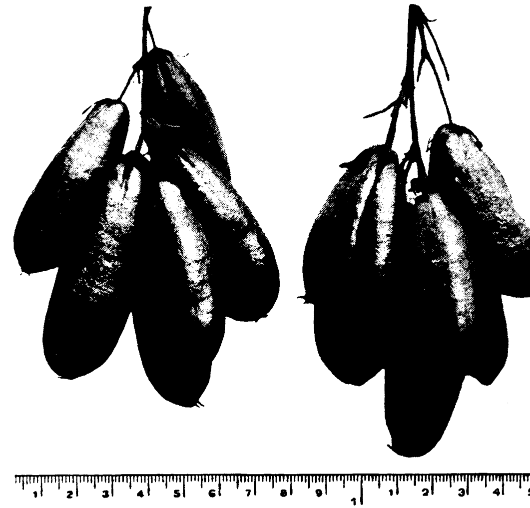
Fruit sirups for delicious cooling drinks are easily prepared of most acid or subacid fruits by boiling the fruit juice and sugar to a sirup instead of to a jelly.

Notwithstanding the excellence of these various products their manufacture on any considerable scale is likely to be delayed for many years for the reason that not enough fruit is produced at any one point to warrant the organization of a preserving plant of even moderate dimensions. In other words the supply of the needed raw material is lacking. Yet, for an organization with ample capital which could afford to make a long-time investment it would appear that here is a neglected opportunity for entering a new and unworked field, free from rivals.

A plant devoted to the manufacture of preserves in the Tropics would have this advantage over a similar plant in the Tem-



(a) The Carambola, *Averrhoa carambola.*



(b) The Kamia, *Averrhoa bilimbi.*

perate Zone that the plant could be kept running uninterruptedly practically the entire year. There would be no feverish activity for a short period followed by long idle months for the equipment. However, such a state of affairs presupposes that the organization has laid careful plans to insure a steady fruit supply from the various species desired for utilization, which should, of course, be ripening at successive dates, so that when the season of one fruit is passing that of another begins.

So far as the Philippines are concerned the mango is at present the only fruit produced in sufficient quantity to keep even a small factory running at full capacity during the time it is in season. The next largest source of supply is the santol. It is true that considerable quantities of duhats, pineapples and lanzones are marketed, but not more than is consumed in the fresh state, so that an additional demand would cause a shortage and a consequent rise in the price of the fruit. It follows that the preserver also in a large measure would have to become a planter as has been the case in Hawaii.

Among the more than 200 species of fruits that grow in the Philippines, the choice naturally would be narrowed down to a dozen or so that most aptly lend themselves to the manufacture of preserves on a fairly large scale, and of which fairly large orchards could be established within a reasonable time. For such a purpose the following species are recommended as the most promising in order of their enumeration: Mango, pineapple, ginger, roselle, santol, tamarind, hevi, lanzon, duhat, carambola, kalamondin, mangosteen, kamia, guanabano, and ketembilla. Other species that could be utilized, but of which plants would be difficult to procure in large numbers for planting, are the various edible species of *Calamus,* several species of *Eugenia, Garcinia* and *Flacourtia.* Still others that might be mentioned are the genipa, bauno and dalinsi. The marang could probably be made into a preserve very similar in quality to that of the mangosteen. If so it might easily and rapidly become the basis of a big preserve industry, as the trees are of rapid growth and very productive.

However, these are speculations for the future.

In the meantime there is an abundance of fruit in the local markets to supply the housewife and home canner who is interested in utilizing the tropical fruits as they come in season with raw material as it were. On the other hand there is so little information available on the subject of preserving tropical fruits that the writer has felt justified in incorporating in the within paper the recipes worked out by Miss V. M. Wakeman and published by the Bureau of Education in 1911. Various changes have been introduced in the text of the recipes but all quantities are quoted as given in the original pamphlet. In order to better introduce the fruits in question to the reader, the recipes have been prefaced with a brief description of the respective species.

Cleanliness should always be a matter of course in the preparation of food, but it is all important in making fruit preserves if these are to keep in good condition for any length of time and not ferment. All glasses, jars and other containers should be washed scrupulously clean, and they should be sterilized by scalding them with boiling water just before the preserved fruit, jelly, jam or sirup is poured in them.

Except where stated otherwise mature but *not over-ripe* fruits should always be selected. All fruit should be sound as a matter of course. Decayed fruit should never be made into preserves.

In all cases except where stated otherwise it is understood that white, granulated sugar is employed. Wherever directions are given for heating the sugar, care should be taken not to carry the heating so far that the sugar is burned or melted.

Glasses for jam and jelly should not be filled to the rim but a small space should be left for the paraffin cover. After the jam and jelly glasses have been filled they should be set aside to cool. When the contents are cold paraffin should be melted and poured smoking hot on top of the jam or jelly. After the paraffin has cooled the tops may be covered with tin or paper caps for further protection if desired.

Canned, preserved or pickled fruit should be put into glass jars, which should be filled to overflowing while the fruit and sirup is boiling hot, and should be sealed at once.

Great care should be taken that sound rubbers that are a good fit are used to tighten the covers, as the keeping quality of the contents of the jar depends upon that it is being hermetically sealed.

All preserves should be stored in a dark, cool and dry place.

DESCRIPTIONS AND RECIPES

BANANA. *Musa sapientum* L.

A coarse herb, sometimes exceeding 6 meters in height, with large, broad leaves, and the finger-like fruits in large bunches. The most important fruit in the Philippines. It is universally cultivated, and occurs in a greater number of varieties than any other fruit in the Archipelago. Lacatan, Latundan, Saba, Gloria and Buñgulan, are the most important varieties in the order of their enumeration, of which Buñgulan it the best in quality. Most of these varieties are eaten raw as a dessert fruit, while others should be cooked or fried in order to be palatable. Preserves may also be made if desired.

Jam.—Rinse, peel, slice and measure; for each cup of fruit add 1 cup sugar and ¼ cup kalamondin (*Citrus mitis*) juice, or ¼ cup sour orange (*Citrus aurantium* L.) juice and 1 tablespoon lime (*Citrus aurantifolia*) juice. Boil until thick.

CARAMBOLA. *Averrhoa carambola* L. (Plate XVI–*a*).

A small tree about 5 meters high, of restricted cultivation, native of tropical Asia, bearing 5-angled, semi-translucent, acid fruits, 6 to 7 centimeters long, suitable for preserves. Trees with subacid fruits that may be eaten out of hand with relish are occasionally found.

Canned Carambola.—Rinse and core. For each cup of fruit add ¾ cup of sugar. Place in pan over a slow fire until sugar is nearly melted, then boil for 10 minutes.

The cores may be used in making jelly.

Jam.—Select large, well-grown fruits. Rinse, pare and core. Put equal quantities, liquid measure, fruit and sugar in pan and heat slowly until sugar is melted, then boil until thick.

Jelly.—Rinse, slice, and add enough water to fruit in pan to prevent burning. Heat slowly and boil until soft. Remove from fire, mash, and squeeze through a double cheesecloth. Return juice to fire and boil until all scum has risen. Remove from fire, strain, measure and return to fire. Add an equal quantity sugar, liquid measure. Heat sugar until near melting point and pour into the boiling juice. Then boil until it "ropes" heavily.

CHICO. *Achras zapota* L.

A small tree, 6 to 8 meters high, with roundish or eggshaped, variable, russetted, sweet, fine flavored fruits, 4 to 6 centimeters long; native of Central America and the West Indies. Cultivated to considerable extent for the Manila market. Of general distribution in the Archipelago.

Butter.—Rinse, pare, seed and slice large, well-grown, well ripened fruits; measure fruit and add an equal quantity, liquid measure, white or brown sugar; for each cup of fruit add 4 tablespoons limejuice; boil 10 minutes. Longer boiling makes fruit leathery. Remove from fire and pass through a colander; return to fire and boil until thick. Put into glasses and treat like jam.

Spiced Butter.—Make chico butter by the preceding recipe. To each 4 cups prepared pulp add 1 teaspoon ground cinnamon, 1 teaspoon ground allspice, ½ teaspoon ground nutmeg, ¼ teaspoon ground cloves. Boil until thick. Put in glasses and treat like jam.

CONDOL. *Benincasa hispida* Cogn.

A cucurbitaceous, annual vine of general distribution, believed to be a native of tropical Asia. Usually trained to grow on an arbor, but may also be grown like the watermelon. The large melon-shaped fruits, nearly ripe, are eaten as a vegetable, boiled, and the mature peel, candied, canned, or pickled, is very acceptable.

Canned Condol.—Select a condol not quite ripe. Rinse, and cut rind in slices 8 centimeters long and 2 centimeters wide, paring away all the green part of the rind and removing seeds. Make a sirup of 2 cups sugar, 1 cup water and 2 tablespoons lime juice. Boil 5 minutes and remove all scum; add the prepared condol and boil until transparent.

Sweet Pickles.—Select large, well developed, not quite mature condols. Rinse, and cut in slices 2 centimeters wide and 8 centimeters long, paring liberally and removing seeds. Make a sirup of 2 cups sugar, 1 cup vinegar, ¼ teaspoon salt, 1 teaspoon ground cinnamon, 1 teaspoon ground allspice, ½ teaspoon ground nutmeg, 1 teaspoon whole cloves, 1 stick cinnamon. Mix the ground spices and put in a bag of double cheesecloth. Put this bag and the other ingredients into the pan and boil 3 minutes. Then put the condol in the pan, cover and boil 10 minutes. Remove from fire and put aside until next day. Reheat and boil until tender. Pack in jar and fill to overflowing with boiling sirup and seal at once.

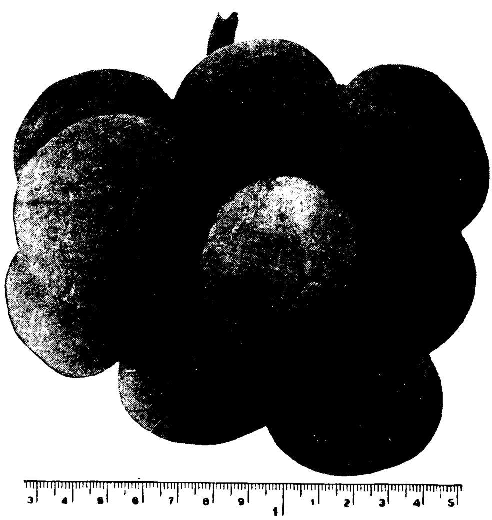
CUSTARDAPPLE. *Annona reticulata* L.

A small, semi-deciduous tree, 5 to 7 meters high, of West Indian origin, with a brownish-yellow, heart-shaped fruit, 8 centimeters or more in diameter, containing a cream-colored, sweet, juicy pulp of good flavor, but inferior to the sugarapple. Common in cultivation in Luzon; sparsely distributed in the Visayas and Mindanao.

Jam.—Rinse, pare, slice and remove seed; put fruit in pan with water enough to cover and boil to a thick mush; pass through a colander and measure. To each cup of pulp add 2 tablespoons tamarind pulp and 1 cup sugar. Boil until thick.

Jelly.—Rinse and slice, retaining skin and seed; put in pan with water sufficient to cover the fruit and boil into a thick

(*a*) The Guanabano, *Annona muricata.*



(*b*) A bunch of santols, *Sandoricum koetjape.*

mush. Remove from fire and squeeze through a double cheesecloth. Measure, and add 2 tablespoons tamarind juice to each cup of custardapple juice; return to fire and boil until all scum has risen. Remove from fire, strain, return to the fire and boil until it hardens in a spoon.

GINGER. *Zinziber officinale* Rosc.

A perennial herb with a creeping, underground rootstock, which dried, forms the ginger of commerce. Cultivated to a slight extent in central Luzon, but of no commercial importance in the Philippines.

Preserved Ginger.—Select young, tender "roots" and clean with a stiff brush. Scrape off the skin with the hands in water to avoid irritation of hands and eyes. Put in a large kettle with abundant water. Boil 10 minutes. Pour off water, add fresh water and 1 teaspoon baking soda. Boil 15 minutes and pour off water. Repeat the boiling in fresh water without adding soda until the ginger is tender and has the desired strength. Then, weigh the ginger and add an equal quantity sugar by weight and enough water to cover. Let simmer for 2 to 3 hours. Pack into jar and fill to overflowing with sirup; seal at once.

GUANABANO. *Annona muricata* L. (Plate XVII–*a*).

A small, attractive, dark-green tree about 5 meters tall, native of the West Indies, with large, oblong, green fruits with soft spines, sometimes exceeding 5 kilograms in weight. The flesh is white, rather fibrous, pleasantly acid of good flavor; eaten as dessert fruit, made into sherbet or preserved. The most widely cultivated species in the genus in the Philippines.

Canned Guanabano.—Select nearly ripe but not soft fruit. Rinse, peel and remove seeds, and cut meat into strips, dropping them into water to prevent discoloration. Make sirup of 2 cups sugar, 1 cup water, 2 tablespoons lime juice. Boil 5 minutes, remove scum and add the fruit. Boil until transparent.

Jam.—Rinse, remove skin and slice; put the fruit in pan with enough water to cover and boil until thick like mush. Remove from fire, pass through a colander and measure. To each cup of pulp add 2 tablespoons lime juice and 1 cup sugar; boil until thick.

Jelly.—Select thoroughly ripe fruit. Rinse and slice, retaining skin and seed; put in pan with enough water to cover fruit and boil until soft, stirring constantly. Remove from fire and pass through a double cheesecloth; return to fire and boil until all scum has risen. Strain, measure and return to fire, adding

1 tablespoon lime juice to each cup of guanabano juice. Heat sugar, equal in volume to the fruit juice, nearly to the melting point and pour into the boiling juice. Boil until hardening on the spoon, removing all rising scum.

GUAVA. *Psidium guajava* L.

A tall shrub or small tree, 4 to 6 meters high, native of the American Tropics, with roundish, variable fruits, averaging 4 centimeters in diameter, which may be eaten out of hand and make excellent preserves. One of the most generally distributed fruits in the islands, but practically of no commercial importance.

Canned guavas.—Select large, well-grown, mature, but still firm guavas. Rinse, pare, cut in halves, and remove seeds, being careful not to break the halves. Drop the cleaned fruit in water to prevent discoloration. Make a sirup of 2 cups sugar, 1 cup water, 2 tablespoons lime juice. Boil for 5 minutes and remove all scum; then drop the fruit into the boiling sirup and cook until semitransparent.

Jam.—Rinse, pare and slice, and drop fruit into water as it passes the knife to prevent discoloration. Nearly cover with water in pan and boil until soft; remove from fire, pass through colander and measure. To each cup of pulp add 2 tablespoons lime juice and 1 cup sugar; boil until quite thick.

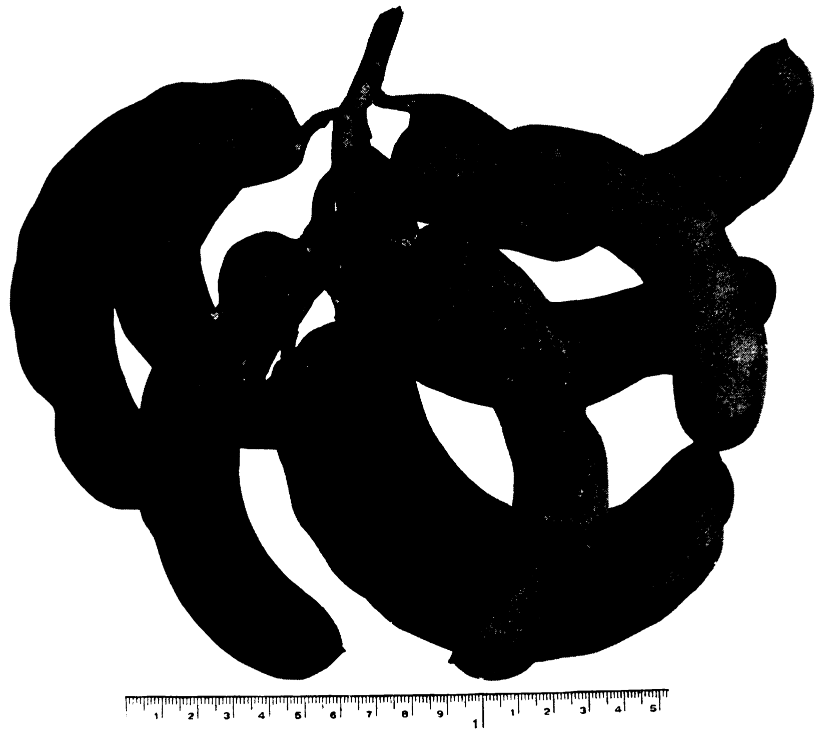
Jelly.—Examine fruit for fruit fly "worms." Rinse and slice into water to avoid discoloration. Boil until soft, in water about ½ the volume of the sliced fruit, stirring frequently to prevent burning; remove from fire and squeeze through a double cheesecloth. Return juice to the fire and boil until all scum has risen. Strain, measure, and return to fire. For each cup of juice add 1 cup sugar and 1 tablespoon lime juice. Heat the sugar almost to the melting point and pour it into the boiling juice and boil until it hardens in the spoon, removing all rising scum.

JUJUBE. *Ziziphus jujuba* L.

A large, spreading shrub to a small, thorny tree, 4 to 10 meters high, best adapted to elevations above 300 meters. Native of tropical Asia. The fruit is smooth, yellowish, quite like the ciruela in size and shape, and contains a large seed. Dried, the fruit of the improved foreign varieties is excellent. The jujube is sparingly grown in the Philippines and the fruit is poor for eating out of hand, but makes a good preserve.

Jam.—Rinse, and boil until soft with enough water to cover the fruit. Remove from fire, pass through colander and

(*a*) A bunch of lanzones. *Lansium domesticum.*



(*b*) The tamarind, *Tamarindus indica.*

measure. Add sugar, equal quantity, liquid measure, to pulp and boil until thick.

KAMIA. *Averrhoa bilimbi* L. (Plate XVI–*b*).

A small tree, 5 to 10 meters high, with oblong, greenish, very acid fruits, 4 to 6 cm. long, produced on the stem and large branches, suitable for preserves. Native of Tropical Asia. Commonly cultivated. A form with sweet fruits has recently been discovered.

Canned Kamias.—Select large, well-grown fruits; remove stems and rinse well. Make a sirup of 1 cup sugar and $\frac{3}{4}$ cup water. Bring to a boil, drop the fruit into the sirup and boil for 5 minutes.

Jam.—Remove stems and rinse well. Put in pan with small amount of water and boil until soft; pass through colander and measure; for each cup of pulp add $\frac{1}{4}$ teaspoon baking soda and 1 cup sugar. Return to fire and boil until thick.

Pickles.—Select large fruits, remove stems and rinse. Make a sirup of 2 cups sugar, 1 cup vinegar, 1 stick cinnamon, 1 teaspoon whole cloves. Boil 10 minutes and strain. Add the fruit to the boiling sirup and boil 3 minutes.

LANZON. *Lansium domesticum* Jack. (Plates XVIII–*a*, XIX–*b*).

A small, handsome tree, 5 to 8 meters high, bearing the fruit in bunches like the grape on the stem and larger branches. Native of Malaysia. The fruits are considerable larger than grapes, velvety, and contain a translucent, subacid pulp of excellent flavor. Eaten as a dessert fruit or may be preserved. Of local distribution in Mindanao, Cebu and Laguna. Requires abundant rain of equal distribution for good success. May be grown up to an altitude of 750 meters, but the best fruits are produced at low elevations.

Canned Lanzones.—Select large, well-grown fruit. Rinse, remove stems, skin and all membranes between the sections of the fruit, dropping these into water as they pass through the hands to prevent discoloration. Make a sirup of 2 cups sugar and 1 cup water. Boil 5 minutes, remove scum and add fruit. Boil 3 minutes.

MAKOPA. *Eugenia javanica* L.

A tree of medium size, up to 10 meters or more in height, with cone-shaped, 3 centimeters or more long, pink or white, very pretty fruits, but usually dry and rather tasteless. Native of tropical Asia. Fairly well distributed in the Philippines.

Canned Makopas.—Select medium sized fruits, rinse and remove calyces, dropping the fruits into water to prevent discoloration. Make a sirup of 2 cups sugar, $1\frac{1}{2}$ cups water, 2 tablespoons lime juice. Boil 3 minutes and remove scum; drop the fruit into the sirup and boil until tender.

Spiced jam.—Remove calyces, rinse and slice. Put in pan with water, $\frac{1}{2}$ the volume of the fruit, and boil until tender. Remove from fire, pass through a colander and measure; for each cup of pulp add 1 cup sugar, 2 tablespoons lime juice, 1 teaspoon ground cinnamon, $\frac{1}{4}$ teaspoon allspice, $\frac{1}{4}$ teaspoon cloves, $\frac{1}{4}$ teaspoon nutmeg. Boil until thick.

Jelly.—Rinse, slice and boil until tender, in water enough to cover the fruit; remove from fire, squeeze through a double cheese-cloth, return juice to fire and boil until all scum has risen. Strain and measure. To each cup of juice add 2 tablespoons lime juice and 1 cup sugar. Heat the sugar until hot but not melting and pour into the boiling juice; boil until it will harden in a spoon.

MANGO. *Mangifera indica* L.

A large, handsome, spreading tree, native of India and Malaya, bearing a more or less kidney-shaped, sweet, rich and juicy fruit, in the Philippines of very good to excellent quality. The best Philippine mangos excel those in all other countries. In quality the Philippine forms, which come true to seed, rank in the following order: Carabao, Pico (syn. Padero), Señora, and Pahutan (syn. Chupadero and Supsupen). The mango is the fourth most important fruit in the Philippines and the following provinces lead in mango production in the order of their enumeration: Cavite, Nueva Ecija, Cebu, Pangasinan, Bohol, and Zambales.

Ripe, the fruit may be eaten out of hand or preserved. Green, it is pickled, or may be boiled and used like apple sauce; it also may be utilized in making a cooling drink.

Canned Mangos.—Select large, firm, but not hard fruit. Rinse, peel and slice off the halves from seed. Make a sirup of 2 cups sugar and 1 cup water, boil and remove scum. Drop in the fruit and cook until transparent.

Butter.—Rinse and peel, and nearly cover with water in pan, and boil until meat drops from seeds; remove the seeds, measure pulp and add $\frac{3}{4}$ cup of sugar to each cup of pulp. Boil until thick and smooth. Put in glasses and treat like jam.

NOTE.—The middles, including the seeds left when canning mangos, may also be used for making mango butter.

MANGOSTEEN. *Garcinia mangostana* L.

A small, attractive tree, 6 to 9 meters high, with dark-green, leathery leaves, native of Malaysia. In the Philippines confined almost entirely to Mindanao and the Sulu Archipelago, and adapted to a humid climate, with fairly abundant rainfall well distributed throughout the year. The fruit is roundish to a trifle flattened, dark red to purplish, about 6 centimeters in diameter. The flesh is snow-white, exquisitely flavored and separates entirely from the rind. One of the best fruits in the Philippines.

In Jolo, Sulu, a preserve of unexcelled quality is made from the mangosteen by boiling the flesh and seed in brown sugar. The seeds impart a delicious, nutty flavor to the preserve and so render this an article of superlative merit.

NIPA. *Nypa fruticans* Wurmb.

A creeping palm with a stout, branching rootstock, and large leaves, 5 to 10 meters long, growing in saltwater swamps. Not cultivated. The sap is collected from the immature inflorescence and made principally into alcohol, and to a less extent into wine, vinegar and sugar. A good preserve is made from the immature seeds boiled in sugar.

Preserved Nipa.—Pick immature seeds with soft kernels. Split the seeds with a bolo or hatchet and remove kernels dropping them into water as they pass through the hands to prevent discoloration. Make a sirup of 2 cups sugar, 1½ cups water and 1 tablespoon lime juice. Boil for 5 minutes removing the rising scum. Then add the nipa nuts and boil 8 minutes. *Longer* boiling results in tough nuts.

PAPAYA. *Carica papaya* L. (Plate XIX–*a*).

A tree-like, dioecious or hermaphroditic herb, indigenous to the American tropics, with large, palmate leaves, of rapid growth. Of wide distribution, and commonly cultivated everywhere. The fruit is large, roundish to oblong, greenish to yellowish, with orange-yellow, sweet, juicy and well flavored flesh, forming a central cavity containing the seeds. Partly grown, the boiled fruits make a delicious vegetable eaten like squash.

Jam.—Rinse, pare and remove seeds and adherent fleshy "skin." To each cup of pulp add 3 tablespoons lime juice and 1 cup sugar. Boil until thick.

Sweet Pickles.—Select half-grown fruits; rinse, pare and remove seeds. Cut into strips 8 by 2 centimeters. Parboil until tender. Make a sirup of 2 cups sugar, 1 cup vinegar, 1 teaspoon ground cinnamon, 1 teaspoon ground allspice, 1 teaspoon whole cloves, $\frac{1}{2}$ teaspoon ground nutmeg, 1 stick cinnamon and the papaya seeds. Tie the ground spices in double cheesecloth, put this, the whole spices and the papaya seeds into the sirup. Boil five minutes. Add the parboiled papaya to the boiling sirup and boil until transparent. Cover kettle and set aside for 24 hours. Then strain sirup, reheat and bring to a boil. Pack in jar, filling to overflowing with hot sirup. Seal at once.

PINEAPPLE. *Ananas sativus* Schult.

An herbaceous plant, indigenous to the American tropics, with long, stiff, usually spiny leaves, arranged in a rosette. The fruit somewhat resembles a very large pine cone, and is sweet, subacid, juicy, and of excellent flavor and quality eaten raw or preserved. Very generally distributed, but grown more for the fiber than the fruit except in Bataan, the only province where pineapple growing has assumed a commercial aspect.

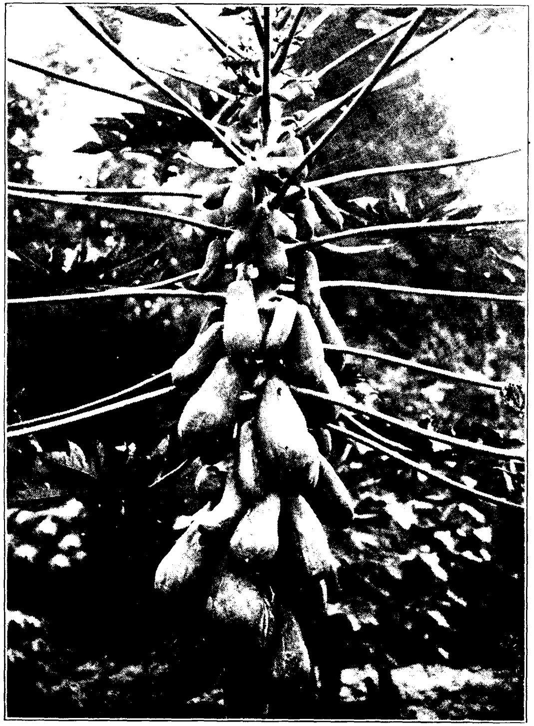
Canned Pineapple.—Select large, well-grown fruit. Rinse, pare, core, remove eyes, and slice to suit. To each kilo fruit add $\frac{3}{4}$ kilo sugar. Place alternate layers of fruit and sugar in the kettle. Put over a slow fire until the sugar is nearly melted. Then boil for 5 minutes.

SANTOL. *Sandoricum koetjape* Merr. (Plate XVII–*b*).

A medium sized tree attaining a height of 15 meters, native of India and adjacent countries to the east. The fruit is roundish, flattened, about 5 centimeters long, light khaki brown, and contains a semitranslucent, juicy, somewhat fibrous, subacid pulp, in some varieties of excellent flavor, in which are embedded five large seeds. Jelly made of santols in unexcelled in flavor and quality and is superior to guava jelly. Of wide distribution and cultivation.

Canned Santol.—Select large, well-grown santols. Rinse, pare and cut the fruit into quarters and remove seeds without breaking the meat, dropping it into water as rapidly as it passes through the hands to prevent discoloration. Make a sirup of 2 cups sugar and 1 cup water. Boil 5 minutes, remove the scum, add the fruit and boil until tender.

Jelly.—Pare, seed and slice, dropping fruit into water as rapidly as it passes through the hands to prevent discoloration. Nearly cover with water in pan, and boil until soft. Mash, and squeeze through double cheesecloth. Return juice to fire and boil until all scum has risen. Remove from fire, strain, measure and return to boiler. To each cup of juice add an equal quantity



(*a*) A hermaphrodite papaya, *Carica papaya.*

(*b*) A lanzon tree, Zamboanga.

sugar. Heat the sugar almost to the melting point and pour into the boiling juice. Remove the rising scum and boil juice until it hardens in a spoon.

TAMARIND. *Tamarindus indica* L. (Plate XVIII–*b*).

A handsome, medium to large tree, up to 20 meters in height, native of tropical Asia and Africa, bearing a fleshy pod with very acid, aromatic pulp; exellent for preserves, jelly and ade. Commonly cultivated everywhere. Sweet-fruited trees are occasionally found.

Jam.—Use pulp obtained when making tamarind sirup or prepared as in making sirup. Take equal parts of pulp and sugar. To each liter of pulp add $\frac{1}{4}$ of a level teaspoon baking soda and boil until thick.

Sirup.—Select immature tamarinds; scrub clean with a brush, rinse, break in pieces into pan with enough water to cover and boil until soft like mush. Remove from fire and strain through double cheesecloth. Add $\frac{1}{2}$ teaspoon baking soda to each liter of juice and boil down to $\frac{1}{2}$ the original quantity, removing the rising scum. Remove from fire, strain, measure and return to fire. Add $\frac{1}{4}$ cup sugar to each cup of juice. Boil 20 minutes. Fill sterilized bottles, cork and seal.

About 1 teaspoon of the sirup in a glass of ice water makes a very refreshing drink.

NOTE.—The fully ripe fruit of the tamarind makes a jelly and a flavoring sirup for an "ade" of unexcelled flavor and quality.

COTTON

Compiled by RAFAEL B. ESPINO *of the College of Agriculture, Los Baños*

INTRODUCTORY REMARKS

In the absence of sufficient Philippine literature on cotton in these Islands and with the hope of giving the readers a mental picture of the enormous importance of cotton and the great possibilities of growing it successfully in this country, this compilation was written.

It is also the aim in writing up this paper to give our planters and prospective planters a sort of guide in the selection of species or varieties and in the cultural phases of the problem.

SPECIES OF COTTON IN THE PHILIPPINES

The cotton plants belong to the family *Malvaceæ* and to the genus *Gossypium*. There are about 42 species of cotton, found mostly in the Tropics of both hemispheres. Many of these are cultivated. In the Philippines, Merrill has reported 4 species growing in Manila, and that all of these are manifestly introduced. Of these supposed 4 species in the Islands, Merrill has described only two, and the following key will separate these 2 species from one another:

Leaves 3 lobed, up to 12 centimeters long; corolla about 4 centimeters long; seeds free, covered with a dense fuzz in addition to the wool .... *Gossypium hirsutum.*

Leaves 3- to 5-lobed, up to 25 centimeters long; corolla 6 to 8 centimeters long; seeds conglomerate, glabrous, woolly but with no fuzz. *Gossypium brasiliense.*

The genus *Gossypium* is described as composed of "annual or perennial herbs or shrubs, mostly erect, branched. Leaves mostly palmate, 3- to several-lobed. Flowers large, axillary, mostly yellow, often purple at the base inside. Bracteoles 3 large, leafy, cordate, lobed-laciniate. Calyx cup-shaped, truncate or 5 toothed. Corolla campanulate, the petal convolute or spreading. Ovary 5-celled. Capsule loculicidally 3- to 5-valved. Seeds densely clothed with a fuzz or with woolly hairs, or both."

Of the 2 species described by Merrill, *Gossypium hirsutum* is known in Tagalog as "bulac" and as "algodón" in Spanish. This species, it is said, is probably raised here from American origin. It flowers along the months of May and June. It is widely distributed in tropical countries, but it is of quite recent introduction into the Philippines.

The other species of *Gossypium* described by Merrill, is *G. brasiliense*. This species is known in Tagalog as the "bulac-castila" and it has the same "algodón" name in Spanish. This species is widely distributed in the Philippines but it is a native of Brazil. It flowers all the year round and it is grown in Manila mostly for ornamental purposes.

In local usage, we have the following varietal names:

Balawan Light Brown, Balawan Brown, Bobuy, Bulac, Bulac-castila, Burac, Candava, Capas, Gapaz kinachila, Gapas sangley, Moro, Taal, Toquillo or kidney cotton, "Soot" light brown, "Soot" brown.[a]

We have also Sea Island, two or three types of Caravonica, Calaca, Egyptian and several American upland types of cotton. A few of these latter are Triumph, Saunder's 3, etc.

In connection with the 2 species described by Merrill, it should be remembered that these are the only ones found in Manila or its vicinity. As was reported by Merrill himself there are now about 4 species of cotton in the Philippines; one of these is the *Gossypium herbaceum* L. which is a long staple variety and which was formerly grown rather extensively in Ilocos Norte and in a few adjacent provinces, but it is said that its cultivation was discouraged by the Government in order to encourage the cultivation of tobacco in those localities. The industry still exists, however, although on a greatly reduced scale.

COMMERCIAL COTTON IN THE WORLD

Quoting Parlatore, Matthews said that all commercial cotton is derived from seven species of *Gossypium*. These species are the following:

1. *G. barbadense*.—This species has a long silky staple and is known as Barbados, Sea-Island, Egyptian, and Peruvian cotton. This plant grows to be 6 to 8 feet high and has yellow flowers.

2. *G. herbaceum*.—This species includes most of the cotton from India, South Asia, China, and Italy. It is an annual and grows to a height of 5 to 6 feet. The "seeds are generally

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[a] These names were collected from a number of publications regarding cotton in the Philippines. Probably some of these names are synonymous.

covered with a soft undergrowth of fine down, which is an objectionable feature." The flower is yellow and the plant is perhaps the hardiest species of cotton for it can be grown in many localities under different soil and climatic conditions.

3. *G. hirsutum.*—This species includes most cotton from southern United States. It is known as upland cotton, shrubby in habit and seldom reaches a height of 7 feet. The seeds are covered with an undergrowth of down.

4. *G. arboreum,* is mostly found in Ceylon, Arabia, etc. As its specific name suggests, it is like a tree, from 12 to 18 feet high. The fibers are greenish and very coarse and the flowers are reddish in color.

5. *G. peruvianum,* as its specific name suggests, is a native of Peru. It is also found in Brazil. This species is perennial and the fibers obtained from the second and third years are the only ones utilized.

6. *G. tahitense.*—This species of cotton is found chiefly in the Tahiti and other Pacific islands.

7. *G. sandwichense.*—Is found growing mostly in Hawaiian Islands.

Commercially cotton is classified as "long staple" and "short staple." To the long-staple type belong all of the commercial species which yield fibers from 1 to 2 inches long, and the species which yield fibers from ½ to 1 inch long belong to the "short-staple" type. As to commercial value, the whiter, cleaner, and more silky the cotton is, the higher the value it has but that consisting of short napped fibers are always considered inferior. The best and the most highly prized of all is the Sea-Island cotton of the *Gossypium barbadense,* which is extensively grown in Florida.

From the preceding list of commercial cottons in the world, it can be seen that two or more species reported to be found in these Islands are included. It must be admitted therefore that as far as these species (*G. herbaceum* and *G. hirsutum*) are concerned we have valuable species of cotton which are well acclimatized in some parts of the Philippines.

STATISTICS ON COTTON

Record shows that about 26 millions of acres are devoted to the cultivation of cotton in the United States. India is next in acreage, being about 23 millions; while Egypt, Russia and all other countries or any other country have less than 3 million acres of cotton. In number of bales of cotton, the United States produces about 58 per cent of the cotton of the world, India 13 per cent, Egypt 6 per cent, Russia 3 per cent, Brazil 1 per cent, and the rest of the world, 19 per cent.

In the export of cotton, the United States leads the rest of the world. Her exportation amounted to about 10 millions bales in 1916—which exceeds all exports of cotton from all other countries combined. India ranks second to the United States in the exportation of the cotton but she has less by only 2 million bales. Other countries that export cotton in the descending order, are Egypt, France, Belgium, Germany, China proper, and Netherlands.

Now, which countries import cotton? For this question, statistics for 1916 may be examined for the answer. Only the leading countries in imports may be cited here. These are the United Kingdom, Germany, France, Japan, Italy, Austria Hungary, Russia, and Belgium. Of all of these countries the United Kingdom leads in the importation of cotton. She holds a record of more than 4 million bales in 1916. In the same year Germany imported about 2½ million bales; France and Japan imported about the same, about 1½ million bales each; while each of the remaining countries mentioned above imported less than one million bales of cotton—the importation into Belgium was the smallest, being only about a little more than one-half million bales.

WHY SHOULD THE PHILIPPINES RAISE COTTON

If we were to think for a moment what the statistical data before us really mean, we will realize that the United States and India are the only great producers of cotton. And, if we were to find which country geographically is very near to us and which at the same time imports a large quantity of raw cotton, we will find that Japan is the country. Japan imports a large part of her raw cotton material from the United States, while India sends her cotton mostly to Europe and to England. The soil and climate of the Philippines is well adopted to cotton.

The presence of insect pests of cotton might probably be raised as an objection to the planting of cotton in the Philippines. Indeed, this objection is well-founded, for we have insects thriving upon wild malvaceous plants and these insects are also enemies of the cotton plant. But in spite of the damage which is done by these insects, and although cotton has never been given the proper care, this plant is still found here and there in the Philippines.

As already mentioned, at least for the llocos provinces, if not for the Philippines as a whole, the culture of cotton was much more important and extensive in former years than it is at present. Its cultivation has always been almost entirely confined to the provinces in Luzon; the cultivation of cotton in the Visayan and Mindanao Islands being comparatively insignificant. In 1902 the area devoted to cotton alone in Ilocos Norte amounted to 1,591 hectares and the quantity produced was 605,029 kilograms of fiber. In the same year Ilocos Sur produced 244,140 kilograms on 645 hectares. If the lands devoted to the cultivation of this staple in these two provinces were to be combined, they would constitute 73.2 per cent, of the total for the whole Philippine Islands (3,053 hectares) or 64.2 per cent of the 1,322,118 kilograms of the entire production of the Philippines.

Besides these two provinces two other provinces may be mentioned here which had an area in excess of 100 hectares in cotton. These are Batangas which had 239 hectares and La Union, with 266 hectares devoted to cotton culture. These two provinces were reported to have produced in 1902, 21,206 and 362,434 (note difference in yield per hectare) kilograms of cotton, respectively. The remaining provinces of the Philippines combined, constituted only a cotton area of 312 hectares with a total production of 89,286 kilograms of fiber.

It is not to be overlooked that the foregoing statistics are good only for 1902, but whether it is applicable to the present time or not, is a question which will soon be answered when the Philippine Census for 1918 comes out. It is, however, safe to say that the Ilocos provinces and the Province of Batangas are still engaged not only in the raising of this crop but also in utilizing its fibers in the manufacture of some native clothing. This information was obtained from some students of this College who are familiar with the industries of the Provinces of Ilocos and Batangas, being themselves natives of these provinces, and this information is substantiated by the present sale some native cloths are made in Ilocos and which in local markets, are known as "Habing Iloco," and those that are woven in Batangas, called "Habing Batañgan."

The foregoing discussions simply tend to show that there are varieties of cotton now grown in some parts of the Philippines which are really resistant to the insect enemies of cotton. It is therefore apparent that with the kind of soil and the climate we have, together with the use only of pest-resistant varieties of cotton, the cultivation of cotton in these Islands will undoubtedly prove a success.

The next question naturally is whether or not we have the needed labor. The raising of cotton, as is well-known, requires a lot of manual labor—in picking and in the care of the plantation. All of these forms of labor can easily be supplied here in the Philippines, for there are many women and children in the Philippines who are only eagerly awaiting for such kind of work as the picking of the bolls of cotton, drying the staple, baling, and so on. Moreover, these women and children will nowadays be very glad to accept a much lower wage than the Negroes in the United States do. We can therefore, raise cotton more cheaply here than in the States and possibly even cheaper than in any other cotton producing country. If this is true, the Philippines therefore can raise cotton cheaper and can send her cotton to Japan with less cost for transportation than for similar quantity and quality of cotton raised in other countries.

Should we raise cotton in the Philippines in order to compete with other countries in the exportation of this staple to Japan and other countries? No, the Philippines should begin to raise cotton extensively because we have the needed soil, climate and labor for the successful production of cotton. Moreover, the extensive cultivation of cotton in the Philippines should be encouraged in order to induce the establishment of factories for the manufacture of cotton goods in the Islands and thus reduce the enormous sum of money we send out of the country every year for the purchase of cotton and its manufactures, which in all came to the enormous sum of ₱58,016,844 for 1918. This stupendous sum is even more than the sum we spent in the same year for the purchase of iron and steel or of rice.

The following table shows the values of imports of cotton and its manufactures into the Philippines by the principal countries of origin for 1918:

Cotton and manufactures

Countries of origin	Total for 1918	Per cent of total
United States	₱41,106,801	70.85
United Kingdom	3,718,247	6.41
France	16,371	0.03
Germany	5,262	0.01
Italy	8,680	0.61
Netherlands	6,413	0.01
Spain	17,203	0.03
Switzerland	558,780	1.00
China	1,250,893	2.16
British East Indies	260,599	0.04
Japan	11,042,101	19.03
Other countries	25,494	0.04
Total	58,016,844	99.62

The preceding table shows that the United States, Japan, United Kingdom, or China, exported cotton goods to the Philippines to the amount exceeding one million pesos in 1918, and as was already mentioned the total importation of cotton goods into the Islands in 1918 amounted to more than 58 million pesos.

In this connection, it might be quoted as to what the Philippine Bureau of Customs said, "In general the prices of cotton goods prevailing in 1918 were approximately 50 per cent higher than the prices that prevailed in 1917, but notwithstanding this drawback cotton imports during this year (1918) exceeded those of previous years both in quantity and in total value."

The preceding statistics plainly and conclusively demonstrate the importance of cotton or cotton goods to the inhabitants of the Philippines. These statistics show also that our importation of cotton goods has increased enormously in 1918 over that of any of the previous years and no doubt will increase as the years go by and the number of inhabitants of the Philippines increases.

REVIEW OF FIELD TESTS OF COTTON IN THE PHILIPPINE ISLANDS

Probably the first field test which was written up was about the cotton culture in La Carlota (Negros) in 1885, which had contradictory no apparent success. Unfortunately this failure cannot at present be attributed to any known factor of production for there was no mention made of the particular species or varieties tested and probably the planting was done when the bolling stage came during the time when it was rainy and when the insect enemies were at the destructive life-stage. As Copeland said, if tried in La Carlota the cotton should be sown about the end of September. This remark probably has some reference to the fact that the field trials in question were not made in proper season.

A specific example of this case may be found in the trials of Thomas in 1908. This man found that the American cotton plants that were tried in Bukidnon produced good-sized bolls with plenty of lint. Unfortunately the plants matured before the rainy season was over and many of the bolls rotted.

A similar experience may be found in a report of the Bureau of Agriculture in which it was said, "during the early development of the bolls, they were profuse and very fair crops would have been obtained had it not been for the ravages of weevils and other insect pests. The weevil trouble assumed such a serious stage that a boll rarely reached the picking stage in a perfect condition."

Another failure in the cultivation of cotton was reported in 1911 by Nesom. In this test three varieties of Caravonica were planted on November 26, 1910; the wool variety did not germinate at all, while the alpaca type grew to be 150 to 200 centimeters in height, and the silk variety attained a height of 160 to 240 centimeters with bushy, vigorous plants. These two latter varieties began to flower "about the middle of February but produced no bolls worth harvesting."

All experiences emphasize the urgent necessity of knowing first whether or not the varieties or species of cotton are properly acclimated to the particular locality where they are to be grown. They show also the importance of knowing not only the complete life history of the cotton plant itself but also of knowing the climate of the locality and the life-history of the insects destructive to this crop. Knowing the climate or at least the coming of the rain and the time when the insect pests are at their most destructive stage, the planter can, no doubt under proper cultural method, escape the enemies of this staple. This suggestion is recognized and accepted to be highly practical in cotton culture, and it is by this means that the cotton industry in the United States, Hawaii, Egypt and in other places, owes a large measure of success.

In connection with the acclimatization phase of the problem several cultures have been started this year at this College, in which varieties or species of cotton natives as well as foreign are grown simultaneously. These cultures are expected to be repeated year after year until a time is reached when the yield can no longer be increased by acclimatization or when one or more varieties shall have been found to be the most promising, at least under the climatic and soil conditions present on the College Farm.

Another piece of investigation which is now on the way is the determination of the best part of the year for the planting of two or three native varieties of cotton in this locality. The seeds obtained from Batangas that are used in these tests are no doubt well acclimated here. The seeds are planted every month and are spaced in the field at three or four different distances. Careful records of climatic factors, such as rainfall, temperature of the air and of the soil are being taken, which will be used in the interpretation of results that will be obtained from the field tests.

Another piece of investigation which will be taken up soon at this College is a thorough study of the life-history of the insect enemies of cotton, together with the study of the best means of combating them or of escaping the destructiveness of these pests. The logical sequence to these studies will be the selection of varieties or species or individual plants which are more or less resistant to the diseases or pests.

In connection with the study of some of the factors of production we might cite here the observation of Alcarraz in 1894. This investigator reported that the Ilocos Provinces or the northwestern part of Luzon have conditions well-adapted to the cultivation of cotton. He said that cotton requires for its entire vegetative development 4500° to 5500°C. and that Vigan, Ilocos Sur, satisfies this requirement inasmuch as at this place from November till the middle of April, the cumulative temperature runs to 4560°, and from May 1st till the 30th, the sum total of temperature of the air was found to be 7560°C. The 4560°C. is for the entire vegetative development of the cotton plant in Vigan, which lasts for 5½ months while the 5760°C. is for the entire life time of the plant—until harvest, a period of about seven months. It should also be observed that this writer said that there was no low temperature which might interfere with the normal development of the plant, because the temperature in Ilocos never went below 16°C.—which is considered the minimum limit for the successful cultivation of cotton.

Although excessive rains are injurious to planted seeds and interfere with harvest—making the seeds in the ground to decay and the fibers in the bolls to rot, yet Alcarraz reported that in Ilocos one need not fear this source of difficulties, because in this place the rainy season ends in October and begins in June. Moreover, it is said that rain is so scarce in these places that it never exceeds 60 millimeters deep in the soil.

This information again emphasizes the fact that the climate in Ilocos is favorable to the successful cultivation of cotton.

Now comes the question of soil. Cotton, like most plants, requires rich soil, easy to work. This type of soil is found in Ilocos for there are alluvial soils which can be irrigated. Alcarraz even pointed out that sides of mountains in Ilocos are well suited for the cultivation of cotton.

Other investigators also found the possibility of growing cotton successfully in certain parts of these Islands. For example, Thomas although he reported on the failure of American cotton in Bukidnon, yet acknowledged the fact that Gapas sangley or moro cotton aroused interest in Manila. This variety produced bolls plentifully, the seeds were easily extracted and the lint came out freely. The fiber is rather short, curly and coarse but the cloth made from it was very durable.

Another promising result was obtained by the Bureau of Agriculture in 1911. From the preliminary tests made by this

Bureau, it was found that "certain native types of cotton were found to exhibit such encouraging results that it was deemed, not only advisable, but also necessary, that a more detailed and more systematic investigation be carried out."

Native varieties of cotton were compared in the field with some American types. The results obtained showed that the varieties that germinated, Toquillo, Gapaz Kinachila, and Gapas sangley or Candava, "made a very luxuriant growth, much superior to the American types, but the natives were a little bit more late yielders than the American varieties." In yield, the Toquillo and Kinachila were much inferior to the American cottons, but the sangley compared very favorably with the latter. The native varieties were practically free from the attacks by the weevil. The American types, however, were very badly infested.

The recent report of the Director of Agriculture of these Islands brings to light two contradicting results obtained on two occasions. One of these states the failure of American upland type of cotton and some native types, while other results enabled this writer to say that their "experiment shows that our soil and climatic conditions are favorable to the growing of Sea Island cotton and that same will thrive well." This writer further went on saying, "the value and use of the Sea Island cotton have recently considerably increased on account of its suitability for use in the manufacture of rubber tire fabric for automobiles and other similar motor vehicles."

A well-drawn general conclusion from the 1912 field work on cotton of the Bureau of Agriculture may be quoted here, with slight modification, and will serve as a general conclusion for all the work on this staple that have so far been carried out by this Bureau:

1. The cultivation of American and other foreign species on a large scale from imported seed at least in the vicinity of La Carlota, is an unsafe investment. This can probably be accomplished only after the seed has been selected from plants which have been thoroughly acclimated to local conditions, or after it has been improved by crossing with one of the native species.

2. Of the native species, the Toquillo and the Sangley are the only two that can be recommended for cultivation on a large scale. Careful selection of seed will undoubtedly increase their yield.

3. The successful cultivation of cotton in the Philippines depends to a large extent on the proper time for planting. This varies somewhat with the different species, but the rule is the same, e. g., the seed should be planted so as to bring the plants to maturity not later than the middle of the dry season. After that period, heavy rains are liable to set in with such frequency as to impair the quality and quantity of the floss.

HISTORY OF COTTON

The earliest use of cotton was said to have been in Peru and India and possibly also in Persia. According to Matthews, in India the importance of cotton was realized as early as in prehistoric time, and this country is said to have been the center of cotton industry from 1500 B. C. to about the same number of years after the beginning of the Christian Era. Cotton is said to have been introduced into China and Japan from India rather early but it was only about 1300 A. D. when the industry became very popular in China. How cotton got into Persia, Peru and India is not known. It is believed, however, that this staple was introduced into Egypt where it was known ever after, abuot the fifth century B. C., from Persia. Spain was the first European country to have made cotton goods, but the European cotton industry, it is said, began at about the end of the eighteenth century, when the first cotton fabric was produced in England in 1772. The Levant and Macedonia were then the greatest producers of cotton.

In the United States, cotton was first grown in the American colonies (in Virginia) in 1621 but the first mill for the manufacture of cotton goods appears to have been erected more than one hundred fifty years later (1787) at Beverly, (Mass.), and ever since that time this country has been the greatest cotton producer in the world. Since the Civil War in the United States, India and Brazil also came into prominence as big producers of cotton.

ECONOMIC IMPORTANCE

The principal economic use of cotton is for clothing. The statistics already given in the first part of this paper indicate the enormous importance of the cotton plant as a source of fiber for the manufacture of cloth. It is probably safe to say that in countries where cotton is not grown very extensively the fiber is the only material utilized, but where cotton is grown very extensively the inhabitants make use not only of the fiber but also extracted oil from seed. The oil is an important product for the market—the good grade of cotton seed oil is used in making lard and salad oil, while the poor grade is utilized in the manufacture of soap and phonograph records; the residue is sold as cotton-seed-meal, either for fertilizer or feed of animals. The cotton seed is also used for the manufacture of certain explosives.

In addition to the use of cotton fiber already mentioned, this material is also employed to a considerable extent for cordage purposes. Ropes for tents and ships are sometimes made of cotton fiber. The fiber is also used in the manufacture of canvas for sails, and as absorbent for dressing wounds. Lints of certain species of cotton are nowadays used as linings of some rubber tires for automobiles.

THE FIBER

The cytological study of the fiber of cotton reveals the fact that the development of this structure begins before fertilization is accomplished, by radial growth of epidermal cells of the seed coat. This outgrowth soon assumes its final diameter, and remains unicellular until its mature stage. At its mature stage the fiber is elongated; the apical end is closed while the basal end is attached to the seed coat. While growing the fiber is cylindrical in shape with a lumen which is continuous from end to end of the cell. When mature, however, the cell collapses and forms a flat ribbon-like structure, which when placed under the microscope, is seen to be spiral or twisted and the two edges of the cell are thickened. Matthews said that the presence of the lumen in each fiber no doubt adds to its absorptive capacity for liquids, and its capillary action allows cotton fiber to absorb and retain salts, dyestuffs, etc., but the principal power of the cells to absorb and to retain these materials, says Matthews, does not come from the presence of this inner canal of the cell, for when cotton is mercerized the canal is almost always entirely obliterated "and the inner walls are pressed against each other, and yet mercerized cotton is much more absorptive of dyes and other materials than ordinary cotton." This extraordinary power of the mercerized cotton to absorb and retain dyestuffs, according to Matthews himself, is due to the presence of minute pores on the walls of the fiber.

In chemical composition, cotton fiber is made up of 87 to 91 per cent cellulose; 7 to 8 per cent water; 0.4 to 0.5 per cent wax and fat; 0.5 to 0.7 per cent protoplasmal residue and 0.12 per cent ash; together with a very small quantity of coloring matter. The specific gravity of air-dried cotton is said to be 1.5.

In regard to the size of the fiber, this differs according to species or varieties of cotton. Some varieties produced longer fibers than other varieties. This is also true in regard to the diameter of the lumina or the thickness of the cell-walls of individual cells. Matthews has presented a large number of measurements, together with those obtained by other workers. A few only of these data may be given in the following paragraphs.

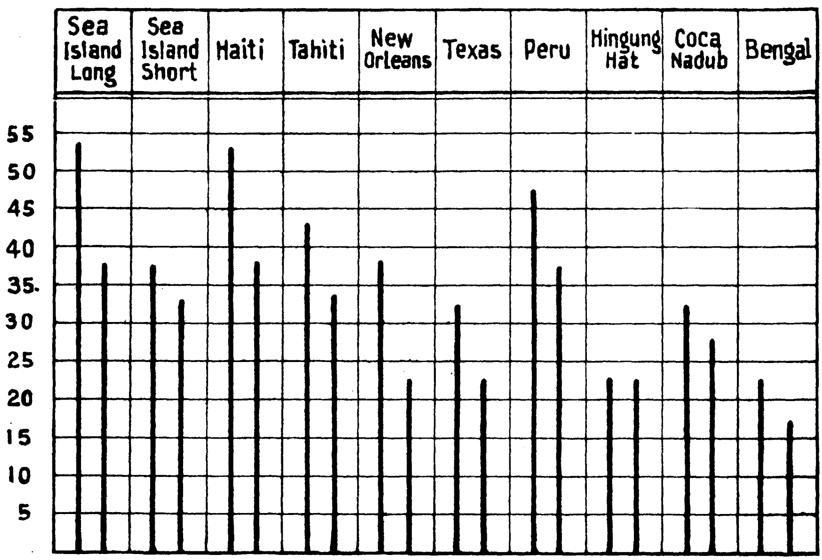
Matthews quoting Wiesner, gives the following measurements as the average width (diameter of the broadside) of fiber cells from different species of cotton:

	mm.
Gossypium herbaceum	0.0189
Gossypium herbadense	0.0252
Gossypium arboreum	0.0299
Gossypium conglomeratum	0.0255
Gossypium acuminatum	0.0294
Gossypium religiosum	0.0333
Gossypium flavidum	0.0378

In length of the staple Höhnel gives the following table:

	cm.
Gossypium herbaceum (Macedonia)	1.82
Gossypium herbaceum (Bengal)	1.03
Gossypium barbadense (Sea Island)	4.05
Gossypium barbadense (Brazilian)	4.00
Gossypium barbadense (Egyptian)	3.89
Gossyipum arboreum (Indian)	2.50
Gossypium conglomeratum (Martinique)	3.51
Gossypium acuminatum (India)	2.84
Gossypium vitifolium (Pernambuco)	3.59

Matthews gives also Lecomte's graphic representation of the maxima and minima lengths of the fibers obtained from different types of cotton:



For the tensile strength of the cotton fiber as compared with those of other kinds of fibers, Royle may be quoted as to the results of tests made by Dr. Wight. The following table shows the comparative breaking strength of the following fibers:

	Pounds.
Coir (Cocos nucifera)	224
Hibiscus cannabinus	290
Sanseviera zeylanica	316
Gossypium herbaceum	346
Agave americana	362
Crotalaria juncea	407
Calotropis gigantea	552

The preceding table shows that the cotton fiber is stronger than oir, Hibiscus cannabinus (local name) or sanseviera zeylanica but weaker than the maguey.

Another piece of investigation on the strength of cotton material gave the following results:

Normal strength of cloth	100
Saturated with moisture	104
Dried on hot cylinder	86
Again dampened	103

These results show that the alternate moistening and hot drying of cotton material caused little or no deterioration at all in its strength.

CLASSIFICATION OF COTTON FIBER

Grade Names.—The present method of grading or classifying cotton fibers in the United States dates back to about 1800, when this system was first used in Liverpool, England. At present, almost all of the agricultural schools in the southern States in the United States, give a course on the grading of American cotton. The county agents of the United States Department of Agriculture in the cotton States are supplied with instructions in regard to the classification of cotton fiber. Samples of the standard grades of cotton fiber in the United States are kept in tubes and some are kept in vacuum.

It takes several years of experience in order to be able to classify correctly all the grades and qualities of cotton fibers now in use, but the grower does not need to be well posted on all of the grades. Often, it is enough, if he knows at least three principal grades, namely: Low middling, Middling, and Good middling, since this range of grades includes a majority of white cotton.

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A more complete list of the official cotton standards of the United States may be given as follows:

1. Middling fair.
2. Strict good middling.
3. Good middling.
4. Strict middling.
5. Middling.
6. Strict low middling.
7. Low middling.
8. Strict good ordinary.
9. Good ordinary.

No attempt will be made here to define fully each of these grades. It should be said, however, that the "Middling, as the name itself indicates, is the middle or basic grade, and is the grade upon which the market quotations are based. All grades above Middling should bring higher prices, and all below Middling, lower prices than that quoted for Middling, the amount above or below varying according to the commercial differences in use where the cotton is marketed." Each of these standard grades may be modified according to the degree of whitenesses of the samples. For instance, when the cotton fiber is not white its nature is ordinarily indicated by the use of one or two modifying words. In other words, at some markets there may be several classes of the same grade of cotton; e. g., Middling off color, Middling spotted, Middling yellow tinged, or Middling yellow or blue stained.

Object of Classification.—In brief it might be said that the objects in making the classification of the cotton fibers are (1) To aid in determining the comparative values of the different qualities of cotton, and (2) to aid in making the purchase and the sale of cotton more satisfactory when samples are not available.

Factors that Determine the Grade.—Without including all the points to be considered in deciding the grade of cotton, it should be said that the principal factors in determining a grade are (1) The presence of foreign matter or impurities, such as leaf, dust, sand, motes, and cut seeds; (2) color of the fiber; and (3) the quality of ginning.

SOME ENVIRONMENTS OF COTTON

Introductory Remark.—As yet no careful experiments have been carried out on the cultivation of cotton in the Philippines in relation to the climate or weather of these Islands; and what little is known is already given under the *Review of the Field Tests of Cotton in the Philippines.* For this reason nothing will be said under this topic and possibly under the following ones too except some sort of generalization based on observations made in other places, with the hope that this generalization will simply help as guide in carrying out experimental and observational work on cotton in this country.

Climate.—According to the experience in Egypt, it takes about eight or nine months before most varieties of cotton attain the mature stage, so that the plants remain in the field and are exposed under varying or different climatic conditions for this length of time before the plants are harvested. Since cotton is a heat-loving plant, it should be grown in protected places where it is not too cold and where there is little or no wind. In Egypt, for four months after the time of sowing, the seedlings experience a gradually increasing temperature, which reaches its maximum of about 36.5°C. at about the end of the fourth month.

In regard to moisture, it is the experience in Louisiana that regular and well distributed rains during the growing period and dry weather during the ripening period, are best suited to the successful growing of cotton. The amount of rainfall in Louisiana that gave a good yield of cotton come to be on the average of 12.2 centimeters per month.

In Egypt the climate is quite different. Usually rain is said not to visit the cotton fields from the time the crop is planted until the last picking is made, and although a moderate shower seems to be beneficial to the plant, most planters prefer to raise the crop without any rain at all. This, however, does not imply that a successful cotton crop can be grown without the supply of water. What the farmers in Egypt do, in order to supply the plant with water, is to irrigate the field. In this connection, it should be noted that these farmers are very careful as to the amount of irrigation water to be supplied to the plants and the time of its application. In fact, these farmers firmly believe that success in cotton growing depends upon the proper use of irrigation. Their experience being that if cotton be irrigated irregularly, that is, if water be withheld at one period and excess given at another—the fibers are checked in growth and although the growth of the fiber begins again when water is supplied the lint is inferior, being short, extremely weak and brittle. The farmers in Egypt think that hot and moist atmosphere at the time of flowering has some direct relation to the length and the strength of the fiber produced.

In Hawaii, all cottons are, or tend to become perennials and have a tendency to produce flowers whenever the moisture of the air and of the soil is of certain amount. In sections where there is a rainy and a dry season, the usual habit of the plants is to grow luxuriantly during the rainy season and to produce bolls when the dry season comes. Continuous excessive rainfall produces but few flowers and makes the plant produce excessive vegetative growth.

Soil.—Cotton can be raised on all kinds of soil, though with different success. On sandy soils the plants are found not to do well. On heavy soils, the plants when provided with sufficient moisture, grow to considerable height, but the amount of lint produced is not proportional to their size. The most favorable soil is a medium loam. In Egypt the soils used for the cultivation of cotton are usually alluvial. A striking feature of some soils devoted to the culture of cotton in Egypt is the presence in the soils of a small percentage of salt brought on to the land by the water from the Mediterranean. This is said to exercise a beneficial effect on the strength and color of the fiber. However, the excess of the salt in the soil leads to a stunted growth of the plant and the development of short but not weak fibers. Another effect of the salt upon the cotton plant is the early production of bolls.

PREPARATION OF THE LAND

Cotton growers in the United States and in Egypt seem to agree that the first attention should be given to the preparation of the ground for cotton. It is their experience that a thorough breaking and commingling of the upper soil which should be increased in depth to 20 or 25 centimeters, using plow and harrow, is more effective than deeper but less thorough pulverization of the soil. If the soil is not friable or is not thoroughly pulverized, germination of the seeds is slow and uncertain.

In case the soil is too shallow, the upper soil only should be thoroughly prepared and every year the plowing should be increased in depth gradually, for it was found from actual practice that subsoiling did not always pay for the extra expense.

Ordinarily after pulverizing the soil, ridges are made by a moldboard plow, about 90 centimeters apart. If the time for the sowing of the seeds has not yet come, the land remains ridged until planting, when new ridges are made by splitting the old ones. There are some planters who, for one reason or another, allow their land to remain flat while waiting for the planting season, in which case less surface is exposed to the air, sun and other agencies, than when the land is ridged, and consequently less benefit is derived from such exposure. An exposure to these agencies for at least ten or twelve days before planting is found always beneficial to the plant.

DISTANCE IN PLANTING

The results obtained from careful field tests in several cotton growing countries, seem to show that the cotton plants should be thinned to one in a place and should be so arranged in the field that they are nearly in squares. The distances recommended that give the best results are 130 by 90 centimeters, and 105 by 105 centimeters.

GERMINATION OF SEEDS

Before discussing the germination of cotton seeds, one or two words should be said in regard to the selection of seeds for planting.

One of the greatest difficulties in raising cotton of uniform fiber is the difficulty of maintaining the purity of the seeds of a particular variety which the farmer prefers, so that after a period of two or three years the planter in the United States is forced to buy new seed with the idea that his seed will "run out" in this length of time. The true explanation, however, is that the variety gets mixed either (1) by cross-pollination with other varieties growing in the neighboring farms or (2) seeds of two or more varieties become mixed in ginning. To avoid these difficulties farmers engaged in the raising of cotton from the same locality represented by uniform soil and climatic conditions throughout the entire area, should coöperate in the use of only one variety of cotton which is proved to be best suited under the conditions of that locality. Following this suggestion, insures the production of cotton of only one variety and practically there is no possibility of producing hybrid cotton in that locality.

If this is not found practicable farmers should see to it that the seeds for planting are picked by hand in order that it may not become mixed with seeds from cotton of another variety. If hand picking is found impracticable because a large quantity of planting seeds is needed, then gin should be employed to separate the seeds from the fiber, but it must be observed in order to obtain seeds of only one variety, that the gin heads, the seed bin and trough are entirely free of any seed that may have been left from some other variety of cotton. Another way of avoiding the mixing of seeds of two or more varieties is by ginning very early in the season or after the rush of the season is over. In such a case the ginner can give special precaution to maintaining the purity of the seed. In giving this advice the writer is aware of the fact that it is a little premature as we have not any gin yet in the Islands but since one of the main aims of writing this paper is to advocate the serious cultivation of cotton in the Philippines, therefore it is but proper to give the planters and prospective ones some modern ideas of raising cotton.

Turning now our attention to the germination of the seed, it should be said that the customary practice in cotton growing districts is to sow the seeds directly in the fields where the plants are expected to be grown. It must be admitted that this procedure is practicable where rain falls rather frequently or where the use of irrigation water, in time of drought, could be resorted to. In some places where rainfall and irrigation are not available the planters even go to the trouble of sprinkling their plantings. This last method, of course, is feasible only when the plantation is small.

In regard to the time of sowing the seeds, this takes place in Egypt at different times of the year, depending of course upon the locality and upon the weather. It is customary in Egypt to sow the seeds from the end of February until May. At this time of the year it was observed that the temperature of the soil varies in different parts of the day and from day to day; but the magnitude of the periodical change of soil-temperature diminishes with increasing depth, being negligible below 50 centimeters. In view of this fact the root tip in the early stages of germination is subject to great variation in temperature, but after the root has grown about 15 centimeters or more, the temperature of the soil at this depth is found to be constant, except for the annual change. Actual measurements show that at the depth of 50 centimeters the soil temperature is about 17° C. at the beginning of March, rising to about 25° C. in the summer. To demonstrate the practicability of knowing the soil temperature in a locality, it may be cited, according to Balls, that sowing of seeds in the middle of February near Cairo will take twelve days to spread out the cotyledons of the seedlings, while identical sowings made in the middle of April may appear in five days, temperature being the limiting factor. In this connection it might be said that in the Philippines, according to some information received from some students of this College, the sowing of seeds in the fields usually takes place during the months of October and November. The few seeds of cotton that were sown in germinating boxes and in plots at this College began to germinate on or about the fifth day of sowing—indicating that we have the right temperature of the soil or air for the rapid germination of cotton seeds.

Balls observed that the percentage of germination of cotton seeds in the field varies, other things being equal, with the date when the seeds are sown. The lowest percentage of germination was found when the seeds were planted too early or too late in the season.

In a very general way it can be said that the proper time for sowing the cotton seeds is (1) When sufficient soil moisture or rainfall can be supplied to the plants during their early stages of development; and so (2) that the flowering or bolling stage takes place during the month when rainfall and strong winds do not usually occur, and (3) that the flowering stage comes during the time when the insect enemies of cotton present in the locality are not at the destructive stage of their life history.

FERTILIZERS AND MANURES

Nothing can be said of great importance on this topic except that the application of commercial fertilizers and manures depends upon the kind of soil (physically and chemically) where they are to be applied; the time of application—with reference to the stage of development of the plant and the time of the year; the amount of fertilizers applied; the amount of water supply in or to the soil—in the form either of rainfall or irrigation water; the proportion or combination of the fertilizers to be applied; and the application of commercial fertilizers possibly depends also upon the variety of the cotton plant to be grown.

For the Philippines, all of these points should be experimented with before a somewhat thorough knowledge of the fertilizer-requirements of the cotton plant would be appreciated and comprehended. Writers in other countries, however, believe that there are no fertilizers that will give better results on cotton than well-preserved and thoroughly rotted farmyard manures, which are to be applied sometime before the planting season. This effectiveness of the farm yard manures is believed to be increased, if the manures are to be mixed with a liberal dose of acid phosphate, say 50 to 100 kilos to each ton.

With concentrated fertilizers, it is said that the best results are obtained from old and worn uplands, if 10 parts phosphoric acids, 3 parts nitrogen, and 3 parts potash were applied. But on lands where a well-ordered rotation system such as (1) corn and cowpeas, (2) small grains, followed by cowpeas (the latter to be made into hay) and (3) cotton, each crop liberally and judiciously fertilized, each succeeding cotton crop will require a somewhat less amount of fertilizers.

CULTIVATION

The cultivation of the cotton field should be frequent but should not be deep in order not to destroy the shallow-buried roots of the plants. The cultivation should occur about once a week and once in a row with the use of a wide cultivator that will reach almost from row to row, and should commence soon after the plants produce the third leaf. This should be continued at certain intervals up to the time when the flowers are developing. As results from this care it may, in general, be stated that "early, frequent, and shallow cultivation tends to produce and mature a crop of early bolls; deeper and later continued cultivation tends rather to delay and hinder the development of the early bolls, but may increase the final and the total yield of the crop in sections where the weevil does not occur."

HARVEST

As already mentioned, ordinarily a crop is harvested at its eight or ninth month in the field. When the bolls begin to open frequent pickings are necessary. Boys and women are mainly employed in picking. If the bolls are allowed to remain too long after opening, rain, winds, birds and gravity get in their work and the fibers will soon fall on the ground. In places where winds or storms do not occur at the time when the bolls open, it may be possible to have three or four weeks between picking, but ordinarily eight to fourteen days, is all that should be allowed.

The amount that can be picked in one day depends upon the amount of cotton open, which in turn depends upon the season of the year, the length of time that elapsed since last picking and the prolificacy of the plants. A willing, experienced and active picker of course can work more efficiently than a slow and awkward picker. In Louisiana the quantity picked by one laborer in a day differs considerably. Some laborers can hardly pick 100 pounds each; others pick 300 to 350 pounds; and the first-class pickers make a record of 500 to 600 pounds of cotton a day.

In Hawaii, the record for picking cotton is rather low. The largest amount reported for one picking or in one day was only 125 pounds and it is said that 50 per cent of this was moisture. Seventy-five pounds of dry seed cotton is considered to be an average picking in a day.

In Mexico, it is reported that a well-developed cotton tree (Caravonica) yields not less than 2 kilos of bolls, 50 per cent of which is clean fiber. At this rate one hectare of land in which

1,000 plants are grown will yield 1 ton of clean fiber. The yield from upland varieties of cotton is less than this, being about 1,000 kilos of seed cotton, or 333 kilos of clean cotton from one hectare of land.

DISEASES AND PESTS

Some species of Gossypium growing at the College were reported by Professor Reinking to be attacked by certain organisms. This investigator also has reported the "angular leaf spot" on cotton. This disease is caused by a bacterium, *Bacterium malvacearum* Erw. Smith, which gains entrance into the plant through the stomata and through injuries. The organism may live over on the seed and lint for at least four months. It may also live in the soil for a considerable length of time. This organism attacks the leaf, stem and fruit of the plant. The means of control recommended is killing the bacterium on the seeds before planting: The seeds should be delinted in sulphuric acid and then treated in hot water at 72° C. for eighteen minutes. In severe cases, the plants should be sprayed with Bordeaux mixture.

Another disease of cotton that was reported found at the College is a rust. This rust attacks the leaves of *Gossypium herbaceum* and *G. brasiliense,* and entirely covers both surfaces of the leaf with minute brownish to black pustules. This disease, it is said, causes but little damage to the plants. Professor Reinking has reported two rusts on cotton: *Kuehneola gossypii* Arth, and *Uredo desmium* (B. te Br. Petch).

Other cotton diseases found in other countries are given as follows:

Disease name	Causal organisms	Parts of the plant affected
Cotton wilt	*Neocospora vasinfecta*	Whole plant.
Anthracnose	*Collectotrichum Gossypii*	Bolls, stem, leaf, and cotyledons.
Cotton rust	(Bad soil and Weather)	Leaves.
Red rust	A mite	Leaves.
Damping-off or sore-shin	*Rhizoctonia*	Stem, near surface of the ground.
Bacterial blight	*Bacterium malvacearum*	Stem, bolls, and leaves.
Shedding of bolls	(Physiological)	Bolls.
Root-knot Root-galls	Microscopic worm	Roots.
Root nematodes root-rot	A parasitic fungus	Roots.
Areolate mildew	*Ramularia areola*	Leaves.
Cotton leaf blight	*Cerco spora Gossypina*	Leaves.

Among the insect pests of the cotton probably the most serious is the boll-weevil. This pest is a native of Mexico or Central America. In 1892 this insect had come to a certain part of the United States and beginning 1894 the rate of the spread of this pest in the States was from 40,160 miles a year.

Beginning 1901 the rate of infestation was 26,880 miles per year and in 1916 it reached 71,800 square miles. These figures, it is said, do not refer to the area in cotton, for in many places, where the pest was found, only about 10 per cent of the total area was grown to cotton.

Professor Baker is authority of the statement that in the Philippines there are malvaceous plants other than cotton which harbor insect pests of the latter. He thinks that a native boll weevil *Amorphoidea lata* is the most serious insect pest of cottons in the Philippines. But in spite of the presence of these enemies of cotton in these Islands, our cotton, from year to year, can be found growing successfully here and there in the Philippines—indicating that there are varieties more or less resistant to these particular insect pests. The insect enemies of cotton reported during the Spanish régime in these Islands are "grillo de los campos" (Criket), "la oruga gris de una mariposa (Noctua subterranea)" and "larva del Melolonta vulgaris."

Other insect pests of cotton are enumerated as follows:

Cotton leafworm	Stem maggot	Mealy Bug
Cotton aphis	Wireworms	Scale insects
Cotton bollworm	Cut worms	Leaf-folding caterpillar
Red spider	Japanese Beetle	Stem borer

For a more thorough discussion of the life history, extent of damage, methods of control, etc., of the insect pests of cotton enumerated above, and of the cotton diseases caused by bacterial and fungus parasites already given, the following papers may be consulted: Hunter, 1917; Foaden, 1897; Fullaway, 1909; McGregor, 1816; McClelland, and Sahr, 1912; and Hibbard, 1910.

SUMMARY AND CONCLUSION

1. The present paper is based mainly on results of work of about thirty writers. In the absence of sufficient Philippine literature on this subject a compilation of this nature seems desirable and proper to be published in these Islands.

2. Several species of cotton are found growing here and there in these Islands; and formerly cotton growing was quite an industry in Ilocos, La Union and Batangas Provinces. Even at the present time, but of course on a much reduced scale, cotton is raised and is woven into native clothes in Ilocos and Batangas.

3. The United States leads in the production and in the exportation of cotton in the world. Her cotton production exceeds that of the rest of the world combined. Other countries which produce cotton on large scale are, in the descending order, India, Egypt, Russia, and Brazil.

4. In the importation of cotton in a raw state, the United Kingdom ranks first; Germany, France, Japan, Italy, Austria Hungary, and others, also import cotton. Of these countries Japan affords the most convenient market for the Philippines in the event that cotton could be grown here on a large scale.

5. In soil and climate, the Philippines is well adapted in raising cotton. There are indications too that at present good species of cotton are being acclimatized in certain parts of the Philippines and are more or less resistant to the insect pests of this plant. These facts indicate that the growing of cotton in this coutry may find success. Success in raising cotton might lead to the establishment of a number of factories, and might lead also to the exportation of cotton. Should this come to be true, instead of paying out the enormous sum of ₱58,016,844 which this country did pay for cotton and cotton goods alone in 1918, she would either reduce this sum or even export cotton to the neighboring countries. Moreover, men, women, and children who at present have difficulties in finding employment, will no doubt be busy either in the cotton fields or in cotton factories.

6. The Philippine Government should thoroughly investigate the relative suitability of varieties to our very varied climatic and soil conditions, and thoroughly investigate the really serious pests and diseases as to methods of control or avoidance.

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THE PROPOSED WORK OF THE PLANT PATHOLOGY LABORATORIES OF THE BUREAU OF AGRICULTURE AND BUREAU OF SCIENCE [1]

By H. ATHERTON LEE,
Mycologist, Bureau of Science

In taking up the work of the newly organized plant pathology laboratories, it was necessary first to formulate an outline of the problems at hand of the possibilities of meeting such problems with the facilities and personnel available. Before outlining the work it would be well to discuss briefly the need for such work and its possibilities.

There has been little previous experience with plant diseases in these Islands that would permit of any estimate as to their actual seriousness. Mr. John Dumas, Manager of the Calamba Sugar Estate, has published a paper in which he states: "If we were asked: 'What are the most important problems confronting the cane planters and centrals in the Philippine Islands?' Our answer would be: 'Cane varieties, control of cane diseases and labor.' " Later in the same paper he says: "As to the control of cane diseases, while our native canes are *apparently* not seriously affected by disease, on close examination there is hardly a sugar plantation that does not suffer *extensive* losses from diseased cane in its fields."

This statement refers of course to sugar cane only. The other industries are not so well organized as is the sugar cane industry, and would be less apt to be able to formulate a well-balanced estimate as to their losses from plant diseases. We can obtain some idea of the necessity for being in tough with such diseases by comparing the work done in this country with that done in other countries. Java has two American pathologists and at least one Dutch pathologist. The work of Petch and Butler on plant diseases in the British East Indies dates back ten or fifteen years. In the Hawaiian Islands, a territory much smaller in

[1] The present paper is the substance of a discussion held at the weekly seminar of the Plant Pathology Laboratories of the Philippine Bureau of Science on June 16, 1920.

extent than this country, there are at least five pathologists working continually on plant-disease problems. Of these, four are specialized in sugar cane work alone. In Porto Rico, there are two pathologists; in Cuba several; and so forth. Without considering the plant-disease problems of this country otherwise than by analogy with other tropical countries, it would seem that there must be a number of problems which need consideration here.

The ultimate aim of plant-disease studies is of course the control or prevention of such diseases at a low enough cost to be economically feasible. In attempting plant-disease control in this country we are confronted by two obstacles immediately, which make such control difficult. One is that the nature of the economic crops of this country is such as to make control methods difficult. Thus in America our crop plants are fruit trees, such as peach trees, plum trees, and orange trees; truck crops, such as potatoes, asparagus, or sugar beets. We can drive a team down between the rows of such crops and spray them with fungicides. Here our important economic plants are abaca, coconuts, sugar cane and similar crops. We cannot apply fungicides to those crops at a feasible cost and must rely on other methods.

The other obstacle we will gradually overcome. It consists in the present lack of familiarity, on the part of the growers, with the uses of fungicides, spraying apparatus, and other methods of control.

It becomes at once obvious that our primary work, the work which will be immediately possible and give the biggest returns for the labor involved, is to keep the fungus diseases away from the important crops by means of quarantine methods. That is to say, we do not have in this country all of the injurious insects and parasitic fungi that exist; in fact we have been fortunate in that some of the very serious insect enemies and parasitic fungi have not occurred here as yet. Our immediate work then will be to keep those insects and fungi from entering here, by means of a plant-quarantine service. Such a plant-quarantine service will see that all plant materials, fruits, seeds, etc., which enter our ports from foreign countries are free from injurious insects and plant diseases. A more detailed discussion of this plant-quarantine service will be taken up later. The perfection of this plant-quarantine organization is, therefore, the first step in the protection of our important crops from insects and diseases.

The second project for development is the training of Filipino students in the various methods of studying plant diseases. The College of Agriculture of the University of the Philippines is doing very fine work already in the development of pathologists. However, graduates fresh from college need several years of training and maturing before they themselves can become independent workers. This is true in any country; in America we do not make a man pathologist, working independently, until he has had several years of training under a specialist; such work matures a student and gives him the experience and judgment to proceed independently later.

The third project of course is the active investigation of the plant diseases of this country. We are to some extent handicapped in that we are at the beginning of such work in this country. In America two hundred or so pathologists have been working continuously for thirty years. As a result of so large a number of men working over a considerable period of time, a great reserve of information has accumulated upon plant diseases. We, in the Philippines, have only the work of a few recent pathologists in this country to draw upon. We will, however, be considerably aided by the work of pathologists in other tropical countries, since their publications are available here.

The principal export of this country in order of their importance are of course, hemp, coconuts, sugar cane and tobacco. In addition the principal food crop for domestic use is rice. We are therefore organizing our laboratory staff with one assistant to specialize on each one of these crops. Coöperation in these projects with other government institutions will be always the endeavor of our laboratories. The idea of service will be inculcated in each assistant and will outweigh other considerations.

To summarize, then, our work falls in three main projects: (1) The organization of a thoroughly competent plant-quarantine service to protect our crops from the injurious insects and parasitic fungi of foreign countries, (2) the training of Filipino students to become competent investigators, and (3) the active investigation of plant diseases already prevalent in this country with a view to devising control methods. This last, when once developed, will involve extension work among the growers to secure the adoption of control measures.

THE STORAGE AND CURING OF MANDARIN ORANGES AT THE BATANGAS COMMERCIAL CITRUS STATION

By JOSE de LEON,
Superintendent of the Batangas Commercial Citrus Station

In January, 1920, Mr. Josė G. Sanvictores, then Assistant Director of the Bureau of Agriculture, and Mr. H. A. Lee, Mycologist of the Bureau of Science, visited the Batangas Commercial Citrus Station. Among numerous suggestions made by them as to the work of the station it was proposed that the storage and curing of oranges be attempted. The advantage of such storage would be to distribute the selling season over a longer period of time, thus giving the growers a better price for their fruit as well as enabling the consumer to secure oranges at times when it would otherwise be impossible to get them.

The curing of fruit had been attempted previously by Mr. Lee on a small scale, in boxes. Such preliminary investigations showed that the fruits could be made to assume a uniform orange color and in addition their general quality was considerably improved. Following the suggestions of Mr. Sanvictores and Mr. Lee, a storage chamber was constructed at Tanauan. A vault was dug into a side hill, about 6 feet high and 10 feet square; a diagram is presented here, Plate XXI, to show the plan of the construction of this vault and a photograph, Plate XX, shows the entrance. The purpose of this underground chamber was to secure uniform temperature and moisture conditions. No ventilation was provided for in this first experiment.

The fruit from the station orchard was harvested January 31st of this year and about 1,500 oranges of the commonly grown Batangas mandarin variety were placed in this vault. The fruits were handled with great care so as not to injure them but they were not picked quite as carefully as they should have been. The men in handling the oranges in the storage chamber always disinfected their hands with carbolic acid before touching any fruit.

Entrance to Citrus fruit storage chamber, Tanauan, Batangas.

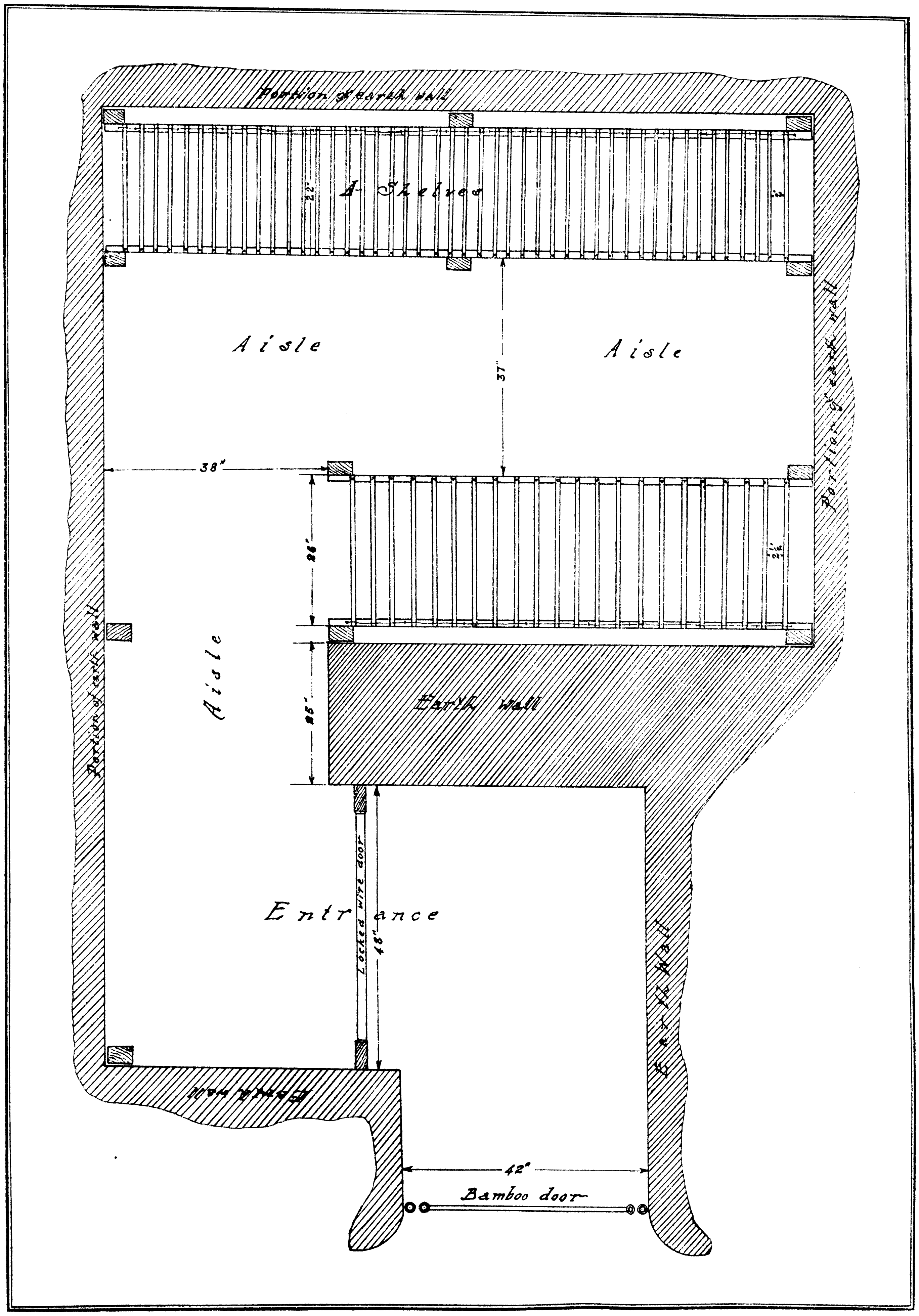


DIAGRAM OF CITRUS FRUIT STORAGE CHAMBER.

The result was very successful and gratifying. The fruits soon assumed a deep orange color, the rind became thinner and the flesh less stringy and of better texture; the flavor of the fruit also was improved. This curing of the oranges was entirely finished twenty days after they were placed in the vault, the experiment, however, was continued to determine to what length of time such oranges could be held in storage. The results are shown in the following table:

TABLE I.—*Showing the percentage of decay in fruits of the Batangas mandarin orange, cured and held in storage in an underground vault.*

Size	Kind of ruit	Number of fruits placed January 31	Decayed February 19		Decayed March 10		Decayed March 31	
			Number	Per cent	Number	Per cent	Number	Per cent
2¼	Clipped, ripe	149	9	6	67	45	122	82
	Clipped, green	241	9	4	136	56	213	89
	Ordinary picked, ripe	100	6	6	8	8	52	52
	Ordinary picked, green	263	10	4	78	30	160	61
2½	Clipped, ripe	265	18	5	116	44	224	85
	Clipped, green	157	6	4	87	55	142	90
	Ordinary picked, ripe	100	2	2	8	8	57	57
	Ordinary picked, green	180	9	5	38	21	99	55
2¾	Clipped, ripe	35	1	8	15	43	30	86
	Clipped, green	30	1	3	18	60	27	90
	Ordinary picked, ripe	35	1	3	15	43	19	54
	Ordinary picked, green	33	1	3	12	36	22	67

The table shows that loss from decay was not serious during the first twenty days; thereafter the loss was so great as to make it impraticable to continue the experiment. Data are given in Table I of the comparative merits of two kinds of picking, one by clipping the stems of the fruit with shears for that purpose, the other by plucking the fruits from the tree by hand. The table shows that there was a larger loss in clipped fruits than in those picked in the ordinary way; that a slightly larger loss was found in the green than in the ripe fruit; that size of fruit did not make any difference in its keeping quality.

These results have proved that mandarin oranges may be stored for a longer time than has heretofore been possible, not only without spoiling their flavor and appearance but actually greatly improving their quality. According to the methods used, twenty days is the longest period of time that is economically feasible. It is hoped next year, however, by more careful handling, by disinfection of the fruits before storing, and by ventilation of the underground storage chamber, to greatly increase the length of time during which fruits may be kept.

Another experiment has been conducted to determine the difference between fruit stored in underground cellars and fruit stored in open air. Of the fruits stored under the different conditions,—open air, an aired shed, and non-ventilated underground storage—the percentages of loss were 24 per cent, 15½ per cent and 26 per cent respectively. Although the fungus decay of fruits was greater in the case of the underground storage than in the shed storage and open air storage, the actual loss of fruits was greater by the latter two methods. This was due to shrinkage and hardening of the fruits in the dry, open air storage, whereas in the underground storage such fruits as did not rot from fungus infection were much improved in color, flavor, juiciness, texture, and general quality.

Preparations are now under way for repeating these experiments next year, combating the fungus decay by careful handling, by fruit disinfection before storage and by ventilation of the storage vault.

ADLAY READY FOR THE HARVEST, LAMAO EXPERIMENT STATION

NOTES ON ADLAY

By P. J. WESTER, *Agricultural Advisor.*

One by one the various economic plants throughout the tropics are becoming the object of study and experimentation with a view to their utilization in one way or another. Now it is a new, undescribed species fresh from the jungle, again, it is a plant once important in a now half forgotten (shall we say) civilization that still is grown in a desultory fashion somewhere in the byways of the world. One of the more interesting plants in the latter class, which has escaped notice is the Adlay, *Coix lacryma-jobi* L. var. *mayuen* Stapf, a form with soft, hulls and very distinct from the ordinary *Coix lacryma-jobi,* with hard, bead-like, shining grains.

The ordinary wild species of *Coix lacryma-jobi* with hard bead-like seeds is known in English by the name of "Job's tears," a literal translation of the name of the plant in Arabic. This product of imagination does no particular harm to a plant grown as an ornament but for an economic crop plant it is an awkward and unsuitable name for general use. Watt [1] employs in vernacular the generic name *Coix* for all forms of the plant but says that "in discussing possible future industrial developments, it is essential that the separation indicated into the forms of *C. lacryma-jobi* that are cultivated and those that are wild should be clearly kept in mind."

In line with this suggestion the writer would propose the euphonious Philippine name "adlay" to designate in vernacular the edible form of *Coix lacryma-jobi* L.

The wild species is believed to have been known already to Pliny and is now of wide distribution throughout the tropics of both hemispheres, but the soft-hulled, edible subspecies under discussion here does not appear to have been known to European writers until in the seventeenth century, though in India, its native habitat, this grain was of very ancient cultivation.

According to Watt the edible form of *Coix lacryma-jobi* is grown in India, and in Tonkin, China, Malaya and Japan. He says that:

[1] Watt, G. The Commercial Products of India, 1908.

"Were a statement prepared of the geographical features of interest in the cultivated plants of British India, *Coix* would have to be commented on as characteristic of the tract of country that stretches east by south from Nagpur to Sikkim, Assam, Burma, the Malaya and China, and be regarded as an important food grain with some of the most ancient aboriginal inhabitants, especially those of Mongolian origin."

The absence of statistics shows that in a broad sense adlay is of relatively slight importance in India as compared with the major cereals, rice, corn, sorghum and ragi, though in some regions it would appear to be of considerable importance, since Watt states that:

"From Darjeeling and through Bhutan to the mountains of Upper and Eastern Assam, the Khasia, Garo and Naga hills, etc., to Burma and the Shan States, *Coix* might be described as not only a fairly plentiful crop but an exceedingly important article of the diet."

There are several varieties of adlay cultivated in India for he continues:

"There are great diversities in size, shape and color of the grain, as also in quality and purposes to which put.—Certain forms are roasted, then husked and eaten whole, being either parched (like corn) or boiled as with rice. Other forms are so very different that the grain may be milled and ground to flour and thereafter baked into bread."

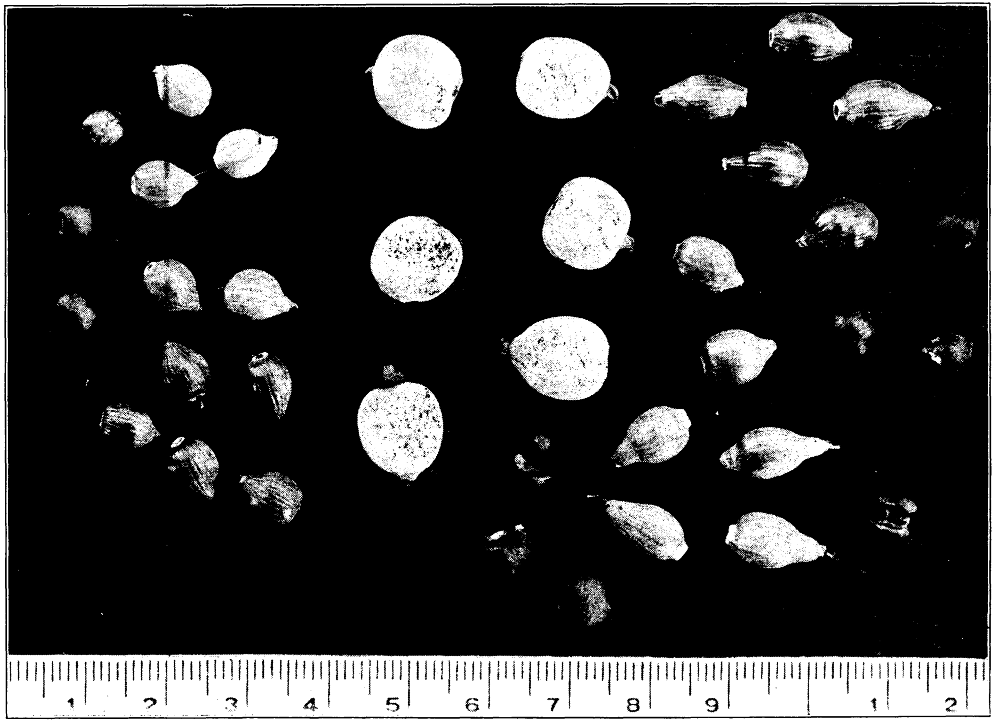
In the "Dictionary" Watts speaks of a large grained variety "fully one half inch long" (12.5 millimeters) growing in Arakan.

When the Chinese general Mayuen invaded Indo-China in the 1st Century A. D., he became so fond of the adlay grown in Annam that he introduced it into China, where it is still cultivated.

Aside from the uses of adlay for food already mentioned, in China the grain is eaten in soup like pearl barley which it very much resembles in appearance. In India it is also made into beer, its principal use in the Philippines.

The adlay as grown in the Philippines is represented by several distinct forms of which five varieties are shown on Plate XXIII.

The largest of these is the Lokfao, of which there are 3,180 to 3,380 grains to the kilo. The hull of the grain is generally white though sometimes it is tinged with a pale blue-gray, or it approaches dark cream in color. The hull is glossy when ripe



PHILIPPINE ADLAY—TO THE RIGHT, TWO UNNAMED VARIETIES FROM BUKIDNON; IN THE CENTER, LOKFAO FROM THE MOUNTAIN PROVINCE; TO THE LEFT, TWO UNNAMED VARIETIES FROM COTABATO.

but in storage much of the outer surface peels off like old enameling from crockery; the striation is absent or represented by short, obscure lines extending from the apex and the base of the grain, the hull is rather thick and so hard that it cannot be broken by pressure between the fingers; the kernel, which has a brown seed coat, is free and encased in two thin, membranaceous skins or coverings between it and the hull from which they also are free.

This variety is grown in the Mountain Province on the Island of Luzon.

Six grains and three kernels of the lokfao are shown in the center of Plate XXIII.

The native inhabitants in this province consider the lokfao as quite distinct from another kind called kope. The grain of this variety is smaller, requiring about 4,920 grains to the kilo, and the hull is thinner, but otherwise the grain is similar to that of the lokfao. The kope is said to mature in 90 days after planting.

The grains and kernels to the right on Plate XXIII are two unnamed varieties from Cotabato Province in Mindanao, one of which is creamy white and the other Brussels brown (Ridgway). Except for this difference in color the grains are similar. The grains are much smaller than those of lokfao and kope, about 11,390 grains making one kilo, and are markedly longer than broad, and obversely semi-pyriform in shape. All are striated and have a thin hull, easily broken by pressure between the fingers. As with the lokfao the kernels are entirely free from the enveloping membranous coverings and the hull.

To the extreme ~~right~~ Left of Plate XXIII are shown the grains and kernels of two unnamed varieties of adlay from Bukidnon, Mindanao. One with a creamy white hull, the other between drab and cinnamon-drab (Ridgway). Coloring excepted the grains of these two varieties have in common the general form of the grain, the thin, brittle, striated hull, which also is easily crushed by a slight pressure between the fingers, and the loose kernel encased in its thin, membranous covering. The grains of these varieties are smaller than in any other varieties noted in the Philippines, from 12,060 to 15,640 grains to the kilo. As a matter of fact there are several gradations in color between the two kinds shown on the plate, and the Bukidnons recognize 6 different variety names of adlay, some of which may be synonymous.

The Bukidnon adlay, hulled and cleaned, can be boiled and eaten like rice, to which it is quite equal in palatability. Without the proper machinery the writer has been unable to make a milling test for flour and bread making.

The writer has not seen growing plants of the adlay varieties grown in Cotabato and in the Mountain Province, but the Bukidnon forms are very vigorous and attain a height of 2 to more than 2.5 meters under favorable conditions. One plant will make from 2 to 4 straws, sometimes 5. The roots are shallow and rarely extend beyond 35 to 40 centimeters from the plant. (Plate XXII).

In the branching of the straws and in the construction of the panicle as affecting the productiveness the individual plants display remarkable diversity, some yielding at least 4 to 5 times as much grain as other plants. See Plates XXIV, XXV, XXVI, showing the existing great opportunities for improvement in the yield by the plant breeder.

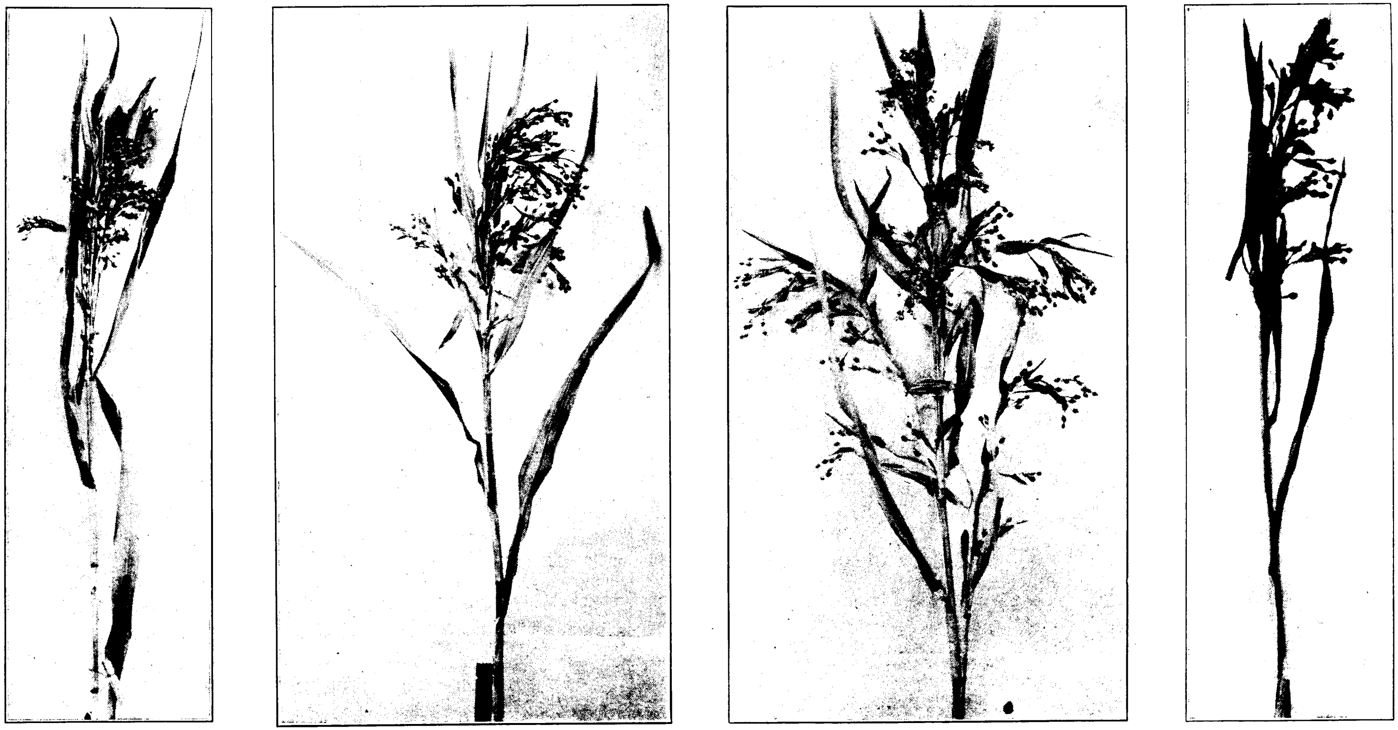
Considering the lack of information relative to the yield of adlay the following notes may be of interest.

In 1918 a small plot, 5 x 6 meters, of adlay was grown by the writer in Zamboanga from seed obtained in Bukidnon. This was sown in the early part of July and harvested about New Year. After an allowance of 10 per cent was made for possible errors due to the small area the yield of grain harvested was calculated at the rate of 3,625 kilos to the hectare of which 2,610 kilos was hulled, clean grain, or 72 per cent of the total weight.

This yield seems remarkably high but Mr. J. E. McCall, industrial supervisor, Bureau of Education, who has grown adlay at the farm schools in Cotabato, claims to have obtained still greater yields of grain. In 1919, 257 square meters were planted to Bukidnon adlay at the Lamao Experiment Station. This plot yielded at the rate of 1,634 kilos of grain and 4,319 kilos air dried straw to the hectare. This low yield is, however, believed to be due to the fact that the seed was not sown until the first days of August, and then in a seedbed from which the seedlings were transplanted to the field in September.

The writer has seen no published statements as to the yield of adlay with which the above figures can be compared, but the figures quoted by Watt show that the proportion of waste in hulling the grain is about the same here as in India.

The analysis of adlay from Bukidnon made by the Bureau of Science is shown in the following table, which for comparison also shows the analysis of various grains and pulses.



ADLAY PANICLES, ILLUSTRATING VARIABILITY IN CONSTRUCTION AND YIELD.

ADLAY PANICLES, ILLUSTRATING VARIABILITY IN CONSTRUCTION AND YIELD.

ADLAY PANICLES, ILLUSTRATING VARIABILITY IN CONSTRUCTION AND YIELD.

Analysis of adlay and various other cereals and legumes.

Samples	Moisture	Protein	Fat	Ash	Crude fiber	Carbohydrates, starch etc. by difference
	Per cent	*Per cent*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent*
Edible adlay (whole grain)	10.02	8.23	8.87	8.94	14.08	49.86
Hulled adlay	10.91	11.27	6.65	1.89	0.45	68.83
Wheat	10.62	12.23	1.75	1.81	2.36	71.18
Corn	10.93	9.88	4.17	1.36	1.71	71.95
Oats	10.06	12.15	4.33	3.46	12.07	58.75
Rice	11.88	8.02	1.96	1.15	0.93	76.05
Millet	11.66	9.25	3.50	2.35	7.29	65.95
Mongo	9.21	18.30	0.88	4.23	4.89	62.49
Pea	12.40	20.68	1.31	2.88	4.21	58.52
Beans	15.25	19.63	1.72	3.29	3.54	46.57

Here it will be noted that hulled, the state in which the grain is eaten, the Bukidnon form closely approximates wheat in starch and protein content, which cereal it exceeds in fat. With a greater protein and fat content than either rice and corn it is a more complete human food than either of these cereals.

For comparison with the Philippine adlay the following analysis of hulled adlay grown in India quoted in Dictionary of Economic Products of India is of interest:

	Per cent.
Moisture	13.2
Albumen	18.7
Starch	58.3
Oil	5.2
Fiber	1.5
Ash	2.1

Like corn, *Zea mays* L., adlay is monoecious, or the stamens and pistils are borne in different flowers on the same plant. Like corn adlay is therefore easily cross-pollinated, and the precautions used in breeding pure strains of corn are equally applicable in breeding work with adlay. In other words, two or more varieties cannot be grown side by side in the same field without becoming hybridized.

Adlay does the best on a rather friable, loose to loamy, fairly rich soil, and should not be planted on heavy, clayey lands. According to the observations made in the Philippines it grows well from sea level up to an elevation of at least 1,000 meters. In India it is grown up to an altitude of 1,500 meters. The plant requires a moderate rainfall during the growing period but heavy rains do not injure it provided the land has good drainage.

From preliminary experiments with adlay at Zamboanga and at Lamao it would appear that in field culture adlay should be sown in June and July to early in August, or so that the plants have the benefit of the rainy season, and can be harvested during the dry period. Four to five seeds should be planted to the hill, the hills 40 to 60 centimeters apart, in rows 70 to 80 centimeters apart. If the seed is poor more seeds should be dropped in the hill.

After the seeds have germinated the field should be cultivated and hoed like corn. Thereafter, as the plants develop they rapidly shade the ground and assist in choking the weeds rendering further cultivation unnecessary.

When the grain is ripe the stalks should be cut from 60 to 75 centimeters from the top, tied in bundles and dried, and subsequently threshed and cleaned like other grains.

The tender plants of adlay make a good forage for cattle and horses, and grown for this purpose several cuttings can be obtained from a sowing. The seed should then be drilled in rows and not sown in hills as when the plant is grown for the grain.

In a broad sense adlay cannot, of course, hope to supplant rice and corn in the dietary of the people in the Archipelago, but it might well be used to supplant these grains, partly as a human food, partly as a stock feed and for poultry. Considering its reputed breadmaking qualities the possibilities of native grown adlay as a wheat substitute is worthy of careful study, for our wheat flour imports have steadily increased until in 1919 with ₱8,929,116 the value of the wheat flour imports exceeded the imports of rice which amounted to ₱8,817,362.

In the light of our present knowledge concerning the plant, adlay cannot yet be recommended for general planting; but because of its high and well balanced food value, its cultural adaptability to a wide region of the Philippines and the many and varied uses to which the grain may be put, and its apparent productiveness which, it is true, requires verification, adlay deserves a thorough investigation.

THE BREADFRUIT [1]

By P. J. WESTER, *Agricultural Advisor*

It is a paradoxical fact that considering its potential value as an abundant producer of a nourishing, wholesome and palatable food, there is no tropical fruit today so neglected and of so little actual importance as the breadfruit.

This statement, (always speaking of the seedless variety) applies to the tropics at large so to speak, not the Philippines alone, barring the Marquesas and the Society Islands and other Polynesian Archipelagos where the breadfruit has been the staff of life of the once numerous populations.

The breadfruit, *Artocarpus communis* L. (Plate XXVII) is a handsome tree up to about 18 meters high in the wild, seedy species, and is a native of Polynesia. The cultivated, seedless form here discussed, rarely growing more than 15 meters high in the Philippines, originated in one of the Polynesian archipelagos, whence it has spread to a large part of the tropics elsewhere. The leaves are large, dark green and deeply incised. The male and female flowers grow in separate receptacles on the same tree. The fruits, (Plate XXVIII–*b*) growing one to two and sometimes three together near the end of the branches, are large, subrotund to short-oblong, sometimes exceeding 18 centimeters in length and 2 kilos weight, somewhat irregular in shape; the surface a series of flat and broad tubercular projections.

The tree is hardy, of rapid and robust growth, it comes early into bearing and produces an abundance of fruit over many months of the year. While the tree does the best with a rainfall of fairly equal distribution it is quite tolerant of short, dry periods, and it flourishes under irrigation in lieu of natural rainfall. The actual fruit production per unit area of this fruit seems never to have been ascertained,—perhaps because there is probably nowhere an acre of breadfruit trees planted

[1] In the Philippines the seedless breadfruit is known as Rima. The seedy form which is of prehistoric introduction, long ago escaped from cultivation and is variously known under the names Antipolo, Anublin, Kamasi, Pa-a. Paakak. and Tipolo.

in a solid orchard,—but it must be large, considering the fruitfulness of the tree, and it probably equals and even excels in yield many of the banana varieties cultivated in this Archipelago. Considering the composition of the fruits we find that the breadfruit is nearest comparable to the banana. Only the nuts have a greater food value.

In the immature stage the fruit is green and the flesh white and somewhat spongy and fibrous. Raw it is inedible, but sliced, boiled or baked, in eating qualities it recalls a sweet potato in texture, and makes a wholesome, starchy, palatable vegetable for the table as a substitute for potatoes, sweet potatoes or other starchy vegetables.

In "Useful Plants of Guam," Safford states that in that island "a kind of biscuit is made by slicing the fruit into moderately thin sections after having cooked it, and drying the slices either in the sun or in ovens. Thus prepared it will last from one breadfruit season to another. The dried slices may be eaten either as they are or toasted, or ground up and cooked in various ways."

When the fruit matures surface and flesh both turn yellow and the fruit exhales a sweet, rich aroma. On ripening the flesh becomes soft and sweet and is somewhat fibrous raw, but may be eaten with relish, though most Europeans would probably consider it too sweet and aromatic. Cut into slices 3 to 4 centimeters thick and baked in an oven, the ripe breadfruit makes an excellent dessert eaten alone or with cream, and still retains to some extent the characteristic rich aroma of the ripe, fresh breadfruit. It always makes a good preserve.

In the Marquesas and other Polynesian archipelagoes where the breadfruit is the *pièce de resistance* in the dietary of the people the fruit is thrown into pits in the ground, where it ferments, and is then made into cakes and baked, when it is said to make a palatable, wholesome food.

The high food value of the breadfruit may be surmised from the analysis in the following table adapted from the "Report of the Hawaii Agricultural Experiment Station, 1914." For comparison analyses of the banana, mango, and duhat, other popular fruits in the Philippines, are also quoted from Philippine Journal of Science, Vol. VIII, No. I, Sec. A, p. 76, 1913.

The difference in the sugar starch content in the two breadfruits is unquestionably largely due to their state of maturity when analyzed, the Samoan being the more mature.

A BREADFRUIT TREE 5 YEARS AFTER PLANTING IN THE FIELD. SET OUT IN 1915 IT BEGAN TO BEAR IN 1918, AND CARRIED GOOD CROPS IN 1919 AND 1920. LAMAO EXPERIMENT STATION.

Fruit	Edible portion	Total solids	Edible portion						
			Ash	Acid as sulfuric	Protein	Sugar	Fat	Fiber	Carbohydrates other than sugar
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Breadfruit, Hawaiian	77.75	41.82	.952	.049	1.575	9.49	.190	1.204	27.89
Breadfruit, Samoan	83.44	26.89	1.152	.078	1.575	14.60	.517	.978	9.21
Banana, Chinese	70.00	21.28	.995	.245	1.788	16.66	.180	.253	
Mango, Carabao	73.00	17.02	.450	.140	.220	13.24			
Duhat	57.50	15.63	.287	.838	.619	12.99	.524	.164	
Lanzon	80.00	19.90	.590	.770	1.130	13.42			

It has been stated that in the South Sea Archipelagoes the breadfruit attains an excellence that is not equalled elsewhere but this statement is probably subject to revision. The excellent quality of the fruit reported especially from the Marquesas Islands may be due to the excellent varieties reported to grow there which, strange to say, no one has attempted to introduce into other parts of the tropics. Then again, with a better knowledge of the fruit and its preparation than in other lands the people there probably know better how to bring out it gustatory qualities. Be this as it may, the writer has eaten breadfruit in many places and prepared in several different ways, but he failed to fully. appreciate its full value until he had an opportunity to sample fruit ripened on the tree. There is no question but that much if not most of the inappreciation of the fruit by the Europeans is due to the fact that they have only eaten partly mature fruit (and then perhaps improperly prepared) for the fruit must be thoroughly ripe on the tree to be at its best.

The lack of interest in this unique and useful fruit and the absence of more than scattered trees in all countries but its native home is chiefly traceable to the indifference evidenced to the fruit by the European in the tropics, who all too often unjustly and to his own detriment views with disdain the new and strange eatables in his temporary home. The native dweller of whatever tropical country he may live probably would like to plant a few more breadfruit trees, did he know how to get them, but since the fruit contains no seeds and young plants grow very seldom from the roots of the old few young trees are planted.

The observation of the formation of adventitious buds on injured roots of the breadfruit tree led the writer to conduct a series of experiments with root cuttings in 1913, during which it was found that properly handled and made at the right time the rooting of cuttings was a very simple matter. Directions how to proceed were subsequently published, but various correspondents who have tried the method have failed to obtain good results, hence it has seemed desirable to again discuss the subject more in detail.

The cuttings are here inserted from the latter part of May through June to July which at Lamao marks the close of a long, dry season and the beginning of the rainy period. With proper treatment up to 80 per cent of the cuttings made during this period will make healthy plants, but made at any other time of the year very few cuttings will grow.

The successful rooting of the cuttings at the time indicated is probably due to the fact that during the prolonged dry season and the consequent cessation of growth of the tree much of the sap has gradually been withdrawn from the top and stored in the roots. They are supercharged with vitality, so to speak, at the end of the dry season. The elaboration of the stored and concentrated juices of the plant which is stimulated by the absorption of moisture from the rooting medium then gives rise to the adventive budding of the roots.

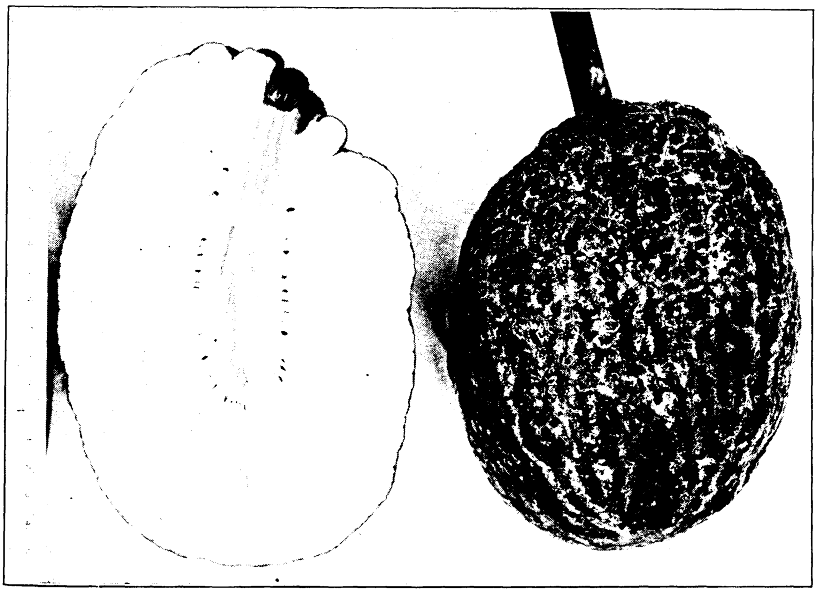
If this explanation of the rooting and adventitious budding of the roots is correct, it follows that in other parts of the tropics the cuttings should be inserted at the end of the dry period notwithstanding when it occurs during the calendar year.[1]

In nursery practice it has been found best to dig out the soil in a plant bed to a depth of 20 centimeters, and fill it with clean, sharp, medium coarse sand. A sandy loam may be used but this is less satisfactory. The sand should be leveled, saturated with water and tamped down as hard as possible. The roots of the tree are then dug up carefully so as not to injure them. They should not be allowed to become dry while they are exposed in the air and should not be allowed to lie exposed to the sun.

At the point of severance from the tree the roots should not be more than six centimeters in diameter, especially if several roots are dug, and it is a better practice to use many of the smaller roots for cuttings than to cut one or two large ones near

[1] Repeated attempts to shield bud the breadfruit on seedlings of the same species all have proved abortive. Cleft and crown grafting has never been tried by the writer but ought to be experimented with, because if successful it would be a convenient means of propagating the seedless form rapidly.

(*a*) DETAIL OF A BREADFRUIT TREE IN BEARING.



(*b*) THE SEEDLESS BREADFRUIT.

the trunk of the tree. The small wounds are more quickly healed and there is less danger of the tree being uprooted by typhoons. The stump of the root should always be cut smooth and the wound carefully painted with coal tar before it is again covered with soil to prevent decay and entrance of termites. So many roots should not be removed from a tree that it is severely injured.

The entire length of the root, even to portions no thicker than a lead pencil, may be made into cuttings. Still smaller roots than that have been rooted at Lamao but the plants are not so vigorous as those grown from bigger cuttings.

The roots should be sawed off into cuttings 20 to 25 centimeters long and the wounds trimmed smooth with a sharp knife. While not imperative it is a good practice to paint the wound on the *thickest end of the cutting* with coal tar or white lead. Then a trench should be made in the sand bed and the

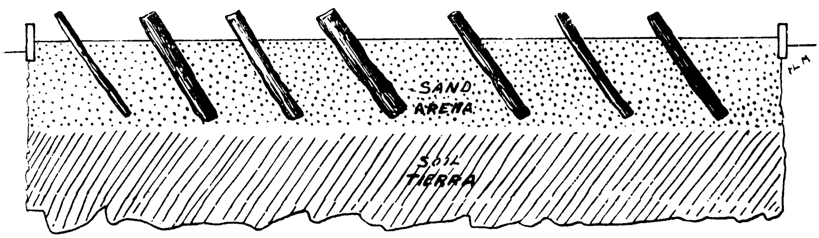


FIG. 1. Root cuttings of the seedless breadfruit inserted in the propagating bed

cuttings inserted diagonally, as shown in fig. 1, so that the thickest end of the cutting is from three to at most six centimeters above the surface of the bed. It is best not to place the cuttings closer than 12 centimeters apart in the row, or the rows less than 25 centimeters apart, so as to avoid injury to the rooted cuttings when they are removed from the cutting bed. The trench should be made large enough so that the cuttings can be inserted without injury. They should never be bruised by pushing or forcing them down into the sand.

The sand should be packed as hard as possible about the cuttings and the bed well watered. If this has not already been done a bamboo shed should finally be erected above the cuttings to protect them from excessive sunlight.

After the cuttings are inserted the sand should not be kept saturated by daily applications of water, for then the sand frequently sours and the tiny roots rot off as they appear. The watering should not be repeated until the sand is dry, say once in 5 to 7 days. On the other hand it is beneficial to spray the cuttings with water twice or thrice, just enough to wet them, during the hot, dry days before the rains appear. Or to spread damp sacking over the cuttings during the hot part of the day, always removing it at night. This is, of course, not necessary when the rains begin to fall and the atmosphere is moister.

The sprouting of the cuttings is sometimes very irregular. Occasional cuttings will be ready for removal from the cutting bed in the course of two months after insertion, while other barely sprout in five months. The majority will be large enough for removal and transplanting to the nursery or into bamboo tubes or baskets at the age of seven to eight months, and with good care the plants are usually large enough for transplanting into the field six to seven months later.

When transplanting is performed about three-fourths of the leaves should be cut off in order to reduce excessive transpiration of water from the plants, which should not be set out deeper than they grew in the nursery.

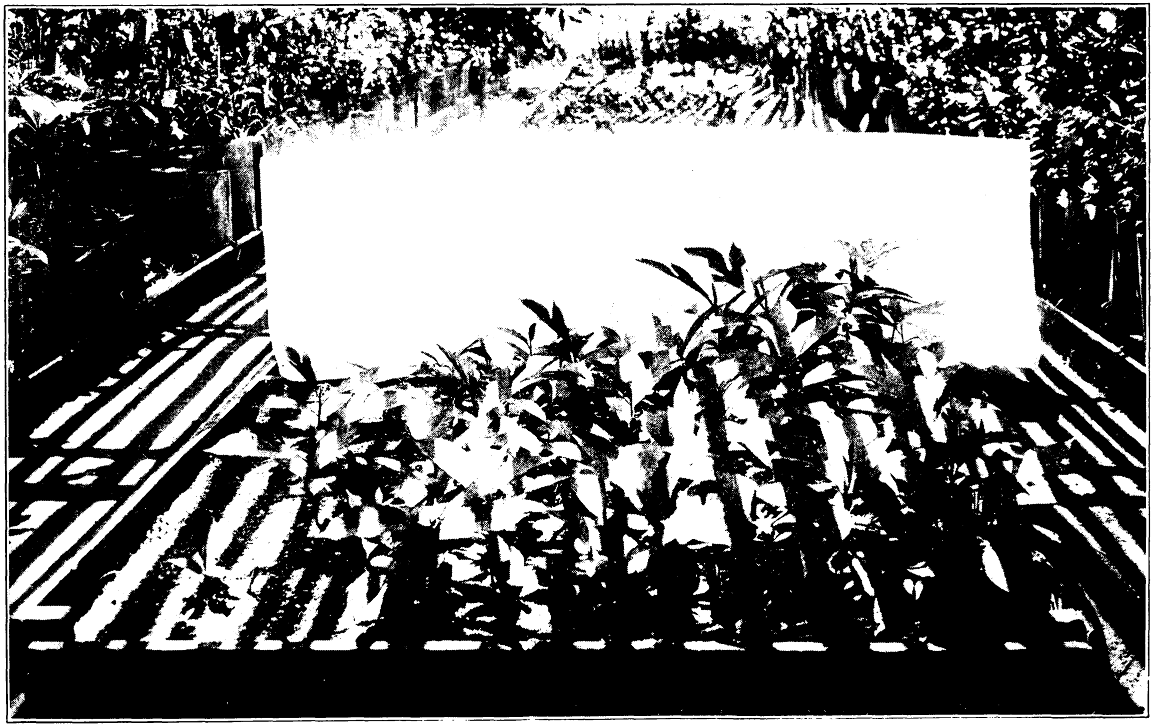
In the orchard the breadfruit should be spaced from 10 to 14 meters apart depending upon the fertility of the soil and the abundance and distribution of the rainfall.

With a thought of the pecan and other nuts which are becoming so extensively grown in the United States, some one there has said that "tree farming is the farming of the future." This is a thought of no little significance for the Philippines, indeed, for any land where the breadfruit can be grown.

Rice and corn, the two great staple foods of the Philippines, are subject to attacks of locusts, and destruction by floods, and depending upon natural rainfall the abundance of the rice harvest is annually governed by uncontrollable forces, oftener being short than normal.

It is not claimed that the planting of breadfruit would be a "cure-all" for our annually recurring food shortage, in many parts of the islands actual famine, but it is undeniable that if every farmstead had a dozen or more well cared for breadfruit trees, the fruit produced would go a long way towards warding off want and famine in times of scarcity of other food. And the space occupied and the care required to bring the trees into fruiting and subsequently to maintain them in good bearing condition would be very slight. The trees would remain unaffected by locusts and other plant pests and even in the regions where the dry season is exceptionally long, if they were properly mulched, they would require very little water. Over the greater part of the islands no irrigation whatever would be

ROOTED ROOT CUTTINGS OF THE BREADFRUIT, READY FOR TRANSPLANTING FROM THE CUTTING BED TO THE NURSERY.



BED OF ROOTED ROOT CUTTINGS OF THE BREADFRUIT. LAMAO EXPERIMENT STATION.

required. For all the above reasons the extended planting of breadfruit trees is strongly recommended. And—

The great world powers with tropical possessions—the United States, France and England—have numerous war craft constantly cruising the oceans for training purposes. Could it not be arranged, when one of these vessels is dispatched on a cruise in the South Seas, to have on board a trained agricultural explorer familiar with the breadfruit to bring from that remote region to the other parts of the tropics the superior breadfruit varieties growing in the South Sea Archipelagoes, which, since the native populations are fast dwindling away, may otherwise soon be lost to civilization forever? Again, it would be a benevolent enterprise that should appeal to the imagination of some philanthropist intent on serving his fellowmen.

It would appear that here is a unique opportunity for some one in authority or for some one with the means to do so, to perform a service to mankind of far-reaching value combined with no little romantic interest.

CURRENT NOTES—THIRD QUARTER

By F. G. GALANG

Supervising Inspector of Horticultural Stations

VEGETATIVE PROPAGATION OF FRUIT TREES AT THE LAMAO HORTICULTURAL STATION

Vegetative propagation to improve the fruit trees is one of the phases of work at Lamao Experiment Station, Lamao, Bataan. The results have been published from time to time in the Bureau of Agriculture publications. During the last few months the following species have been successfully shield budded: Pakurinu, P. I., No. 2739; Bitungol, *Flacourtia sepiaria; Flacourtia sepiaria* on Serali, *Flacourtia ramontchi; Ficus sycomorus;* Baniti, *Garcinia dulcis;* Pangao, *Sterculia oblongata;* Sansapote, *Licania platypus;* Lamuta, *Cynometra caultiflora;* Talisay, *Terminalia catappa* on Dalinsi, *Terminalia edulis;* Arahis, unidentified sp.

Directions for the above-mentioned species:

Pacurinu.—Use either petioled or nonpetioled light brown to greenish and mature budwood; cut the bud 3½ to 4 centimeters long; age of stock at point of insertion of bud should be similar in appearance to that of the scion.

Bitungol, *Flacourtia sepiaria.*—Use petioled, brownish and mature budwood; cut the bud 3 to 5 centimeters long; age of stock is unimportant.

Flacourtia sapida on Serali, *F. ramontchi.*—Use nonpetioled, turning to brownish in color and quite mature budwood; cut the bud 3 to 3½ centimeters long; point of insertion in the stock should be the same age and appearance as that of the scion.

Ficus sycomorus.—Use petioled, green and young budwood; cut the bud 3 to 4 centimeters long, age of stock is unimportant.

Baniti, *Garcinia dulcis.*—Use nonpetioled, greenish and quite mature budwood; cut the bud 4 to 5 centimeters long; the stock should be similar in age and appearance as that of the scion.

Pangao, *Sterculia oblongata.*—Use nonpetioled and green budwood; cut the bud 4 to 5 centimeters long; age of stock at the point of insertion is unimportant.

Sansapote, *Licania platypus*.—Use nonpetioled, russet and mature budwood; cut the bud 3½ to 4 centimeters long; age of stock at the point of insertion is unimportant.

Lamuta, *Cynometra cauliflora*.—Use nonpetioled, brownish and mature budwood; cut the bud 3 to 3½ centimeters long; the stock should be the same age and appearance as the scion.

Talisay, *Terminalia catappa* on Dalinsi, *T. edulis*.—Use nonpetioled, green and quite mature budwood; cut the bud 4 to 5 centimeters long; age of stock at the point of insertion is unimportant.

Arahis, *Eugenia* sp.—Use nonpetioled, greenish and quite mature budwood; cut the bud 3 to 3½ centimeters long; stock should be the same age and appearance as that the scion.

Cleft or top grafting have been successfully done on the following: Mango, *Mangifera indica;* Ciruela, *Spondias purpurea* on Lanno, *Spondias pinnata;* Yambo, *Eugenia jambos* on Duhat, *E. jambolana;* Chicomamey, *Lucuma mammosa;* Atemoya, *Anona hybrid* on Custardapple, *A. reticulata;* Soncoya, *A. purpurea,* on Custardapple, *A. reticulata; Biriba, Rollinia orthopetala* on Custardapple, *A. reticulata;* Santol, *Sandoricum koetjape;* Genipa, *Genipa americana;* and Pitanga, *Eugenia uniflora.* Following the ordinary procedure of cleft or top grafting, only select same size of stock as that of the scion to be inserted in most cases, with the exception of Anonas, where the stock used can be even larger than the scion.

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All communications should be addressed to the Director of Agriculture, Manila, P. I.

Typical view of the highland plains in Bukidnon

THE PHILIPPINE

Agricultural Review

VOL. XIII FOURTH QUARTER, 1920 No. 4

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BUKIDNON: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

Bukidnon (Plate II) is an inland province in the Island of Mindanao, bounded on the north by Misamis, on the east by the provinces of Agusan and Davao, on the south by Cotabato and on the west by Cotabato, Lanao, and Misamis, between 124° and 126° 30′ east longitude, and 7° to 9° north latitude. It has an area of 3,871 square miles and 45,000 inhabitants. In other words it is larger than the States of Rhode Island and Delaware combined.

The boundary of Bukidnon has been changed from time to time, and as now constituted in the east it follows a chain of mountains, as is also true of most of the Lanao-Bukidnon boundary. In the north the border line has been somewhat arbitrarily fixed along a line supposed to separate the Christian Filipinos from the Non-Christian people in the highlands of that part of Mindanao, in the south to separate the Bukidnons from the Cotabato Moros.

The present boundaries of Bukidnon, like all provincial boundary lines in Mindanao, have been drawn with a view of dividing the territory into provincial units that have common interests of communication, intercourse and population, that can be easily reached from the provincial capital and hence can be administered to the best advantage.

According to a table recently prepared by the Bureau of Forestry, Manila, about 45 per cent of the area of Bukidnon,

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[1] The writer takes pleasure in acknowledging his indebtedness to Col. Ole Waloe, Philippine Constabulary, for access to the Constabulary Monograph of Bukidnon in preparing the present article. Plate II has been traced from a map furnished by Mr. H. E. Neibert, supervising surveyor, Bureau of Lands, and Plates III (*b*), IV, V, VI, and VII have been made from negatives owned by the Bureau of Science, Manila. Plate VIII has been made from a map furnished by the U. S. Coast and Geodetic Survey, Manila.

or 454,980 hectares, still remains commercial forest. There are 287,123 hectares, or 28.6 per cent of the land in prairie or cogon, *Imperata cylindrica;* only 2.2 per cent, or 21,660 hectares are in cultivation; 20.5 per cent, or 206,000 hectares is still unexplored territory.

Topographically Bukidnon is a plateau land with vast, level, more or less rolling plains out of which rise several mountains with peaks here and there attaining an elevation of 1,500 meters or more, lying between a chain of forested mountains in the east and another in the west along the northern part of the Lanao border. While on the mountain slopes the tillable land frequently exceeds this elevation, the crest of the undulating plains is reached at Dalauangan at an elevation of 915 meters, whence there is a general downward slope to Misamis Province in the north and to Cotabato in the south. The plains are intersected by several large canyons of which the Kulaman canyon south of Maluko is the largest. Ravines with rivers or streams of abundant cold, clear water are numerous.

All the rivers in Bukidnon are too small or their descent is too rapid to permit navigation. The largest is the Pulangi or Cotabato River, rising in a small lake on Mt. Gimankil in the northeastern corner of the province, which together with its numerous tributaries, drains the eastern central and southern part of Bukidnon and enters Cotabato at Balatukan. (Plate III *b*). The Cagayan River originates on Mt. Kitanglad and drains the northwestern part of Bukidnon emptying at Cagayan.

The Tagoloan River drains north-central Bukidnon, flowing into Makahalar Bay at Tagoloan. The numerous falls and rapids in the province have a sufficiently ample volume of water to permit the construction of many hydro-electric plants for industrial and transportation purposes.

Mt. Kitanglad, in about the center of Bukidnon, rising to an elevation of 3,000 meters, and Mt. Kalatungan to the southwest of Kitanglad, perhaps 2,000 meters high, are the most prominent mountains. The rise of both these mountains is so gradual that the greater part of their slopes can be used for agricultural purposes. When transportation costs and the difficulties of approach are considered, were Cinchona culture in the Philippines on a large scale to be seriously contemplated, it seems not only possible but even probable that the higher slopes of Kitanglad and Kalatungan might be found preferable for this crop to the vastly more inaccessible country in the interior of the Mountain Province in Northern Luzon.

Oversized Foldout

Considering the topographical features of Bukidnon in relation to its accessibility and the routes of travel from the coast to the interior, Bukidnon may be divided into three districts.

1. The Claveria or northeast district including the territory north of Silo-o, Malitbog and Santa Inez;

2. Central and south Bukidnon, including the country south of the mountain chain extending from Mt. Taga to Santa Inez west of Agusan River and east and south of the agglomerations of mountains about Kalatungan and Kitanglad;

3. The Talakag or western district, between the mountains just mentioned and the provinces of Lanao and Misamis.

The Claveria district is reached by horse trails from Tagoloan in the south, and further north by trails which penetrate from the coast to the interior, where they are linked up by a trail running north and south throughout the district. The eastern part of this district is a heavily forested, unexplored mountain country. The western part along the Misamis border is a rolling plain overgrown with cogon, extending from north to south along the Misamis border. The average elevation of the agricultural country of this district is said to be about 600 meters.

Central Bukidnon is connected with Cagayan through Agusan, Tankulan, Maluko, Impasugong, Malaybalay and Mailag to Valencia by a road passable for autos, which could at slight cost be extended a considerable distance farther south at least to Miuban. A first class road is under construction from Cagayan to Maluko, which has been completed from the coast almost to the boundary line between Misamis and Bukidnon. The remainder of the road is still unsurfaced but nevertheless is in very good condition except during heavy rains. The Kulaman canyon has not been bridged and must be crossed on horseback, after which the journey may be resumed by auto.

Traveling from the coast to the interior (Plate III *a*) there is a rather abrupt ascent to the first plain, which is about 230 meters above sea level. This plain, as one proceeds, rising slowly to an elevation of 375 meters, has a poor, sandy, gravelly and stony soil with numerous boulders scattered over the surface. The vegetation is a thin, short grass with here and there scrubby trees. Unfit for agricultural crops, this plain, however, could be used for grazing purposes though much inferior to the plains to the south in this respect also. At the southern end of this plain there is again a rise to a second table-land from 480 to 510 meters above sea level about Diklum, at Lindaban rising to approximately 1,035 meters above the sea. To Dalirig and Maluko, at 410 meters altitude, there is a slow descent. Then, south of the Kulaman canyon spread the wide, open prairie plateaus to the south and southwest, extending westward beyond Sumilao, which has an elevation of 730 meters, rising slowly to 755 meters at Impolutao and to 915 meters at Dalauangan, from which the plains again fall away toward the south. Kalasungay registers an altitude of 690 and Malaybalay, the capital of Bukidnon, 620 meters. From Malaybalay there is a steady descent southward, with 420 meters at Bogkaon, 325 meters at Mailag, 300 meters at Valencia and 240 meters at Dologon. South of Dologon there is again a slight rise to an average of about 300 meters, until the land again slowly slopes down and southward to merge with the grassy plains in the Cotabato Valley. Though there are exceptional areas here and there, generally speaking the land becomes more fertile as one travels southward. The vegetation on the plains consists of various grasses. While it is present, cogon, *Imperata cylindrica,* is not, as a rule, common on the plains north of Dalauangan. Not before one arrives south of Malaybalay does it begin to show more than the most ordinary vigor.

The fertile country about Linabo to Bogkaon gives way to poorer land in Mailag, whence extends a billowy plain to Lurugan some 450 meters high above the sea. Then more pronounced hills covered with heavy cogon and secondary forest until one arrives in Giniyuran at 630 meters altitude. Finally, passing through the outskirts of the virgin forest one comes out on another cogonal valley at Dagumbaan. Northwest of this place lies a wide belt of virgin forest. In the southwest, as the Bukidnon country merges into Lanao and Cotabato the land is again mostly open. Again, the southern boundary of Bukidnon passes through a big, virgin forest extending into northeastern Cotabato.

The Talakag district includes the northwestern part of Bukidnon between Lanao and Misamis, Mt. Kalatungan and Mt. Kitanglad, and the mountain chain extending from the latter mountain to Kiliog, and is reached from the coast by a road extending from Cagayan to Talakag and Tikalaan, almost due south. The valley is drained by the Cagayan River and its tributaries and is said to have an elevation of approximately 350 meters above sea level. The mountain chains in the west and northwest, along the Misamis and Lanao border, are covered by a commercial forest which descends even to the lower slopes and in the south extends to Mt. Kalatungan and Mt. Kitanglad.

(*a*) View on the road from the coast to Central Bukidnon. Makahalar Bay in the distance

(*b*) Falls of the Pulangi (Cotabato) River, near Maramag, Bukidnon

The remainder of the district is a vast, rolling grass-covered plain not greatly differing in chracteristics from the central Bukidnon prairies.

On the whole the Talakag district is, perhaps, the most fertile part of Bukidnon.

The Bukidnon country everywhere is expressive of bigness and of latent undeveloped resources but nowhere is the scenery so impressively magnificent as in the open, wide-flung, verdant plains on the road from Malaybalay to Mailag, which must be seen in order to be appreciated. In many other provinces the soil is richer and the vegetation is more luxuriant, and they possess other advantages, such as convenient transportation; but nowhere else as here does the Philippines seize upon one's imagination and impress one's senses with their enormous latent wealth; their tremendous opportunities for economic development.

In scenic beauty the approach to Dansalan from Iligan is markedly superior to the ascent to Bukidnon, and Lake Lanao is, of course, an added attraction, but as a health resort for Mindanao and Visayas, Bukidnon is vastly preferable because of its drier climate. The higher elevations are also somewhat more accessible than in Lanao. Everything taken into consideration the upper slopes of Mt. Kitanglad and Mt. Kalatungan are, perhaps, more suitable for a health resort than any other locality in Mindanao.

Except for small patches of abaca, rice, corn and various other food crops and some pasturage, the land is still unoccupied and open for settlement.

Game, in the form of deer, wild hogs, ducks and pigeons is abundant.

CLIMATE AND SOIL

Due to the elevation the climate of Bukidnon is cool, bracing and exceedingly agreeable, especially in the higher altitudes, and as a rule a gentle breeze over the plains during the day adds still more to one's feeling of comfort.

Rainfall records are unfortunately entirely lacking in Bukidnon, but the precipitation is said to be well distributed throughout the year, the driest period occurring from January to May. The verdant plains which greet the eye of the traveler at all times of the year give credence to this statement.

Judging from the vegetation and such local information as it has been possible to obtain, the annual rainfall on the plains of Bukidnon probably approximates 1,800 millimeters annually, while on the higher mountain slopes it possibly exceeds 2,500 millimeters. Again, the volume of rainfall apparently increases as one goes southward, until at Maramag the annual precipitation is probably not less than 3,000 millimeters.

The soil varies from a poor, stony and gravelly soil near the Misamis border to a friable, rather thin loam or volcanic ash rather deficient in humus in Central Bukidnon to quite rich lands in the south of the province. The greater part of the land is rich enough to produce good crops, but everything considered, the open plains of Bukidnon are inferior in fertility to the lands in Lanao and Cotabato.

POPULATION

The population is divided among Bukidnons, Manobos, Moros, Visayans, and Caucasians. Of these the Bukidnons are the most numerous, constituting probably one-half of the population. They are intelligent and industrious and make good laborers, and live in organized settlements on the plains. In numerical strength the Manobos rank second in importance, but as a large part of them still lead a semi-nomadic life, they can not be considered a factor in the agricultural development of the province. The number of Moros, who live mostly in the southern and western part of Bukidnon, is small. The Visayans are few in number, and there are probably not more than a dozen white residents in the province.

AGRICULTURAL INDUSTRIES

Reliable production statistics are not available, but rice, abacá and coffee constitute the principal crops of Bukidnon.

The rice is exclusively upland and is grown on the plains. (Plate VI *a*.) On the average the soil in Bukidnon is thinner and poorer than in Lanao and Cotabato, and the yield is not equal to that in these provinces, but it is undeniable that very large quantities of rice and corn and legumes could be grown on the vast highland plains of Bukidnon also, sufficient to sustain a large local population and yet leave a large surplus for export. The prospects for lowland rice are less favorable.

Very little corn and legumes are planted.

As in Cotabato, adlay, *Coix lacryma-jobi* L., is cultivated for its edible grain but, of course, on a very small scale, though it does well and is very productive. (Plate IV *b*.) It is by no means impossible that this may be found to be a profitable grain here. Wheat might be grown, though the yield would probably not be very heavy.

(*a*) Upland rice at Linabo, Bukidnon

(*b*) Adlay, *Coix lacryma-jobi*, near Malaybalay, Bukidnon

Camotes and cassava are the most extensively planted root-crops, though gabi is grown to some extent. Abaca is grown mostly in the canyons between the plains in the southeast towards Davao, and in the Talakag district. Coffee raising is mostly confined to the settlements on the mountain slopes and grown on a very small scale. (Plate V.) Few vegetables are planted but all temperate and most tropical ones thrive well under proper care. Excellent oranges and limes are found in some localities, such as Sumilao.

Bukidnon is very rich in varieties of many of the food crops cultivated in the Philippines as shown in the following lists, though it should be kept in mind that many varieties are undoubtedly synonymous. It should perhaps be stated that the characters relative to the rice varieties are quoted from the statements by farmers and not from personal examination.

RICE VARIETIES

Along-along	u-ng-c.[1]	Dinauahan	u-ng-w.
Anamag	u-gl-w.	Domorao	u-ng-w.
Anibong	u-ng-c.	Dumaliray	u-ng-w.
Bab-bag	u-gl-w.	Dumagat	u-gl-w.
Bagyauana	u-gl-w.	Dumarok	u-gl-w.
Balanakan	u-gl-w.	Dumpas	u-gl-w.
Balisa	u-gl-w.	Ginauahan	u-gl-w.
Bayako	u-gl-c.	Gumantong	u-gl-c.
Binagik-ik	u-ng-w.	Guyóron	u-ng-w.
Binagtok	u-ng-c.	Handakan	u-gl-w.
Binalagon	u-gl-w.	Hinampañgan	u-ng-w.
Binañga	u-gl-w.	Igok-Kabayo	u-ng-w.
Binayako	u-gl-w.	Imbayong	u-gl-w.
Botikol	u-ng-w.	Indalaui	u-gl-w.
Buaya	u-ng-w.	Inibid	u-gl-w.
Budya	u-gl-w.	Inokod	u-gl-w.
Bulan-bulan	u-gl-w.	Itom-itom	u-gl-c.
Bungbong	u-gl-w.	Kabilao	u-ng-c.
Dakain	u-gl-w.	Kagabon	u-ng-w.
Dalagaon	u-gl-w.	Kagayan	u-ng-c.
Dalaog	u-gl-w.	Kalamuray	u-gl-w.
Dalaui	u-ng-w.	Kalauag	u-ng-w.
Dalikit	u-gl-w.	Kalasauon	u-ng-w.
Dapog	u-gl-w.	Kalohitan	u-ng-w.
Dayuni	u-gl-w.	Kamaylan	u-gl-c.
Diglambuñgan	u-gl-w.	Kambiñgan	u-gl-w.
Digsambok	u-gl-w.	Kasiam	u-ng-w.
Digsaraan	u-ng-w.	Kilang-kilang	u-gl-c.

[1] The characters of the rice are abbreviated as follows:
u = upland.
ng = nonglutinous.
gl = glutinous.
w = white.
c = colored.

RICE VARIETIES—continued.

Kinalabao	u-gl-w.	Panamay	u-gl-w.
Kinalabao	u-gl-c.	Paraligon	u-gl-w.
Kinambayao	u-ng-c.	Patiyokan	u-ng-w.
Kinugitan	u-gl-w.	Payong	u-ng-w.
Komagingking	u-ng-c.	Pungko	u-gl-w.
Kotong	u-ng-c.	Puñgusan	u-ng-w.
Kumpunon	u-ng-w.	Salabak	u-gl-w.
Langkonan	u-ng-c.	Salag-sa-Simukon	u-gl-w.
Libangnon	u-ng-c.	Salaysay	u-gl-w.
Lunga-an-on	u-ng-c.	Salokangkang	u-ng-w.
Luntayon	u-gl-w.	Saloui	u-gl-w.
Luyot	u-gl-c.	Samod	u-gl-w.
Magdinata	u-gl-w.	Sayauan	u-gl-w.
Maguindanao	u-gl-w.	Singilan	u-gl-w.
Malaragao	u-gl-w.	Siniburan	u-gl-w.
Manilanon	u-ng-c.	Siliñgayon	u-ng-c.
Mandual	u-gl-w.	Solog	u-gl-w.
Manongbalay	u-ng-c.	Tabanon	u-gl-c.
Mata-taya-to	u-gl-w.	Tagasalog	u-gl-w.
Miyaray	u-gl-w.	Takilid	u-gl-c.
Molanbolan	u-ng-w.	Tambal	u-gl-c.
Muli	u-gl-w.	Tangkalo	u-gl-c.
Munot	u-gl-w.	Tikoloon	u-ng-c.
Padaligon	u-ng-w.	Tilugao	u-ng-w.
Pagyayoaua	u-gl-w.	Tomagostos	u-ng-c.
Palaynon	u-ng-w.	Tumpog	u-ng.

CORN VARIETIES

Alas-as
Bakolan
Balaguayon
Bilakbakan
Binagik-ik
Dali-an
Dumagat
Gisiñgon
Kalamboyas, syn. Kalauag
Kalamisan
Kalauag
Kaluban
Kalobong
Kayopi
Kolanog
Lagution, syn. Alas-as
Lagkutan
Lambusao
Madiyanas
Maguindanao
Makalukat
Milag
Minanok
Palikat
Polotan
Pusong
Sal-ayon
Sanahon
Sumablay
Tumbaga
Visaya

ADLAY VARIETIES

Binanisil
Bulangkay
Kalam-kalam
Kulangong
Tumalatay

SUGAR CANE VARIETIES

Abuon
Alim
Bagundak
Balagon
Balantinao
Balatukanon
Balokan-o-amo
Balosbos
Bongkalao
Bayakos
Binulauan
Binut-us
Kagumo
Kalana
Kuauo
Lala
Ligas
Liliñganyon
Liñgayon
Lun-agon
Malago

Arabian coffee in the third year. Sumilao, Bukidnon

Ceará rubber, *Manihot glaziovi.* Malaybalay, Bukidnon.

SUGAR CANE VARIETIES—continued.

Malantinao
Malok
Mamasao
Mañgak-hak, (very large)
Mantig
Minamaon
Sablay
Sagkod-maya
Sagkod-sa-piogo
Salabao
Sanglay
Sarañgan
Sibayan
Sinalagao
Sinibayon
Tol-an-o-manok
Tug-asan

CAMOTE VARIETIES

Asinan
Balaguayon
Balangkauitan
Balauang
Balidbiran
Balikuay
Balinbalin
Balugo
Bulakauan
Bulao
Bulog
Burakao
Butiga
Dauis
Domokot
Dumagat
Gauanhon
Gilang
Ginombayan
Inapag
Inglao
Kabali
Kalauag
Kalatin
Kaloayoban
Kamani
Kankong
Kanyag
Kapayas
Kapupo
Kaua-kaua
Kayomyoman
Kolongkot
Kulalong
Laga
Lampaco, syn. Lampanay
Lampanay
Lamputi
Langbayon
Langdañgag
Lantarosa
Linauagan
Lumabog
Makanyag
Malanao
Mandulis
Manuging
Miruga
Misamis
Mugsol
Palapag
Pas-ok
Pulutan
Sabat
Sig-id
Silipon
Siuron
Sugahak
Talapukon
Turay
Yuntukan

GABI VARIETIES

Bagikay
Bayako
Binagong
Binagyang
Binamban
Bo-ol-owak
Buñgutan
Busao
Gula
Haluban
Hapluson
Hug-al
Kahos-sa-ibid
Kalang-iyan
Kapakao
Kapaya
Kaual
Kilala
Kinahos
Kisol
Linamatik
Lumalag
Luyaua
Magioalo
Mañgad-o-Anlao
Murahik
Panabang
Papañga
Salayao
Salimbakon
Salindato
Salompikit
Ta-i-banglos
Tilong

UBI VARIETIES

Banag
Bangkoan
Bantugón
Binakusan
Binuaya
Bokadon
Gumuguba
Dalaigay
Hinal-o
Inampay
Kinalasag
Malinao
Palad-o-lako
Pulog
Tiyok

CASSAVA VARIETIES

Bingala
Europa
Inagoyan

BANANA VARIETIES

Aglogong	Duka	Minama-on
Agutay	Gumagatos	Mooy
Ampal	Inambak	Morado
Angao	Inusa	Mupong
Balakayo	Iuil	Paitan
Balañgan	Kala-ay	Pution
Bayumbuñgan	Kaol-kaol	Sab-a
Biakon	Kalugong	Sab-a-manila
Bikang	Kalugusan	Salombokotin
Binusaya	Kantong	Sulay-bagio
Bololan	Kaposa	Suyak
Dalhay	Kinampilan	Tadyaon
Daliao	Liliñgayon	Talip
Digpusuan	Lonsing	Taolan
Do-ol	Makabukog	Tindok
Dugkok	Maluko	Tulisok

The following wild mushrooms are collected and eaten:

Agpalad	Kahumay-humay	Lemdungan
Agsalayon	Katulay	Ligbos-sa-alaga
Bagsalan	Kauhong	Magao-sabao
Gigipan	Kauli	Mata-sa-adlao
Kahapon	Kaupas	Tangulog
Kasulum	Kulup	Valoy

Among these different kinds the Valoy is said to be the largest and the most valued.

The following wild and cultivated fruits have been noted in Bukidnon:

Aluao, *Euphoria nephelioides* Radlk.
Banago, *Gnetum gnemon* L.
Banana, *Musa paradisiaca* L.
Barobo, *Diplodiscus paniculatus* Turcz.
Bayante, *Aglaia harmsiana* Perk.
Bignay, *Antidesma bunius* Spreng.
Breadfruit, *Artocarpus communis* L.
Bulso, *Gnetum indicum* Merr.
Cacao, *Theobroma cacao* L.
Citron, *Citrus medica* L.
Coconut, *Cocos nucifera* L.
Coffee, *Coffea arabica* L.
Dalayap, *Citrus aurantifolia aromatica* West.
Fig, *Ficus carica* L.
Guanabano, *Annona muricata* L.
Guava, *Psidium guajava* L.
Inyam, *Antidesma ghaesembilla* Gaert.
Jak, *Artocarpus integra* L.
Kamia, *Averrhoa bilimbi* L.
Kariis, *Garcinia lateriflora* Bl.
Lamio, *Dracontomelum edule* Skeels.
Lanagon, *Flacourtia sulcata* Elm.
Lanno, *Spondias pinnata* Kurz.
Lanzon, *Lansium domesticum* Jack.
Lemon, *Citrus limonia* Osb.
Lime, *Citrus aurantifolia* Swg.
Lingaro, *Eleagnus philippense* Perr.
Manalao, *Aglia bordeni* Merr.
Mandarin, *Citrus nobilis* Lour.
Mango, *Mangifera indica* L.
Miaray, *Citrus miaray* West.
Orange, *Citrus sinensis* Osb.
Palanau, *Rubus fraxinifolius* Poir.
Pangao, *Sterculia oblongata* R. Br.
Pangi, *Pangium edule* Reinw.
Papaya, *Carica papaya* L.
Pineapple, *Ananas sativus* Schult.
Pomegranate, *Punica granatum* L.

(*a*) A herd of cattle. Tankulan, Bukidnon

(*b*) Native ponies. Bukidnon

Pomelo, *Citrus maxima* Merr.
Susong-babay, *Citrus excelsa davaoensis* West.
Tambis, *Eugenia aquea* Burm.
Tamil, *Garcinia tetrandra* Pierre.
Tersana, *Eugenia malaccensis* L.

It is therefore apparent that very few fruits are grown and many that are common in other parts of the Philippines still remain to be introduced into Bukidnon.

The following native, still unidentified species are reported by the inhabitants to bear edible fruits:

Balangas. Said to be a large tree, bearing a red fruit 3.5 to 4 centimeters across, with soft spines and subacid, well flavored flesh, containing a large seed. Ripening in August. Probably *Litchi philippinensis* or a related species.

Balangolas, *Eugenia* sp. A large tree, said to bear red, sweet, edible fruits 2 centimeters across.

Bantuan, *Garcinia* sp. A tree said to bear sweet, edible fruits 4 to 5 cm. across.

Bantuan, *Calamus* sp. A smooth-stemmed rattan said to bear an acid, edible fruit.

Gasa, *Quercus* sp. A tree, the fruit of which is said to be about the size of a cherry, the seed of which is eaten.

Gisao, *Canarium williamsi* C. B. R. A large tree with black, smooth fruits about 15 to 20 mm. long, containing one seed, exceeding 20 in terminal panicles. Ripening in September. Of very little if any value as a food plant.

Ginsauan and Guisahan are two other species of *Canarium* reported to bear edible fruits or nuts which are larger than those of Gisao.

Kabangla, *Garcinia* sp. A tree said to bear reddish purple, subacid, edible fruits 3 to 4 cm. across.

Kalibas, *Medinilla* sp. A small tree, with large, handsome leaves, and fruits about the size of huckleberries, in large terminal panicles. Said to be acid and edible when mature. A handsome ornamental plant.

Kamatamata, *Aglaia* sp. Said to be a large tree with red, rough, acid, edible fruits, 25 to 30 mm. across.

Kaguko, *Eugenia* sp. A tree said to bear acid, edible fruits about the size of a lanzon. Possibly *E. mananquil* Bco.

Katii, Katiis, *Castanopsis* sp. A tree reported to bear spiny fruits the seeds of which are roasted and eaten.

Kolambog, *Dillenia* sp. A tree with large leaves and green, acid, edible fruits.

Langusahan, *Palaquium* sp. A large tree said to bear a fruit about the size of an apple, red, smooth and edible.

Luguisan, *Eugenia* sp. A large tree bearing roundish to short oblong, smooth, shell pink, pleasantly acid fruits about 15 mm. across, growing in clusters in the axils of the leaves.

Kinamanyan, *Calamus* sp. A climbing rattan said to bear an edible fruit.

Koboy, *Calamus* sp. A climbing rattan said to bear an edible fruit.

Panansian, *Eugenia* sp. Said to be a large tree with yellow subacid, edible fruits.

Paho, *Mangifera* sp. A large tree with an acid, edible fruit.

Sinian, *Calamus* sp. A stout, climbing rattan with long spines, and large broad leaves; the half mature stems attractively mottled a silvery gray. The fruits are said to be 15 to 20 mm. across, juicy, acid and edible.

Tagbak, *Eugenia* sp. A tree said to bear white, very acid, edible fruits about 4 cm. in diameter, in the axils of the leaves.

Aside from the above enumerated fruits the native inhabitants collect and eat the fruits of several species of *Zinziberaceous* plants, the food value of which is, however, so low that the species cannot properly be ranked among the Philippine food plants.

The abacá varieties cultivated are as follows:

Babalonon	Halugan	Sumok
Balunis	Kilala	Tangkoñgon
Gamagatos	Putian	
Halayhay	Salumpikit	

Bukidnon is preëminently a pastoral country, but all told the the herds probably do not as yet number more than 10,000 head.

While there are several small herds of from 25 to sometimes exceeding 100 animals, there are only two herds of any considerable size, that of the Agusan Coconut Company, which now numbers about 4,000 animals, located at Tankulan and the Crescent Star Ranch at Dagumbaan, with about 1,500. Most of these herds are still made up of native cattle, but they are rapidly being converted into robust mestizo herds by the introduction of Indian Nellore bulls. (Plate VII *a*.)

At Mailag, half a day's ride beyond Malaybalay, horse raising in a small way has been quite successful. (Plate VII *b*.)

NATURAL RESOURCES AND INDUSTRIES OTHER THAN AGRICULTURAL

Lanao, excepted, Bukidnon has a smaller area of commercial forest than any of the provinces discussed in this volume of the *Review*, and the forests are so distant from the coast that the expense of transportation of the lumber would be so excessive as compared with that produced nearer the coast in other parts of the Philippines that lumbering will probably never be undertaken in Bukidnon until the more accessible forests near the coast have been exhausted. Almaciga and bejuco are collected and exported in small quantities but the revenue from this source could be greatly increased.

Cinnamon, *Cinnamonum mindanaense,* locally known as *kami,* of very good quality grows wild in Bukidnon as in all other provinces in Mindanao, and bark might be collected in considerable quantities for export if the attention of the native inhabitants was called to its commercial value. During the Spanish occupation of the island this spice was exported from several points. As a matter of fact the cinnamon obtained from the *kami* is so good and the plant itself grows with such freedom that it is believed that a Philippine cinnamon industry could be established based on the culture of this species.

Buntong, the tall, stout bamboo so common at Lake Dapao in Lanao Province, is also found in Bukidnon, where it is used for construction purposes. Frequently attaining a diameter of 20 centimeters, the buntong is less durable and weaker than the ordinary bamboo, *Bambusa spinosa* Roxb.

TRANSPORTATION AND COMMUNICATIONS

Without sea coast and navigable rivers all transportation in Bukidnon is naturally on land. The status of the present road system has already been touched upon on a previous page. Here as in the other provinces a telephone system has been installed connecting all the more important municipalities and Cagayan, Misamis, which is the connecting link between Bukidnon and the outside world.

Cagayan is, of course, the seaport nearest to Bukidnon, but the protected anchorage is small, and the adjacent land is low and swampy (Plate VIII). Since a careful topographical survey would probably show that the interior of Bukidnon can be more easily approached at less cost by rail from Parang, Cotabato, than from Cagayan, the province is likely first thus to find an outlet to the sea at Parang with its superior natural advantages as a railroad terminus and harbor, especially considering that there is already a good road from Cagayan to Bukidnon.

TRADE

Abacá and coffee are the only exports of importance, though small quantities of cacao, bejuco and almaciga are also brought to the coast. Since the imports for 1918 amounted to about

₱80,000 the total exports probably did not greatly exceed ₱100,000 in value. Approximately one-third of the imports was rice. The other major imports were sugar, cloth and salt.

PROSPECTIVE INDUSTRIES

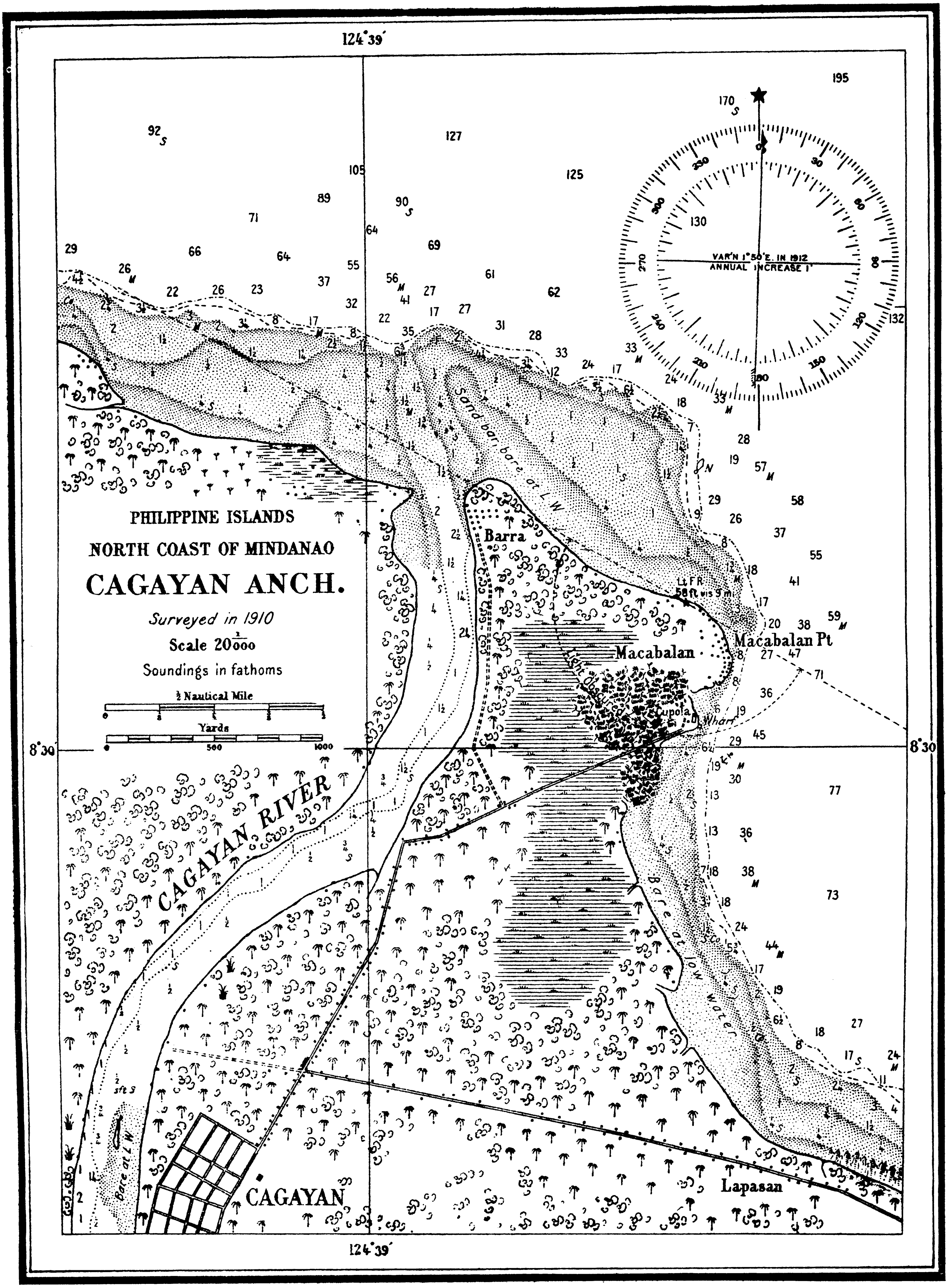
Because of the wide, well watered, verdant plains, Bukidnon is apparently predestined to become one of the principal stock raising provinces of the Philippines, and though the land is well adapted to a variety of crops one may expect this province to remain chiefly a pastoral country for many years ahead.

The vegetation in Cotabato is more luxuriant, but in area Bukidnon is unrivalled as a prospective cattle region in Mindanao, and it is one of the four foremost provinces in the Archipelago in respect to area in pasturage. Corporations wishing to engage in stock raising would here find almost unlimited opportunities to engage in this industry in a big way and under exceptionally favorable conditions. The table lands have a cool climate that in the Philippines is unsurpassed in agricultural areas of similar extent, no mean advantage especially to the European. Good water is abundant everywhere. Again, the isolation of Bukidnon renders protection against contagious animal diseases a comparatively simple matter.

The Bukidnon coffee has attained an enviable reputation for quality but the production is limited in quantity. On a large scale Arabian coffee cannot, of course, be recommended for planting because of the *Hemileia,* but several of the blight resistant coffees from Java have shown up very favorably, and in time coffee may confidently be expected to rival stock raising in importance.

In the interior abacá is already quite an important product, comparatively speaking, and under the small culture system this crop may be extended very considerably though it is not recommended to the big planter. In this connection it might be said that to the homeseeker of limited means no province in Mindanao would appear more attractive than Bukidnon. The climate is healthy and agreeable, the water is good and plentiful, there is abundant pasture for cattle everywhere, the land is adapted to crops easily handled under a small culture system, such as rice, corn and coffee, and it can be cleared without difficulty.

Tea has been introduced and there is apparently no reason why this crop should not be successfully grown on a large scale. As has already been stated on a previous page the prospects for cinchona culture in the Philippines are most favorable in Bukidnon. Camphor might be grown here also.



MAP OF CAGAYAN ANCHORAGE, MISAMIS

Ceará rubber was introduced many years ago and being easily propagated it has become dispersed to the most remote settlements. The trees have made a remarkable growth and it is by no means impossible that this rubber may become a crop of some importance in Bukidnon. (Plate VI.)

Except, perhaps, on the lower plains as one descends into Cotabato in southern Bukidnon, Para rubber and coconuts are not recommended as plantation crops for this province.

All plantation ventures presuppose the importation of labor from other regions.

Nowhere is the pineapple more at home than in Bukidnon. The fruit of the Cayenne variety, so extensively grown in Hawaii, and which has been grown at Diklum for several years is here unsurpassed in size and quality. With ample capital to push the project, a big, prosperous fruit canning industry might well be established here. In this connection it might be stated that the largest pineapple center in Hawaii is located in a region very similar to Bukidnon in the general topographical features, in elevation, climate and soil, though there is somewhat more rain in Bukidnon. As the Island of Mindanao is settled and convenient transportation routes are opened up Bukidnon may be expected to supply the markets of Mindanao and the Visayas with citrus and other fruits requiring a cool climate for their best development.

Finally, the geographical location, climate and elevation combine to make Bukidnon—with special reference to Mt. Kitanglad and Mt. Kalatungan—the logical territory for a mountain resort for Mindanao and the Visayas.

LANAO: ITS NATURAL RESOURCES AND OPPORTUNITIES FOR DEVELOPMENT [1]

By P. J. WESTER, *Agricultural Advisor*

GENERAL DESCRIPTION

The Province of Lanao (Plate VIII) is located between 123° 35′ and 125° east longitude, and 8° 35′ and 7° 15′ north latitude on the Island of Mindanao, and is bounded on the east by Bukidnon, on the south by Cotabato and Illana Bay, on the west by Zamboanga, and on the north by Pañgil Bay, Iligan Bay, Misamis, and Bukidnon. It has an area of 2,439 square miles and a population of 91,443 inhabitants. By way of comparison, it may be noted that while it is the smallest province in Mindanao, yet Lanao is larger in area than the State of Delaware, which is 2,050 square miles in extent.

According to the Bureau of Forestry 65.4 per cent, 412,890 hectares, of Lanao is commercial forest, 7.9 per cent, 50,730 hectares is open land or covered with cogon, *Imperata cylindrica*, 19.7 per cent, 124,006 hectares, is still unexplored territory; and only 1.5 per cent, or 9,090 hectares, is under cultivation.

Lanao derives its name from Lake Lanao, which name is the Maranao equivalent for "lake." This lake is located about 660 meters above sea level and is about 18 miles long and 16 miles broad at its greatest width, and is said to cover an area of approximately 200 square miles.

With the exception of a comparatively narrow strip of land on the coasts, Lanao is a highland country with a series of valleys and plateaus, rising to an elevation of about 900 meters at Lake Dapao, well watered by numerous rivers and streams.

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[1] The writer takes pleasure in acknowledging his indebtedness to Col. Ole Waloe, Philippine Constabulary for access to the Constabulary Monograph on Lanao Province, and to Governor F. W. Carpenter of the Department of Mindanao and Sulu for the use of the provincial annual reports. The Director of the U. S. Coast and Geodetic Survey, Manila, courteously furnished the map for Plate XV. The map of Lanao has been traced from one furnished by Mr. H. E. Neibert, supervising surveyor, Bureau of Lands. Plate XIV is from a negative owned by the Bureau of Science, Manila.

Oversized Foldout

The more noteworthy mountains include Mt. Butig, south of Lake Lanao, 2,250 meters high; Mt. Gurain about 2,100 meters high, west of the lake; Mt. Inlaoan rising from the shores of Nunungan to a height of 1,585 meters; and the Kapay mountains in northeastern Lanao.

The Agus, the outlet for Lake Lanao, is the largest river in the province. With its large volume of water, its numerous falls and rapids Agus is a potential source of water power of great importance. The Mataling, emptying at Malabang, is the second most important river and through one of its tributaries drains Lake Dapao. Mandulug emptying into Iligan Bay, a short distance northeast of Iligan, is the longest river in the province. Several small rivers drain the Lanao basin east of Lake Lanao and so augment the Agus. Numerous other small rivers and streams drain the remainder of the province, flowing to the coasts both in the north and south.

Aside from Lanao, there are several small, very attractive lakes at varying elevations, such as Butig, Dapao, Nunungan, Talao, Dagayuñgan, and Uyaan. In passing it may be said that while native fish are found in the lakes and rivers, black bass have been introduced into Lanao and carp into Nunungan and Dapao.

The single most impressive feature of Lanao Province is Lake Lanao, apparently a gigantic extinct crater located in the center of the province, surrounded by undulating grass-covered plains and valleys, with here and there mountains rising from the plain. Most of the population are settled in the Lake Basin.

Lanao is well worth a visit by the traveling tourist, because of the scenic beauty of the lake country, the beautiful Maria Cristina Falls on the Agus River and the interesting native population.

The lake is best approached by auto from Iligan on the north coast over the excellent, well maintained road, at first skirting the sea and then passing through Camp Overton, the base of the military operations against the Moros during the early days of American occupation, but now abandoned. Here the road makes an abrupt turn to the south and begins a steady climb to the lake. The Maria Cristina Falls, 68 meters high, and the largest in the Philippines, may be reached a few kilometers from Camp Overton. The road winds its way here through virgin forest, there through undulating hills, and again hugging the precipitous mountain side, with now and then glimpses of streams and rivers, through cultivated fields and by picturesque Moro homes, until one ascends the rim of the old crater lake, when the country below spreads out in a beautiful wide, map-like panorama. (See Plate X *a.*) Then a kilometer or two upward and on the other side there is the glittering lake, set in a frame of green, billowy plains with towering mountains in the distance. To the right is Camp Keithley and proceeding across the Agus River as it leaves Lake Lanao, one reaches Dansalan, the provincial capital, attractively located on the lake shore.

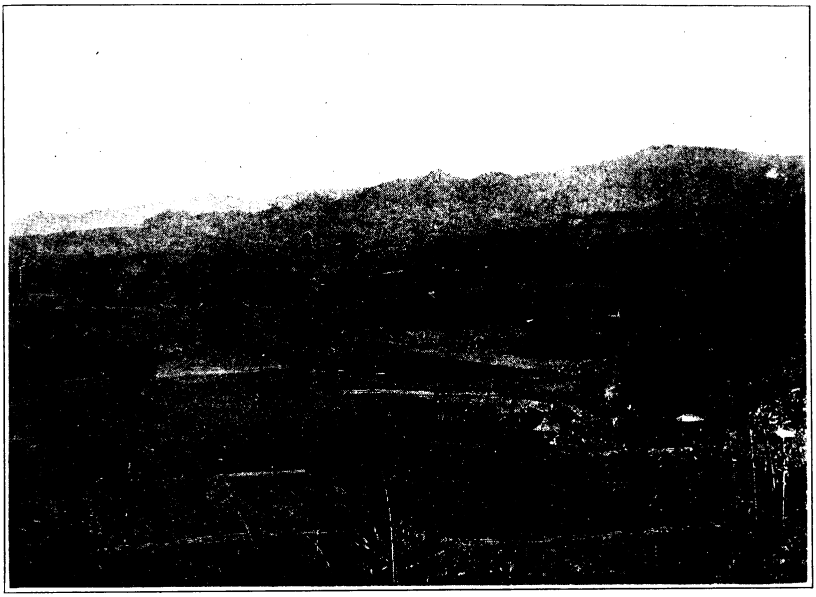
Dansalan is the southern terminus of the first-class road but interesting trips can be made from here on Lake Lanao by launch, of which there are several in service on the lake, to the various settlements on the lake shore, Tamparan, Ganasi, and Uatu being the most important. Lumbatan, too, is interesting and worth visiting because of its agricultural school.

For those who may wish to go overland to the south coast of Lanao there is an interesting horse trail from Ganasi to Malabang. Starting at Ganasi this road leads through a hilly, sparsely populated country, alternately passing through cogonales, patches of secondary jungle, and large clumps of a tall, spineless bamboo locally known as "buntong," steadily ascending until Lake Dapao is almost reached, a small but very pretty body of water. Stands of tall dap-dap trees, *Erythrina indica,* passed now and then mark small coffee "plantations" of former days. These trees are quite picturesque and striking during the leafless and flowering seasons, and reach astonishing dimensions as compared with those commonly seen on the lowlands. Apparently they have here found an ideal home. (Plate XIII *a*).

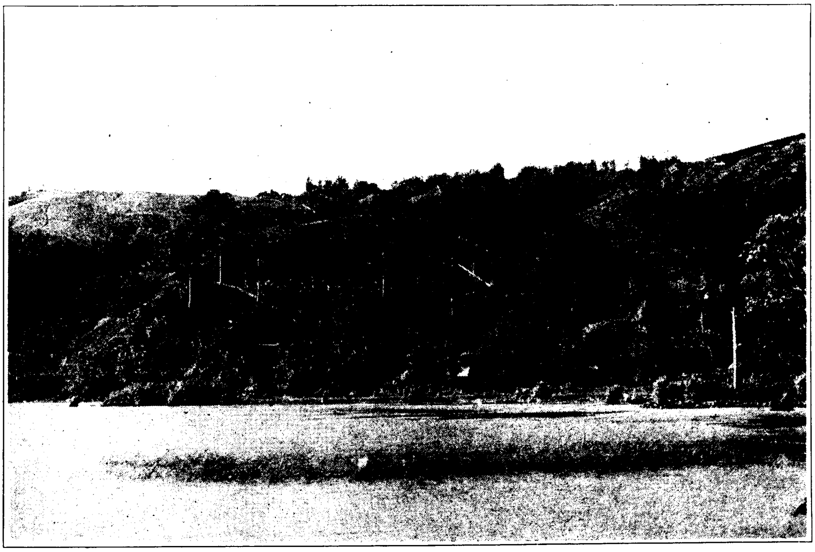
Nowhere in these Islands is tropical vegetation more opulent than at this mountain lake with its attractive pandans, (Plate XI *b*) graceful tree ferns and large groves of giant bamboos, the latter by far the biggest in the Philippines. This bamboo, a spineless and still unidentified species, is found already a short distance from Ganasi, traveling to Dapao, and it also grows in the highlands of Bukidnon though in the climate of Dapao it seems to reach its maximum development. (Plate XI *a*).

Shortly before reaching Lake Dapao the road begins to descend, and the descent is still more pronounced after one leaves Dapao for Malabang. The road here passes through a virgin forest which is practically unexplored botanically. The rainfall is heavy and of equal distribution and the soil is a light, very fertile volcanic ash rich in humus on the southern exposure of the mountain range.

Malabang, on the south coast, is interesting because of its old forts, erected by the Spaniards, and still in good repair, and its large springs of clear, cold water.



(*a*) Typical view of the settled region near Lake Lanao



(*b*) Typical view of the shore line of Lake Lanao at Ganasi

The soil in Lanao is exceedingly fertile, and as a whole the land is much superior to Bukidnon for agricultural purposes. Nowhere a heavy clay so far as seen, in general the soil is of a more compact texture in the northern part of the province, traveling from Iligan over Dansalan to Malabang. The land on the south of Lake Lanao, from Lumbatan to Madalum around the southwestern corner of the lake is very light and permeable, which is characteristic also of the land on the trail from Ganasi over Lake Dapao to Malabang.

CLIMATE

While the climate on the coasts is warm and sultry, in the interior highlands it is cool and pleasant, though the rains are rather too plentiful for comfort.

Except for those following, kindly furnished by the Director of the Weather Bureau, Manila, rainfall records for Lanao are lacking.

A few miles inland from the north coast to an elevation of perhaps 250 meters, the average rainfall is probably not more than 1,800 millimeters annually, but this is quite equally distributed, with the least rain falling from January to May. With the rising elevation the precipitation increases in volume until on the plateau lands and valleys in the interior it is possibly 3,000 millimeters. The rainfall in the interior is abundant at all times of the year. Near the south coast the rainfall probably approximates 2,500 to 3,000 millimeters annually, well distributed throughout the year, judging from the character of the vegetation and the rainfall records of Tukuran, Zamboanga, also furnished by the Director of the Weather Bureau.

TABLE I.—*Rainfall in Lumbatan, Lanao*

Month	1917	1918
	mm.	*mm.*
January	161.3	370.4
February	164.2	237.5
March	231.1	188.0
April	365.5	461.5
May	282.5	265.4
June	469.5	508.0
July	191.6	259.1
August	----------	82.6
September	156.9	----------
October	437.4	374.7
November	185.4	124.4
December	----------	----------

TABLE II.—*Rainfall at Tukuran, Zamboanga* [1]

Month	1917	1918
	mm.	*mm.*
January	55.1	404.8
February	70.6	0.0
March	76.7	----
April	248.2	127.0
May	434.6	241.9
June	195.5	421.6
July	130.4	303.8
August	320.3	806.3
September	192.3	186.4
October	405.8	277.5
November	170.9	218.9
December	361.7	----
Total	2,662.1	----

See also the rainfall records from Buldun and Kabasaran quoted in the descriptive article of Cotabato in the previous issue of this REVIEW.

POPULATION

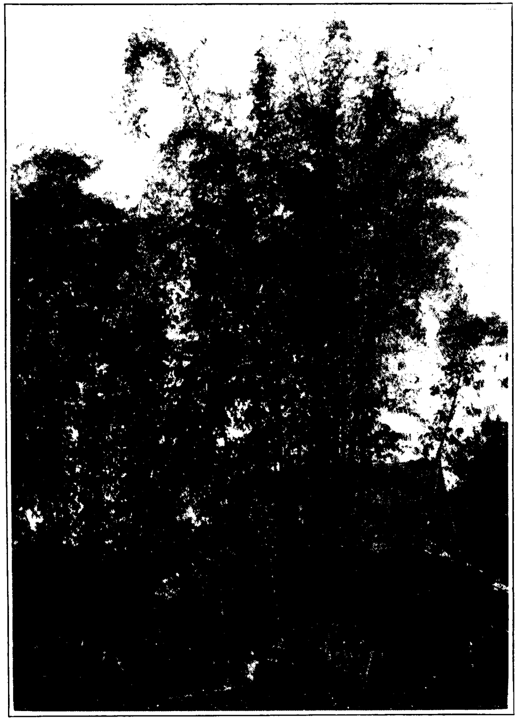
Of the 91,443 inhabitants, according to the Census of 1919, some 80,000 odd are Maranao Moros, found throughout the province. They are a robust, strong and warlike people and are notably energetic, intelligent and industrious, and for a long time successfully resisted invasion. They are occupied principally in farming and fishing, and their farms in the interior are remarkably well managed considering the degree of culture and the primitive tools of the people. The Maranaos make good plantation laborers, but they cannot be depended upon as a labor supply for development work since they mostly own and till their own farms. There are some 6,000 Visayan settlers living principally on the north coast of the province, trading, farming and fishing. About 2,000 Manobos live in the northeastern corner of Lanao adjacent to Bukidnon. Some 150 Americans live in Lanao. As in other provinces in the Philippines most of the local import and export trade is in the hands of Chinese. Japanese are found here and there.

HISTORICAL REVIEW

The authentic written history of Lanao is scant.

The Spaniards first penetrated to the lake region in 1639, bringing six boats from Iligan, but later retreated to the coast as the result of renewed hostilities by the Moros. They did not again approach the lake for a period of about 250 years. Active operations against the Moros were again begun in 1890. Mala-

[1] Tukuran is located on Illana Bay in Zamboanga near the Lanao boundary.



(*a*) Giant bamboos on the road from Ganasi to Lake Dapao, Lanao

(*b*) Vegetation on the shore of Lake Dapao, Lanao

bang was permanently occupied the following year, and an expedition penetrated to Lake Lanao from the south, and four gun boats were placed in commission on the lake within the next few years. The Americans occupied Iligan in 1900, and penetrated to the lake in 1902. Civil Government was established and Lanao made a province in the Department of Mindanao and Sulu in 1914.

AGRICULTURAL INDUSTRY

Agriculture is the principal industry in Lanao, and while it is carried on in a limited way, the native farmer in Lanao is far in advance of his compatriot in the neighboring provinces of Bukidnon and Cotabato.

Rice, coconuts, and abacá are the principal crops, but corn, coffee, sugar cane, cassava, camotes, gabi, cacao and bananas, and various vegetables and fruits are grown to more or less extent. A small quantity of tobacco is also grown. The following statistics furnished by Mr. Antonio Peña, chief, division of statistics of this Bureau, presents a picture of today's agricultural development.

TABLE III.—*Agricultural statistics of Lanao.*

Crops.	1918			1919		
	Area in hectares.	Quantity.	Value in pesos.	Area in hectares.	Quantity.	Value in pesos.
Rice	2,594	[a] 37,999	185,428	3,548	[a] 45,592	357,024
Corn	561	[a] 4,315	25,803	341	[a] 2,772	21,069
Coconuts	512	[b] 305	[f] 64,077	635	[b] 227	[f] 65,872
Abacá	385	[c] 124	54,607	197	[c] 105	31,408
Coffee	----------	[d] 48,100	19,300	----------	[d] 48,553	19,840
Sugar cane	61	[e] 81	10,149	90	[e] 106	11,050
Tobacco	19	[d] 7,850	3,960	34	[d] 10,672	7,674

[a] Hectoliters.
[b] Copra, metric tons.
[c] Metric tons.
[d] Kilos.
[e] Crude sugar, tons.
[f] Value of all coconut products.

Lowland rice is the most important crop and is produced mostly in the valleys on the western shore of Lake Lanao about Taraka and Ramain, that are estimated to have about 8,000 hectares of excellent rice land. Upland rice is also extensively cultivated and produces well. With the exception of Cotabato, Lanao is the only province in Mindanao which is self-sustaining in respect to rice and it also exports minor quantities of this grain when the seasons are favorable for the crop. The rice industry is capable of great extension, especially that of upland rice, and rice could easily become an export crop of no mean importance in Lanao.

The now most important money crop for export is copra. At present most of the copra is produced on the north coast where planting began earlier than on the south coast and it is still in the lead though the south coast is rapidly gaining in the area planted. All the coconut plantations on the north coast are in the form of small holdings, while on the south coast a few modern plantations of considerable area have been set out about Malabang, the largest of which is reported to have some 40,000 trees. These plantations are all of recent origin and the oldest are just coming into bearing. (Plate XII *b*).

The soil and climate in the wide lowland belt along the coast is well adapted to coconuts and large areas may be expected gradually to be planted to this crop.

As yet abacá is of relatively little importance but the area planted to this crop, which is well adapted to native culture, is slowly increasing even in the interior.

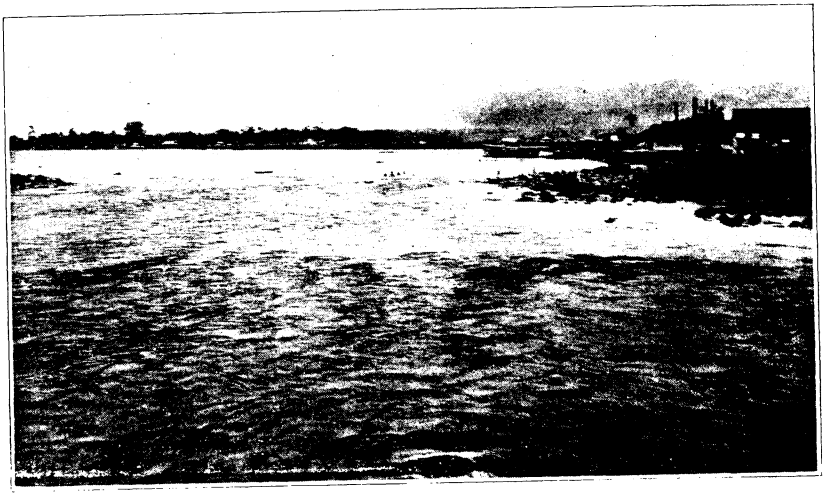
Before the entrance of the Hemileia into the Philippines, Lanao was famous for its coffee, of which fairly large quantities were exported from Iligan and Malabang, and the traces of this industry are still visible everywhere in the highlands in the dap-dap groves in which the coffee (Arabian) was planted. (Plate XIII *a*). But, aside from the attacks of the coffee rust, the industry was further demoralized during the Spanish and American campaigns against the Moros and very little coffee is produced now. As a matter of fact, owing to the excessive rains, Lanao is not well adapted to Arabian coffee, the planting of which is not advisable. The cropping of the new rust resistant coffees is not adversely affected by heavy rains, and these coffees, which have already been successfully introduced, unquestionably have a bright future in the province.

Corn and sugar cane are grown to a slight extent at the low elevations near the north coast. Camotes are grown very successfully and are together with rice and cassava the principal food staple of the Moros. At an elevation of 600 meters and above the white potato has been found very successful when properly handled.

FOOD PLANTS

Most tropical vegetables found in other parts of Mindanao are also grown in desultory fashion in Lanao. The temperate vegetables succeed well at the higher elevations.

The following is a list of the food plants cultivated in Lanao recorded by the writer during a visit to Lanao in 1919.



(*a*) Lake Lanao from the bridge over Agus River. Camp Keithley to the right

(*b*) Coconut plantation near Malabang, Lanao

RICE VARIETIES

Ambutu	l-al-n-w [1]
Andarugung	l-al-ng-c
Baku	l-al-ng-w
Bantuan	l-al-ng-c
Bugabung	l-al-ng-w
Dibauingan	l-al-ng-w
Gabay	l-al-ng-w
Ginataan	l-al-ng-w
Gumaos	l-al-gl-w
Ikugakuda	l-a-gl-c
Karuni	l-al-ng-w; best cooking and highest priced rice.
Kutung	l-a-gl-c
Languban	l-al-gl-w
Lantik	l-al-gl-w
Lumilu	l-a-ng-w
Masappi	l-al-gl
Pandangaraga	l-al-gl-w
Paray	l-al-ng-w
Pulutan-narambuyung	l-al-ng-c
Pulutan nilibdan	l-al-gl-w
Pulutan salading	l-al-gl-w
Sampan	l-al-gl-w
Samurung	l-al-gl-c
Sanguyud	l-al-gl-c
Sarumpikit	l & u-al-gl-c
Tagatus	l-al-ng-c; popular, productive.
Takilid	l-al-ng-w; most popular; productive.
Tumbaga-lukus	l-al-ng-c
Ulayan sauatau	l-al-gl-w

CORN VARIETIES

Kilala	Lamit	Subuanun
Kumuning	Limba	
Kutung	Palikat	

SUGAR CANE VARIETIES

Balagin	Itum	Maru
Balatinau	Lamuk	Kilala
Bankarau	Mamasau	Sambulauan
Biñgaya	Maransabuku	Turisan

CAMOTE VARIETIES

Bangala	Kaluniat	Minurak
Bugagay	Kapatan	Muntud
Bundutakuda	Kasulug	Natu
Burut	Katukud	Panikapan
Danapa	Kupaya	Parilan
Dangarimban	Lagilay	Samboangan
Dikabagin	Lumakang	Silay
Dikirin	Lungau	Turun
Gumangung	Makalimpan	Uatakasulug
Gundarusa	Makauyag	
Inampay	Malukamba	

GABI VARIETIES

Dinatan	Labisarut	Ruknaandau
Kapukau	Mampang	Rumandiar
Karangar	Pangamutiin	Sakikakuak
Karay	Papakabanug	Sarayau
Kaual	Rikit	

[1] u = upland
l = lowland
al = awnless
a = awned
ng = nonglutinous
gl = glutinous
w = white
c = colored

CASSAVA VARIETIES

Kapuk
Kalumpang
Mariga bungala
Sirupa

BANANA VARIETIES

Amas
Borongan, large excellent quality.
Bulutan
Butuan, syn. Mangay
Duka, syn. Amas
Kilala, syn. Morado
Lakatan
Ligakuda
Ligaunta, syn. Daliring señora and Tindoro
Mangay
Morado
Pagadatan
Pakal
Pandaka
Tadiao
Tinduk
Saba

WILD AND CULTIVATED FRUITS

Aluao, *Euphoria nephelioides* Radlk.
Banana, *Musa paradisiaca* L.
Bauno, *Mangifera caesia* Jack.
Cacao, *Theobroma cacao* L.
Carambola, *Averrhoa carambola* L.
Ciruela, *Spondias purpurea* L.
Citron, *Citrus medica* L.
Coconut, *Cocos nucifera* L.
Dalayap, *Citrus aurantifolia* var. *aromatica* West.
Durian, *Durio zibethinus* L.
Guanabano, *Annona muricata* L.
Guava, *Psidium guajava* L.
Igang, *Eugenia garciae* Merr.
Inyam, *Antidesma ghaesembilla* Gaert.
Jak, *Artocarpus integra* L.
Kabuyao, *Citrus hystrix* D C.
Kalpi, *Citrus webberi* West.
Kamia, *Averrhoa bilimbi* L.
Karimug, *saurauia recticulata* Merr.
Kinubo, *Rubus moluccanus* L.
Lanzon, *Lansium domesticum* Jack.
Lemon, *Citrus limonia* Osb.
Lime, *Citrus aurantifolia* Swg.
Lingaro, *Eleagnus philippense* Perr.
Mankil, *Eugenia mananquil* Bco.
Marang, *Artocarpus odoratissima* Bco.
Orange, *Citrus sinensis* Osb.
Palanau, *Rubus fraxinifolius* Poir.
Papaya, *Carica papaya* L.
Pineapple, *Ananas sativus* Schult.
Pomelo, *Citrus grandis* Merr.
Ragini, *Rubus rosaefolius* Sm.
Sugarapple, *Annona squamosa* L.
Susong babay, *Citrus excelsa* var. *davaovensis* West.
Tersana, *Eugenia malaccensis* L.

The following wild as yet unidentified fruits are also reported to be edible:

Anibung
Lugisan
Ngingir
Malamau, *Garcinia* sp.
Ribas, *Medinilla* sp.
Unga balagin, *Calamus* sp.

Among the little known or noteworthy fruits it may be of interest to know that the bauno has not been found above an elevation of 450 meters.

A "bauno forest" is said on good authority to exist near Momungan, about 330 meters above sea level. The durian trees attain very large dimensions in the rich, friable, volcanic soil on the south coast of Lake Lanao, and trees exceeding a meter in diameter and 25 meters in height are common at an elevation of some 675 meters. The marang trees still grow large and vigorous up to 900 meters altitude.

(*a*) Groups of Dap-dap trees, *Erythrina indica*, in the highlands of Lanao indicate old coffee "plantations." (This on the trail from Ganasi to Lake Dapao)

(*b*) An unusually productive Durian tree said to be "everbearing." Dansalan, Lanao

The Moros distinguish the following mango varieties: Dudul, Kagapas, Titi, Madum, and Bagitan of which the last one is said to be a rare variety found only at Uatu, the fruits as large as a papaya, sweet and fine flavored and devoid of fiber. Among the bananas the Borongan is a large fruit of excellent eating quality deserving wide distribution in other parts of the Philippines.

An exceedingly interesting form of citrus has been noted in Dansalan with foliage quite near to *Citrus miaray* from Bukidnon, which has not been seen anywhere else.

The following edible mushrooms are reported:

Balagindasan.	Tangulug.	Muna.
Gagatusin.	Karap.	Riga.
Garupu.	Kalana.	Damulugan.
Nuling.	Kipi.	
Gigipan.	Tubu.	

NATURAL RESOURCES AND PRODUCTS OTHER THAN AGRICULTURAL

The forests constitute an important source of wealth in Lanao. Because of their accessibility the most valuable forests are those located in the northwestern part of the province, and on the mountain slopes facing Illana Bay. Another large forest covers the mountains along the Bukidnon border descending into the Lake Lanao basin. This forest is so difficult of approach that it will probably remain in its primeval state for a long period. It should, however, for this very reason continue to prove a valuable source of almaciga and bejuco. One lumber company has obtained a large concession in the northwestern part of Lanao with headquarters and sawmill in Kolambugan. (Plate XIV.) The forest contain the same timbers found in other parts of Mindanao.

Bejuco (rattan), almaciga, and beeswax is collected in the forest in small quantities which could be readily increased.

Adjoining the excellent agricultural lands from Katapagan southward there is a nipa swamp, *Nypa fruticans*, some 9,000 hectares in extent on Pañgil Bay, reliably reported to be the largest in the Philippines, exceeding in area the large nipa swamps in Bulacan and Pampanga on Manila Bay. The vigor of the plants in this virgin swamp, which has never been exploited, is extraordinary. With the rapid growth in popularity of farm tractors, and the increased demand for motor spirits the cost of which is steadily mounting, it would seem that here lies an undeveloped source of fuel in the form of alcohol of very great extent and value, and that adjacent to an exceptionally large body of excellent agricultural land.

Gold, silver, copper, and coal are known to exist in the Kapay mountains, but a geological survey has never been made and the extent of the deposits is not known.

An abundance of fish is available on the coasts but no fisheries have been developed.

TRANSPORTATION AND COMMUNICATIONS

Lanao has connection with the outside world by the means of small steamers from Cebu which make weekly calls at Iligan. The *S. S. Tablas* calls twice monthly at Iligan and Kolambugan on her way from Zamboanga to Butuan, stopping also at several other towns on the coast. On her way between Zamboanga, Cebu and Manila, the *S. S. Mindanao* makes occasional stops at Iligan and Kolambugan. The *S. S. Research* on her trips between Zamboanga and Cotabato at times makes Malabang a port of call.

Malabang has a wireless station, and Iligan has cable connection with Cebu. The interior of Lanao is served by a local telephone system connecting all the more important points.

Iligan and Dansalan are connected by a first class road approximately 31 kilometers long.

Lake Lanao forms an important means of communication in the interior, and one steam and a small number of motor launches are in operation on the lake between Dansalan and Ganasi and intermediate points, aside from numerous native sailing craft. From Malabang there is a good trail to Ganasi, and several other trails connect all the other settlements which thus can be reached on horseback. During the military régime good wagon roads were constructed from Malabang to Ganasi and Lumbatan, but these roads have not been maintained and have reverted to horse trails.

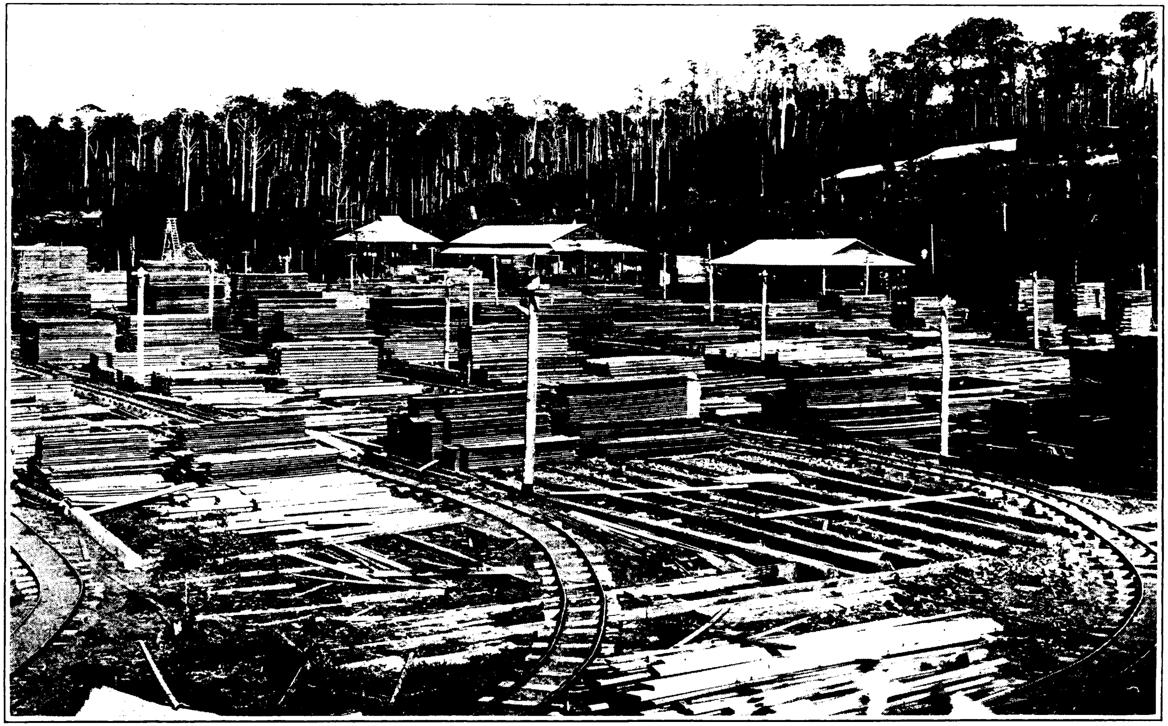
TRADE

The import and export trade of Lanao is conducted through Iligan and Malabang. The lumber is shipped from Kolambugan.

Copra, lumber and abacá constitute the principal exports of Lanao, but rice, corn, coffee, mats, camotes, bejuco, almaciga, beeswax, cattle, and marine shells are also exported in small quantities. The export of all could be greatly increased given the proper impetus.

PROSPECTIVE INDUSTRIES AND DEVELOPMENT

As may be gathered from the foregoing the industries of Lanao are destined to become chiefly agricultural. Lumbering for many years will continue to remain of considerable importance and when properly organized an alcohol distilling industry of large proportions should grow up.



Lumber yard in Kolambugan, Lanao

The greater part of the land in the Lake Lanao basin is already occupied by Moros. Still, there are considerable bodies of good agricultural land available for settlement by the immigrant of moderate means—for instance in the Taraka valley, especially adapted to rice, and the districts around Lake Butig and Dapao, suitable for rice, potatoes, coffee, and tea. Munay also has a fine body of agricultural land open for settlement well adapted to coffee and rice. Until the more remote regions shall have been reached by good roads the more accessible lands near the sea coasts, those on the road from Iligan to Dansalan and the valleys near the shore of Lake Lanao, are preferable for such settlements. There is abundant room for immigrants on the fertile agricultural lands on the mountain slopes facing the coasts on the cogonales and the secondary forest land which is easily and cheaply brought under cultivation.

Crops adapted for the small farmer of this type are coconuts, coffee, abacá, rice, and peanuts; and corn in the drier districts on the north coast. On the light soils at the southern end of the lake basin, potatoes of excellent quality can be, and unquestionably some day will be produced on a large scale for exportation to other parts of the Philippines,—when there are better and cheaper means of transportation.

For big capital there are first the forests on the mountain slopes facing Illana Bay available for exploitation. But as in Agusan lumbering itself should be but the preliminary step in developing this country into large coconut, rubber, coffee and tea plantations. Other crops will be renumerative, but it is believed that here the conditions are more favorable for the development of a big tea industry than anywhere else in the Philippines. The rust resistant coffees of the Robusta type should also find ideal conditions here.

The largest body of agricultural land is located south of Kolambugan, over Katapagan to the divide of the watershed between Pañgil Bay to the north and Illana Bay to the south.

This land is exceedingly fertile, of gentle slope, rising from the sea coast, and is drained by numerous rivers. It is unquestionably one of the most attractive locations not only in Lanao but in the whole Island of Mindanao for the opening up of large plantations ventures. Aside from enormous tracts of grazing land in the foot hills to the east and south, the first class agricultural land in this area is conservatively estimated to not less than 60,000 hectares. Sugar cane might be grown on a large scale and there is abundant room for big rubber and coconut estates.

As a matter of fact, a project was organized by the Spaniards with a view of colonizing this district many years ago, but the early pioneers were unable to remain because of the repeated attacks of the hostile Moros and the project finally was abandoned. A herd of wild carabaos descended from those abandoned by the Spaniards is all that remains of the adventure.

Another attractive district for development on a big scale is the valleys drained by the Maridigao and Malitabug Rivers and their tributaries in the southeast of the province, with outlet at Parang. Other desirable sites are located around Lake Dapao, at Lake Butig, at Munay and Taraka.

Lanao does not possess pastures comparable in size with the tremendous areas in Cotabato and Bukidnon, but they merely seem small in comparison. In reality they are large.

With its many natural advantages, Lanao lacks a really good harbor such as the Nasipit in Agusan, Malalag in Davao and Parang in Cotabato. For a large port Kolambugan (Plate XV) has greater advantages than any town on the coast and may some day become a railroad terminus of some importance though the superior advantages of Parang in Cotabato will inevitably attract the commerce of southern Lanao and possibly of the entire lake basin in the interior of the province.

Oversized Foldout

A DESCRIPTIVE LIST OF MANGO VARIETIES IN INDIA[a]

By P. J. WESTER, *Agricultural Advisor*

PRELIMINARY REMARKS

The ancestral home of the mango, it is perhaps only natural that India should also be the original home of many of the choicest mango varieties and that there the mango was first grafted. The tremendous variability of the Indian mango itself must have long ago acted as a powerful stimulus to the ancient horticulturists of that country in their early efforts to devise some means of reproducing exceptionally good trees, though the art seems to have been very crude until within very recent times. But however long ago the first mango graft was made and however crude the methods employed, not to speak of the many varieties perpetuated that are of little value to the planter of today, he owes the Indian mango growers of the past a debt of a magnitude that perhaps few realize.

Some twenty or more years ago when the mango began to attract attention in earnest in the United States, because of the exaggerated or, perhaps more truly, misinterpreted reports of travelers, the belief gained ground that all Indian mangos were greatly superior to the common mango. As a result a large number of varieties were imported into the United States from India, many of which have now fruited.

With the occidental planter it is a universally accepted rule that to warrant its culture a species or variety must possess sufficient merit of one kind or another over others, depending upon the object for which it is grown. Mere differentiation from other kinds is not sufficient.

With due deference to the influence of local environmental conditions, nevertheless the experience in Florida, Hawaii and Porto Rico with a large number of the imported grafted Indian varieties has been very disappointing, and their behavior has done much to indicate that a very large part of the named and grafted mango varieties in that country apparently are little

[a] This paper was originally prepared as a part of Bulletin No. 18, The Mango, Revised Edition, but in the course of preparation it increased in volume until it was found advisable to print it separately.

more than local curiosities which seem to have been propagated more because they caught some one's fancy than because of their intrinsic merit. This opinion is strengthened by a careful study of the available descriptions of Indian mangos at hand, and while there can be, of course, no question but that there are numerous mango varieties in India that are of very superior quality and could be imported to great advantage into the countries where they are still foreign, it is equally true that there are also a large number of sorts that are of very little if any value to the fruit grower, at least from a commercial point of view. It is obvious, therefore, that indiscriminate importation of mangos from India is likely to lead to the introduction of many worthless kinds that had better have been left out.

There is already considerable interest manifest in the Indian mangos, and since, with the recent advance in the asexual propagation of the mango, this interest in the importation of the Indian varieties is likely to increase, and the descriptions available are contained in scattered publications most of which are out of print, it has seemed worth while to compile a descriptive list of those mangos so far as descriptions are available for the convenience of prospective importers of Indian mangos.

Unfortunately descriptions of a very large number of the Indian mangos are very fragmentary, and it is much to be hoped and desired that this deficiency in so many varieties in the present list may be remedied by those who are in position to furnish this information. Photographs, of course, best illustrate descriptive matter of this kind, but line-drawings, such as those shown in this paper, serve excellently to bring out the more essential features of the fruit and seed.

Large as the list appears it is really very incomplete. Aside from mention of several other undescribed varieties De published a list of 103 varieties grown in Murshedabad alone, which is not here reproduced. In "Gardening in India" Woodrow devotes more than seven pages of fine print to a list of celebrated mango trees in India. It is probable, however, that most of these are old seedlings that never have been perpetuated. "The Mango," by the same author, containing descriptions of some eighty odd varieties, has unfortunately not been available for consultation.

Most of the more complete descriptions that follow have been made from a series of notes sent to the author some years ago by Mr. A. C. Hartless, Superintendent of the Government Botanical Gardens, Saharanpur, India, accompanied by a large series of line drawings most of which are reproduced herewith.

Other descriptions, based upon fruits grown in Florida, are republished from this Bureau Bulletin No. 18, *The Mango,* 1911. A very large number of descriptions have been adapted from *"A Treatise on Mango"* by P. C. De, originally published in 1897. Woodrow's *"Gardening in India,"* third edition; Watts' *"Dictionary of Economic Products of India;"* and *"The Mango in Porto Rico"* by F. C. Kinman have also been drawn upon for information. The photographs for the plates have been furnished by Dr. David Fairchild.

Because of the localization of many of the Indian mango varieties, the name of the locality from which a variety is described has been given for the convenience of prospective importers.

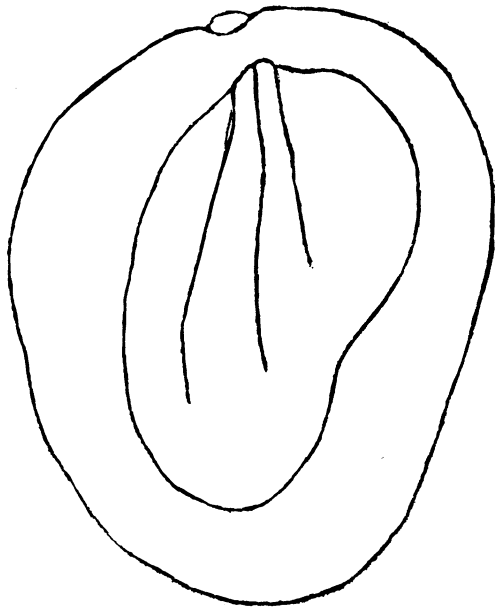


FIG. 1. *Ajwanea*

Saharanpur is located in 30° N. latitude in the United Provinces, northern India. Hajipur, Darbhanga, Malda, Jaynagar and Murshedabad are located in the Ganges River valley in Bengal. Poona lies near Bombay.

DESCRIPTIONS AND COMMENTS

Ajwanea (Fig. 1).— Size small, length, 80 mm., breadth 65 mm., weight 156 grams; form oval-oblique, with shoulders of moderate development, the ventral more prominent than the dorsal; apex broadly rounded, with a slight depression on lower ventral side; surface yellowish green; flesh light orange, subacid and very fibrous; seed rather large, 25 mm. thick, weighing 28 grams.[1]

SAHARANPUR

Apparently a variety of no value for general planting.

Alfonso (Fig. 2).—Size small; length 85 mm., breadth 55 mm., weight 191 grams; form oblong-oval, flattened, with rounded, almost equal shoulders; apex broadly rounded; beak slightly prominent with a slight depression above on lower ventral side; surface smooth, yellowish green; flesh yellow, juicy, aromatic; fiber medium; seed rather large, 19 mm. thick, weighing 28 grams.[1]

SAHARANPUR

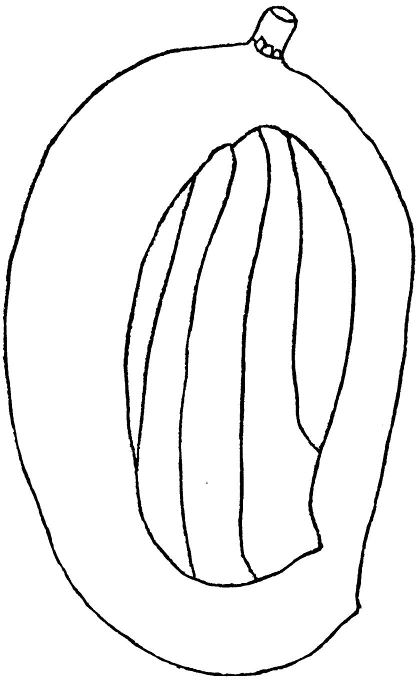


FIG. 2. *Alfonso*

Alfonso (from Lahore) (Fig. 3).—Size medium large, length 82 mm., breadth 73 mm, weight 284 grams; form broadly ovoid, stem inserted squarely in a distinct cavity, shoulders well developed, about equal; beak quite prominent, with a slight depression on lower ventral side; surface rather rough, greenish yellow with a reddish tinge; flesh yellow, juicy and aromatic; of very good flavor and quality; fiber short; seed comparatively small, 19 mm. thick, weighing 21 grams.

The tree is of slow growth but very productive, easily injured by cold. The fruit is of good keeping quality; ripening in midseason.[1]

SAHARANPUR

Apparently a variety well worthy of introduction.

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[1] From notes by A. C. Hartless.

From the mango literature of India it is apparent that the name *Alfonso* and its variants, *Alphose, Aphoos,* etc., really should be considered as a group rather than as a variety name and the different forms should be designated by distinctive names. In his classification of the Indian mangos that have fruited in Florida Popenoe has applied this name to a group of mangos in a still broader sense, including several other varieties such as *Amini, Bennett, Fernandez, Pakria* and *Peters.*

The *Alfonso* in its several Indian variations is the most celebrated and commonly grown mango in the Bombay region, from whence it has been introduced into other parts of India until now it is probably the most widely cultivated mango in that country. The fruit is of good keeping quality and well adapted for long distance transport.

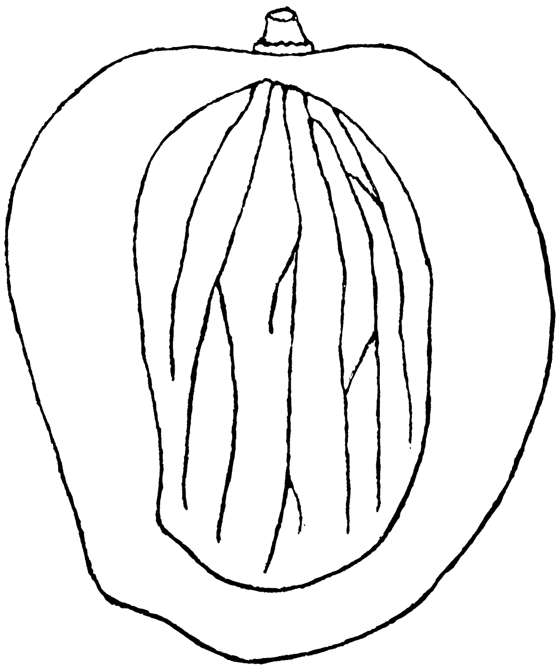

FIG. 3. *Alfonso* (Lahore)

Ali-Buksh.—A roundish fruit, weighing from 225 to 450 grams, the flesh is subacid; ripening in July and August.[2]

MURSHEDABAD

Amini (Plate XVI*a*).—Size small, weight from 170 to 250 grams; form roundish-oblong, oblique, flattened; base flat; ventral shoulder sometimes slightly prominent; dorsal shoulder short and rounded; apex rounded, with a prominent, pointed swelling at nak; surface smooth, bright yellow, with

[2] De, P. C., A Treatise on Mango, 1904.

a heavy red or scarlet blush extending sometimes over more than one-half of fruits well exposed to the light; lenticels numerous, light yellow; bloom heavy; skin thick, tough and adhering to flesh; this rich yellow in color, firm, juicy, fiberless, of pleasing flavor and rather strong aroma; seed large and thick, constituting a larger proportion of the fruit than in most varieties.

The tree is of vigorous growth, tall and open, prolific, and a regular bearer, the fruiting season unusually long.

The above is an adaptation of Kinman's description of the Amini as fruited in Porto Rico where it seems to have been quite successful.[3] Popenoe in a letter states that he prefers it to all other mangos he knows of. The Amini was introduced from India to the United States several years ago, and is apparently one of the most promising of the imported varieties.

Amirgola.—A round mango of ordinary size said to be "one of the best."[2]

BOMBAY

Maries[4] speaks of an *Ameercola* from Madras having a peculiar shape, very distinct and with a rough skin like an orange, which notwithstanding the similarity of names is probably another variety.

Amiri (Ameeri).—Size large, weight 500 to 565 grams; length 15 centimeters; form oblong oval, flattened, compressed at base; apex rounded, the curve ending in a distinct beak at nak; nak 2 to 2.5 centimeters above apex; surface moderately smooth, undulate; color greenish yellow with garnet red on sun-exposed side extending toward base; lenticels conspicuous, whitish or grayish; bloom whitish; skin medium thick, tough; flesh pale yellow in color, moderately tender, juicy; flavor sprightly acid; quality very good; fiber short, confined mostly to edges of seed; seed comparatively small to medium. Season, latter part of June and July.[5]

Introduced from India into United States many years ago the *Amiri* has fruited in Florida, where it has failed to attract much attention however. Too acid for a good dessert fruit it might prove acceptable for preserves.

Amrita-bhog.—An undescribed mango said to be similar to *Misrikund*, which see.[2]

MALDA

Amrita-pal.—An undescribed mango said to be similar to *Misrikund*, which see.[2]

MALDA

Amrita-monda.—An undescribed mango said to be similar to *Misrikund*, which see.[2]

MALDA

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[3] P. R. Agr. Exp. Station, Bulletin No. 24, The Mango in Porto Rico. 1918.

[4] Watt, G., Dictionary of Economic Products of India, Vol. V, 1891.

[5] B. A. Bulletin No. 18, The Mango, 1911.

Anarua.—A long mango with prominent beak and sweet flesh. See *Kerowa.*[3]

DARBHANGA

Antochat.—A large mango, up to 900 grams in weight, roundish, thin skinned; the flesh is yellowish, containing a small seed. The fruit ripens in July.[3]

HAJIPUR

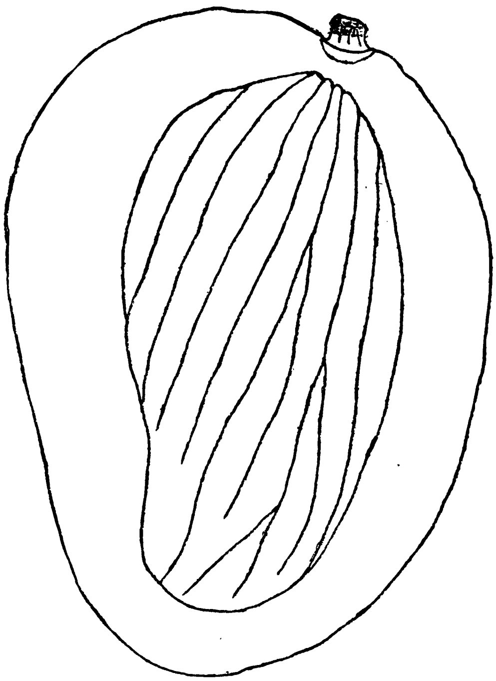


FIG. 4. *Arbuthnot*

Arbuthnot (Fig. 4).—Size small, length 90 mm., breadth 65 mm., weight 184 grams; form ovate, ventral shoulder prominent, dorsal shoulder sloping from stem; apex broadly rounded without distinct beak; cavity on lower ventral side rather slight; surface smooth, orange yellow to greenish; flesh dark yellow, firm, very sweet and juicy, of medium quality; fiber short; seed medium to rather large, 19 mm. thick, weighing 28 grams.

The tree is a slow grower, easily affected by frost and quite productive. The fruit is of good keeping quality, ripening in midseason.[1]

SAHARANPUR

Apparently of no value for general planting.

Aswina.—A large, elongated, flattened fruit weighing from 900 to 1,125 grams; the flesh is sweet and of good flavor. Season of maturity, October.[3]

MALDA

Atai.—Description very incomplete, merely stating that it is "a rare kind, flesh very sweet and tender."[3]

MURSHEDABAD

Baramasi.—The description of this variety is incomplete, merely stating that the tree is a slow grower, of medium frost resistance and prolific, bearing two crops of fruit annually, one very late. The fruit is small, greenish to yellowish, of fair quality only, with a large seed. Keeping quality good.[1]

SAHARANPUR

Apparently one of the "everbearing" kinds, this variety is of little value except to the plant breeder.

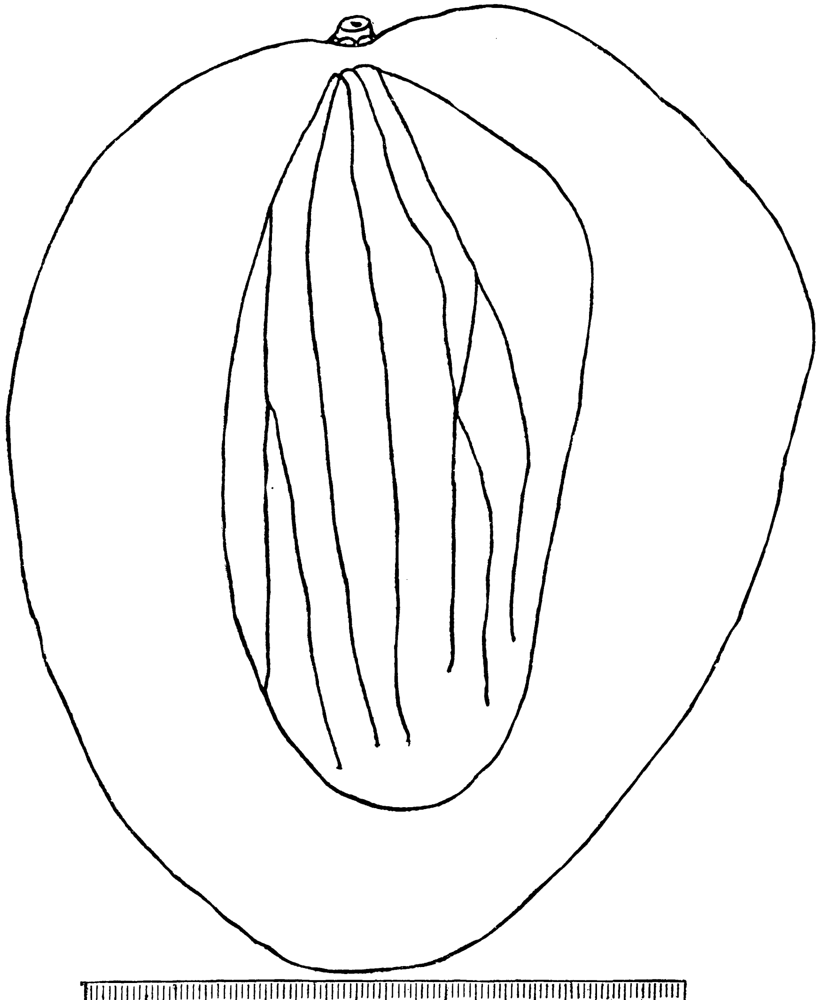


FIG. 5. *Benazir*

According to De the last crop of the *Baramasi* ripens in November, which character seems to be its only redeeming feature as the fruit is unanimously by Indian writers said to be of inferior quality. Maries [4] applies this name (spelled *Barromassia*) to a class containing several kinds, none of good quality.

Batasa.—A roundish, flattened, medium sized fruit, weighing about 225 grams; the flesh is sweet and of agreeable flavor. Ripening in June.[2]

MALDA

The price quoted for the fruit in India denotes this to be an inferior variety.

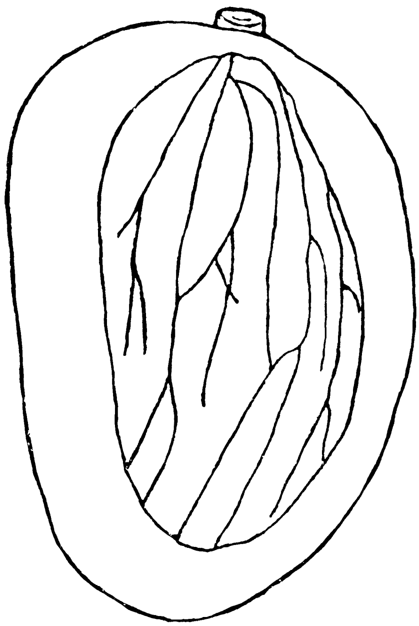


FIG. 6. *Bhaduria*

Belua.—A roundish mango of medium size, weighing 225 to 340 grams; the flesh is of good flavor and very aromatic, having the aroma of the Bael, *Belou marmelos.* The fruit ripens in June.[2]

MALDA

The price quoted for the fruit would indicate this an inferior variety.

Benazir (Fig. 5).—Size very large, length 155 mm., breadth 130 mm., weight 1,134 grams; form ovate to heart shaped, asymmetrical; base inserted in a shallow cavity; shoulders well developed, the ventral comparatively short, falling rather abruptly; apex broadly rounded and without a distinct beak, lower ventral side convex; surface rather uneven, yellowish to greenish; flesh salmon yellow, juicy, subacid and quite free from fiber; seed very small in comparison with the fruit, thin, 20 mm. thick, weighing 28 grams.[1]

SAHARANPUR

A variety apparently worthy of introduction and careful trial.

Bennett (Douglas Bennett's Alphonse).—Size medium large, average weight 225 to 350 grams; form roundish oblique, ventral shoulder higher and somewhat more prominent than the dorsal; apex rounded ending in a small beak; surface smooth, yellow, shaded with pink on the sun-exposed side, lenticels small and numerous; bloom white; skin moderately thick; flesh rich yellow, firm, juicy, subacid, of pleasant flavor and aroma and practically fiberless; seed rather large, monoembryonic.

The tree is of vigorous growth, but rather slow in coming into bearing and is not particularly productive.[5]

Introduced from India to the United States many years ago the *Bennett* has fruited in Florida, Hawaii and Porto Rico, but so far it has there failed to gain favor in competition with other, more popular kinds, notwithstanding its attractive appearance and excellent flavor, which have made the *Bennett* one of the celebrated mangos of India, where it belongs to the *Alfonso* group of mangos.

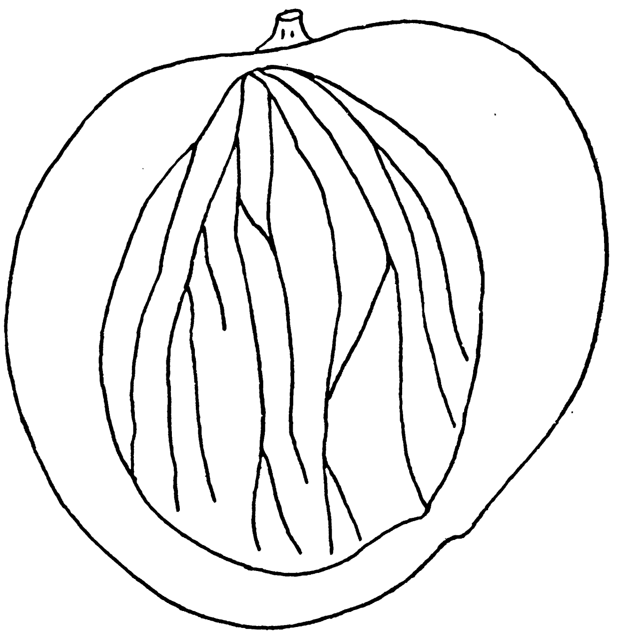


FIG. 7. *Bhaisht*

Bhadai.—See Budaya.

Bhaduria (Fig. 6).—Size small, length 80 mm., breadth 55 mm., weight 213 grams; form asymmetrically ovate to reniform; shoulders rounded, the dorsal rather sloping; apex broadly rounded; lower ventral side slightly depressed; surface uneven, green tinged with yellow; flesh deep orange yellow, juicy, subacid, very fibrous and of rather poor quality; seed medium large, 19 mm. thick, weighing 21 grams.

This variety is of medium vigor, cold resistant, a sparse bearer and the latest to ripen in Saharanpur, India. The fruit is a poor keeper.[1]

SAHARANPUR

Of no value for general planting.

De speaks of two varieties with large fruits of this name from Malda; one roundish and the other long and cylindrical, weighing 900 grams, sweet but of indifferent flavor.

Bhaisht (Fig. 7).—Size small, length 77 mm., breadth 80 mm., weight 375 grams; form roundish oblique, almost flattened, with a rather short longitudinal axis; stem inserted in a broad, shallow cavity; ventral shoulder well developed, dorsal shoulder rather short; apex broadly rounded, depression on lower ventral side scarcely noticeable; surface smooth, green; flesh pale yellow, almost white, subacid, very juicy, of excellent flavor, and quite free from fiber; seed medium large, 19 mm. thick, weighing 28 grams.[1]

SAHARANPUR

There appear to be some discrepancies between the description and line-drawing of this variety. A fruit of the dimensions figured could not possibly have the weight quoted.

A variety of doubtful value.

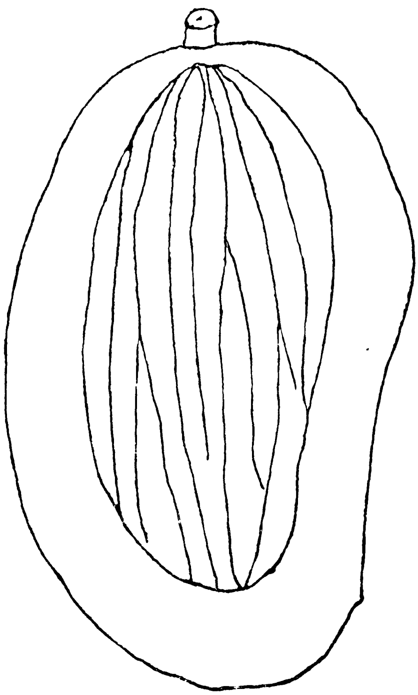


FIG. 8. *Bhurdas*

Bherwa (Chapra).—An oblong mango weighing from 340 to 450 grams; the flesh is sweet but rather watery and insipid, devoid of fiber and containing a thin seed. Ripening in June.[1]

DARBHANGA

Bhupali.—A small, ovoid, very highly colored mango, 170 grams in weight; the flesh is of excellent flavor. Ripening in July.[4]

Bhurdas (Fig. 8).—Size small, length 87 mm., breadth 53 mm., weight 128 grams; semi-reniform; shoulders about equal, narrow; apex broadly rounded, with a slight beak; distinctly concave on lower ventral side; surface uneven, from green to yellow; flesh yellow, juicy, sweet, of agreeable refreshing flavor recalling the pineapple, and very little fiber; seed large for the size of the fruit, 19 mm. thick, weighing 28 grams.

The tree is a good grower and a sparse bearer. The fruit ripens in midseason and is a good keeper.[2]

SAHARANPUR

Apparently of little or no value for general planting.

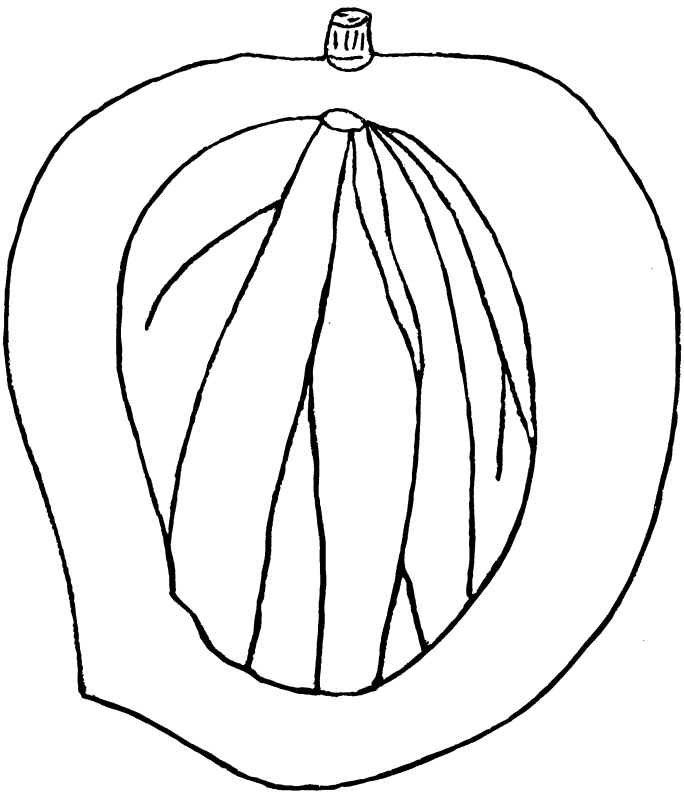


FIG. 9. *Bombay* (Calcutta garden)

Bijnour Safeda.—A fruit of medium size and pale green surface; the flesh is "pink" and of excellent flavor.[2]

MURSHEDABAD

Bira (*Beera*).—No description available. The fruit is said to be excellent and to command a high price. Up to 1904 this variety consisted of only the original seedling, growing in Ichagunge.[2]

MURSHEDABAD

Bombay (*Calcutta Garden*) (Fig. 9).—Size quite large, length 98 mm., breadth 90 mm. weight 432 grams; form obliquely short-ovate, flattened, with almost a square outline seen from the side; stem inserted squarely in a broad, shallow cavity; shoulders broad and well developed, nearly equal; apex broadly rounded; beak prominent; surface smooth, green tinged with yellow; flesh pale yellow, juicy, acid, of good flavor, but rather fibrous; seed quite large, 19 mm. thick, weighing 36 grams.

The tree is of medium vigor, resistant to cold and prolific. The fruit is a good keeper, ripening in midseason.[1]

SAHARANPUR

This variety would appear to be worthy of introduction and trial, especially in the higher elevations of the Archipelago otherwise climatically adapted to the mango.

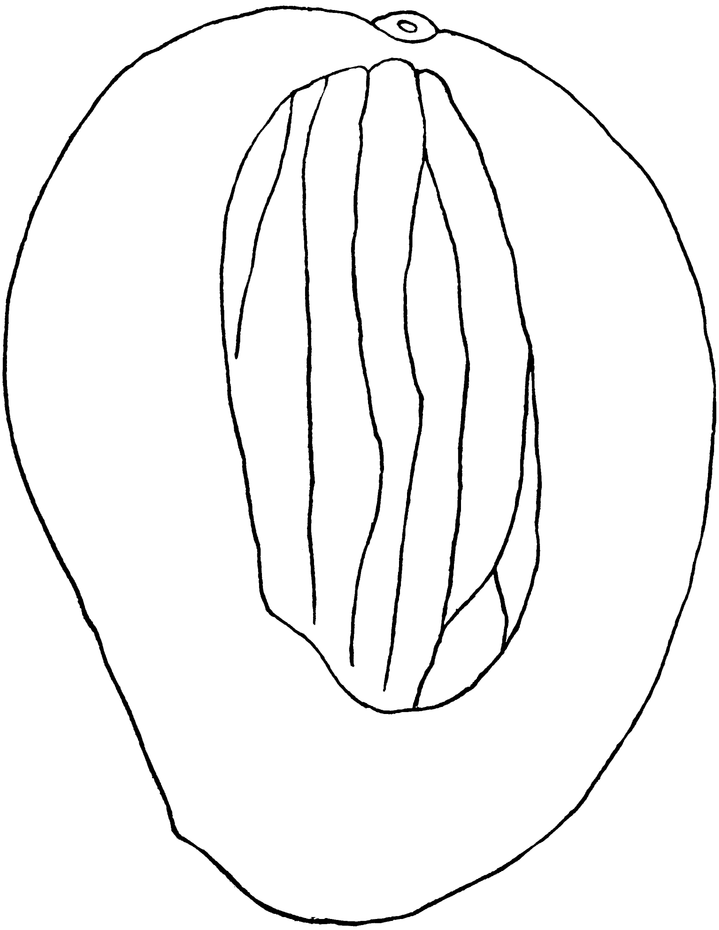


FIG. 10. *Bombay* (Dr. King)

Bombay (*Dr. King*) (Fig. 10).—Size large, length 120 mm., breadth 95 mm., weight 624 grams; form obliquely ovate, attractive, ventral shoulder prominent and well developed, dorsal shoulder sloping; apex broadly rounded, lower ventral side slightly concave; surface uneven, green, tinged with red; flesh pale yellow, juicy, subacid in flavor, and but little fiber; seed quite large, 32 mm. thick, weighing 64 grams.[1]

SAHARANPUR

A variety apparently worthy of introduction and trial.

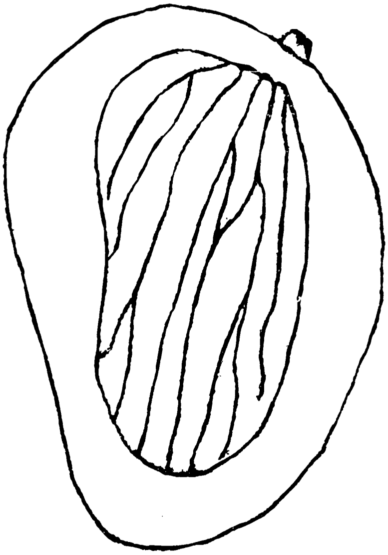


FIG. 11. *Bombay Green*

Bombay Green (Fig. 11).—Size small, length 70 mm., breadth 50 mm., weight 177 grams; form ovate-oblique to semi-reniform; base rounded; stem inserted obliquely; ventral shoulder quite high, dorsal shoulder falling away from stem in a wide curve; apex broadly rounded, with a scarcely noticeable beak; depression on lower ventral side slight; surface smooth, green; flesh deep orange yellow, soft, very sweet and agreeably flavored, devoid of fiber; seed about 19 mm. thick, weighing 21 grams.

The tree is hardy, of medium vigor, and prolific. The fruit ripens early in season and is a good keeper.[1]

SAHARANPUR

The fruit is small but of good quality. Considering also its earliness the variety probably is worthy of trial at high elevations.

Bombay Yellow (Fig 12).—Size small to medium, length 90 mm., breadth 65 mm., weight 234 grams, but the fruit somewhat larger than *Bombay Green* to which it is similar in general outline; surface smooth, green to yellow, tinged with red; flesh deep yellow in color, firm, very juicy and sweet, and of excellent flavor and quality; seed moderately large, 19 mm. thick, weighing 28 grams.

The tree is a free grower, cold resistant and productive. The fruit ripens in midseason, is a good keeper and rated as one of the best mango varieties in India.[1]

SAHARANPUR

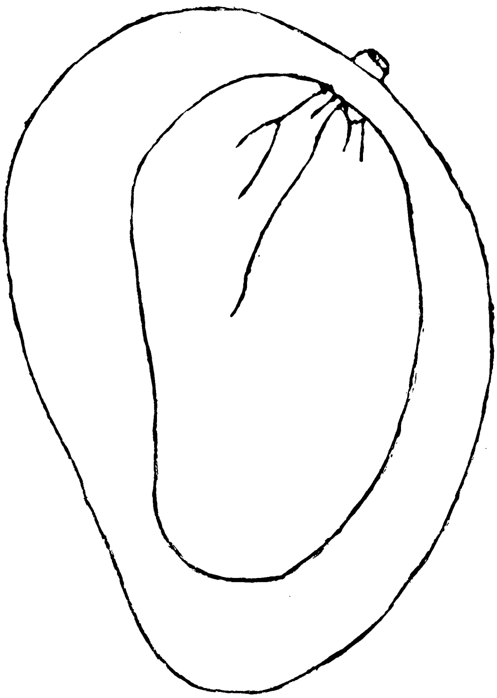


FIG. 12. *Bombay Yellow.*

One of the most desirable varieties for introduction, especially at high elevations.

Bonkhaja.—A round, very attractive, vermilion colored fruit with a prominent beak, from 450 to 900 grams in weight; the flesh is only moderately well-flavored. Season of ripening, July.[2]

MALDA

Borsha.—An oblong, bright green mango tinged with red on the sun-exposed side, weighing about 285 grams, of good quality.[6]

POONA

Brindabani (Fig. 13).—Size small, length 70 mm., breadth 59 mm., weight 156 grams; form obliquely short-oblong; stem inserted squarely in a small, shallow cavity; ventral shoulder broad, dorsal sloping away in a round curve from the stem; apex broadly rounded, the curve ending in a distinct beak; lower ventral side scarcely concave; surface smooth, green to yellow; flesh yellow, very juicy, highly aromatic and of good flavor, but

[6] Woodrow, G. M., Gardening in India, 1899.

very fibrous; seed medium large, relative to size of fruit, 19 mm. thick, weighing 14 grams.

The tree is a slow grower and a sparse bearer. The fruit ripens in midseason and is good keeper.[1]

SAHARANPUR

A variety apparently of very little value.

De also speaks of a *Brindabani* of excellent flavor grown in Malda but fails to describe it.

Budaya (*Bhadai*).—In India a group or class, also called *Malda*, of several varieties that seldom mature before the middle of July, and which sometimes remain on the trees until late in October. The fruits in this group are nearly all large, ranging from 450 to 900 grams in weight.[4]

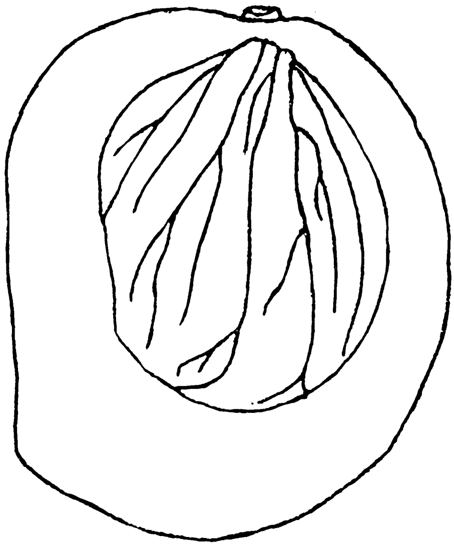


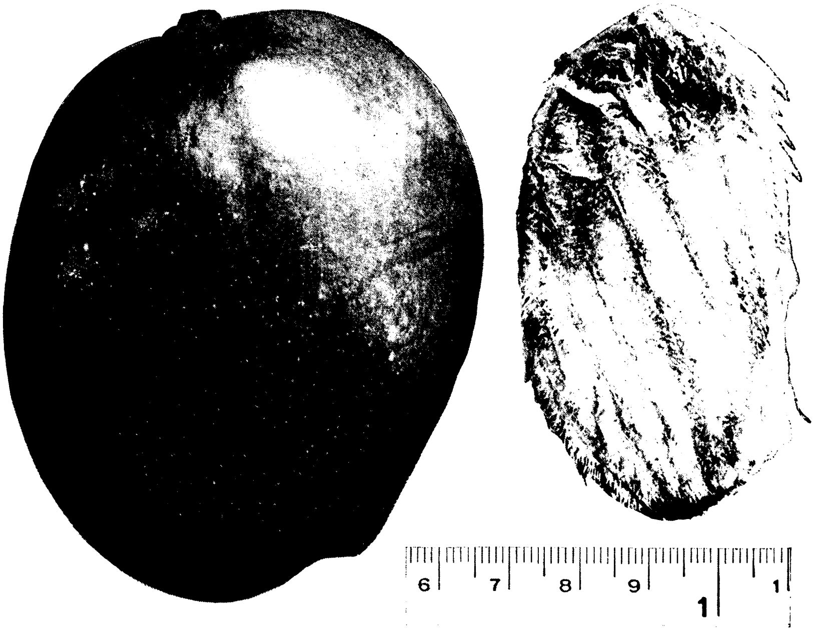
FIG. 13. *Brindabani*

Bulbulchasm (Fig. 14).—Size small, length 75 mm., breadth 60 mm., weight 120 grams; form short-elliptical, flattened; base rounded; stem inserted obliquely; ventral shoulder fairly well developed, dorsal shoulder sloping from stem; apex broadly rounded, nak well up on ventral side, prominent, with a marked depression above; surface smooth, green to yellow; flesh yellow, juicy, spicy, but very fibrous; seed large, 25 mm. thick, weighing 35 grams.

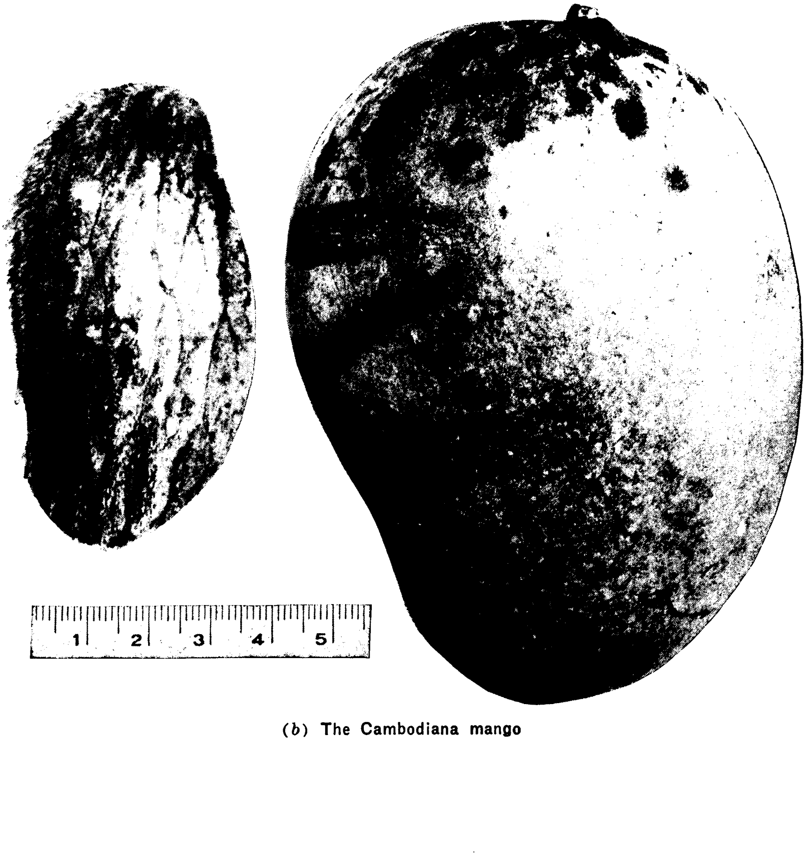
The tree is of good growth and cold-resistant, but a shy bearer. The fruit ripens in midseason and is good keeper.[1]

SAHARANPUR

According to this description the *Bulbulchasm* does not seem to have sufficient merit to warrant its culture, and is evidently not the variety described and illustrated by Kinman as grown in Porto Rico, though the plant material was originally obtained from Saharanpun.[3] The *Bulbulchasm* from Porto Rico is de-



(*a*) The Amini mango



(*b*) The Cambodiana mango

scribed as bearing fruits from 284 to 568 grams in weight, and so is a medium to quite large fruit. In form it is semi-reniform to oblong, with a nearly round cross section; base; "usually rounded, with 3 to 5 shallow depressions extending outward from the stem, the ventral shoulder more prominent than the dorsal. The nak is a dark russet speck situated 25 mm. above the rounded apex and at the apex of a slightly raised V-shaped area." The surface is smooth, dull yellow, tinged with green, having a deep, purplish red or bronze blush on the sun exposed side; bloom white, heavy; lenticels generally light gray, small and numerous toward the apex, toward the base larger with russet centers and more scattered; skin thick but not tough; flesh a rich yellow near the skin, darker near the seed, sweet, rich, aromatic and of good flavor and quality; practically devoid fiber, seed medium large.

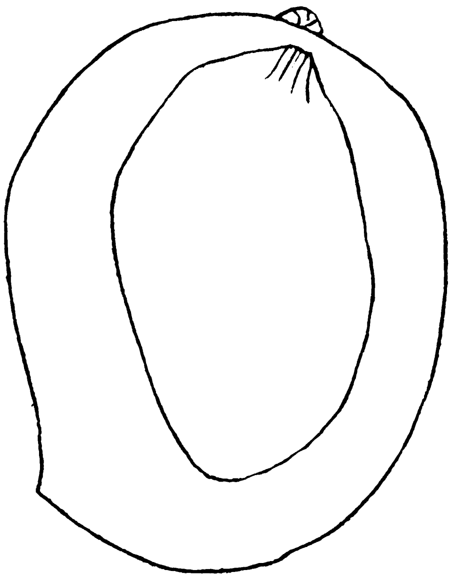


FIG. 14. *Bulbulchasm*

The tree is of short stature, precocious, fairly prolific and a regular cropper. A number of the trees in Porto Rico are said to "have developed large swellings at the points of branching and occasionally at internodes, which ultimately interfere with their development." [3]

Altogether, the Porto Rican *Bulbulchasm* would appear well worthy of introduction into the Philippines.

According to Maries this is one of the best mangos in India.

Calcutta Amin.—A large, reddish fruit of ordinary quality and small seed, ripening in midseason and a good keeper. The tree is cold resistant, of medium vigor, and a sparse bearer.[1]

SAHARANPUR

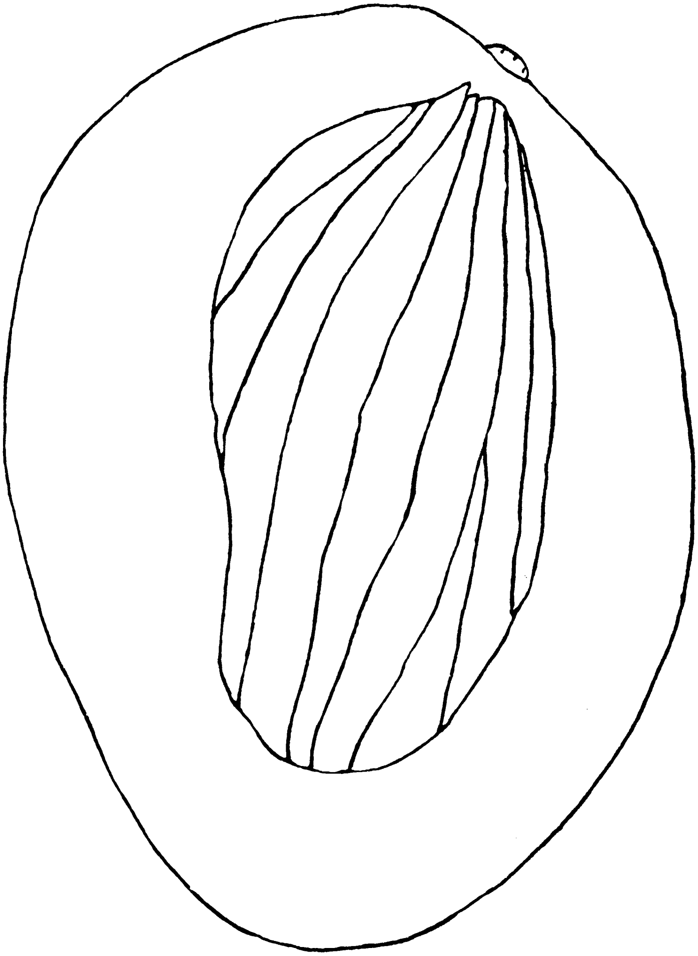


FIG. 15. *Chapta*

Cambodiana **(Plate XVI *b*).**—Size medium to fairly large, with an average weight of about 280 grams, attaining a maximum weight of 450 grams; form oblong-oval to semi-reniform, flattened; stem inserted obliquely, base rounded; ventral shoulder well developed, dorsal shoulder short and rounded, or sometimes almost lacking; apex broadly rounded without distinct beak; surface moderately smooth, greenish yellow to saffron yellow; lenticels numerous, russetted; skin thin; flesh yellowish, sweet, melting, juicy, and possessing a spicy, pleasant aroma, characteristic of the *Carabao* mango in the Philippines, free from fiber; seed medium to rather large, normally polyembryonic.

The tree is of vigorous growth, with long, broad leaves, precocious, prolific, and a regular bearer.[5]

The *Cambodiana* was introduced many years ago from Indo-China into the United States and because of its general excellence has become one of the popular mangos in Florida, Hawaii and Porto Rico.

An excellent fruit for local consumption the *Cambodiana* does not have the keeping qualities necessary for long distance shipments. In Hawaii it has been found highly resistant to the Mediterranean fruit fly, *Ceratitis capitata,* but highly susceptible to the attacks of the American fruit fly, *Anastrepha fraterculus,* in Porto Rico.

Especially recommended for introduction, as being more precocious than the *Carabao* and *Pico.*

Chakla.—A large, rounded mango, weighing 900 to 1,350 grams. Season August.[2]

MALDA

Though the quality of the fruit is not mentioned, the price quoted by De would show it to be a desirable variety.

Champa-daghi.—An undescribed variety said to be "little better than the ordinary mango." Ripening in July.[2]

MALDA

Chandani.—See *Sundali.*

Chapra.—See *Bherwa.*

Chapta (Fig. 15).—Size large, length 125 mm., breadth 90 mm., weight 411 grams; form ovate, flattened; stem inserted obliquely; ventral shoulder large; dorsal falling away from stem; apex broadly rounded, and the lower ventral side scarcely depressed; surface smooth, green; flesh deep yellow, juicy, sweet, with few fibers; seed medium large, 25 mm. thick, weighing 43 grams.[1]

SAHARANPUR

The above description is rather incomplete but would seem to show that the Chapta is a variety worthy of introduction and trial.

Charkichampa.—Description very incomplete, stating that the fruit is juicy but fibrous.[2]

MURSHEDABAD

This variety seems to have been named because the fruit has the odor of *Michelia champaca,* but otherwise has apparently no pomological merit.

Chickna (Fig. 16).—Size small, length 87 mm., breadth 64 mm., weight 184 grams; shape reniform; base and shoulders rounded, the dorsal shoulder more sloping; apex broadly round with a prominent beak well up on ventral side; lower ventral side concave; surface greenish yellow to reddish; flesh orange yellow, juicy, but not sweet, rather insipid and fibrous; seed quite large, 19 mm. thick, weighing 28 grams.

The tree is of good growth, cold resistant and prolific. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Apparently a variety not worthy of importation in the Philippines.

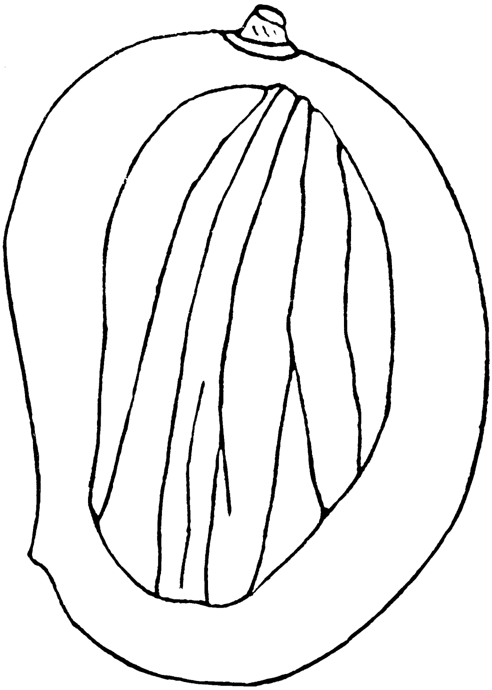


FIG. 16. *Chickna*

Chini sukker.—Description incomplete. Said to be light magenta in color; flesh "pink," sweet, juicy and devoid of fiber, with aroma similar to sandalwood, *Santalum album.*[2]

MURSHEDABAD

Chonga.—A large, very long, slender mango, weighing from 900 to 1,350 grams; the flesh is of indifferent quality. Ripens in July and August.[2]

MALDA

Choursa.—A round, sweet mango of ordinary quality.[2]

MALDA

Chutra.—An undescribed mango of medium size, weighing 225 grams, of ordinary quality.[2]

MALDA

Dadh mungo.—A medium sized, yellow fruit weighing 340 grams; the flesh is white, very sweet and juicy. The tree is very prolific, the fruit growing in bunches. Season July.[2]

HAJIPUR

Worthy of attention especially because of its productiveness.

Darika.—A large, elongate fruit, sometimes attaining a weight of 900 grams; the flesh is sweet, but lacking in flavor. Season, July and August.[3]

MALDA

Darma.—A roundish, large mango sometimes attaining a weight of 900 grams; the flesh is very sweet, rich and of good flavor, resembling that of Bael, *Belou marmelos* Lyons, but said to be "tough."[2]

DARBHANGA

Daudbogh.—A fruit of medium size, rarely exceeding 225 grams in weight, cylindrical in shape, surface yellowish; the flesh is of excellent flavor. Ripens in August.[2]

MURSHEDABAD

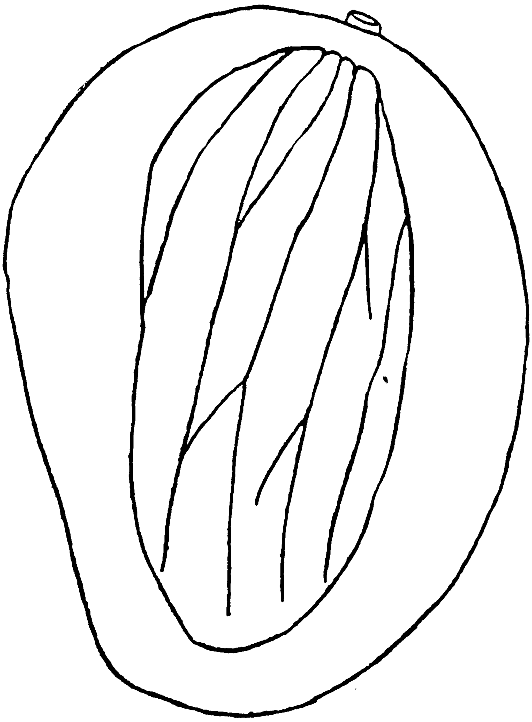


FIG. 17. *Davys*

Davys (*Davy's Favorite*) (Fig. 17).—Size small to medium, length 95 mm., breadth 70 mm., weight 213 grams; form oval to semi-reniform; base and shoulders rounded; apex broadly rounded, with a hardly distinguishable beak; lower ventral side hardly depressed, surface smooth, green to yellowish; flesh yellow, rather dry, subacid, with but little fiber, seed quite large, 19 mm. thick, weighing 35 grams.

The tree is a good grower but a poor cropper. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

The above description tallies quite well with that of Kinman who describes and illustrates it from Porto Rico, under the name *Davy's*. Here the plate shows a heavy coat of short fibers adhering to the seed.[3]

Lacking especially desirable features, considering its shy bearing qualities, there is apparently nothing to recommend its culture.

Dayal Singh.—A medium sized fruit, weighing 225 grams, elongate and thin skinned. The fruit ripens late, until the middle of October.[2]

HAJIPUR

Derrima.—See Durma.

Dhumo.—A round, very large fruit, with moderately sweet flesh.[2]

JAYNAGAR

Dilsaj.—A large, oval, thick-skinned fruit from 900 to 1,350 grams in weight; the flesh is subacid and somewhat fibrous. The tree is very prolific and the fruit ripens in July and August.[2]

MALDA

Divine.—A medium sized, ovoid-oblique, somewhat flattened mango, 225 grams in weight; the surface is greenish yellow with a dull red blush at the base, rather rough and unattractive; the flesh is sweet, rich and juicy but without character; the seed is of medium size.

The tree is of slow growth, but precocious, prolific and a regular bearer. The fruit is resistant to the American fruit fly.[3]

According to Kinman, from whose description the above adaptation has been made, the *Divine,* which is of West Indian origin, is a second rate variety even for home use, and is not recommended for commercial planting.

Doanti.—The variety is said to have no special merit and has been named because the fruit has twin seeds, "one as usual, and the other in the so-called tumor." [2]

MURSHEDABAD

Dudia (Doodia).—This name applies to a group of mangos of which there are several varieties. The description is very incomplete, merely stating that the flesh is whitish, sweet and very juicy but fibrous.[2]

MURSHEDABAD

Dula (Doola).—An obscure mango, said to have the flavor and aroma of the cantaloupe, *Cucumis melo* L.[2]

DARBHANGA

Durga-bhog.—A very large, flattened, vermilion colored mango, from 450 to 1,800 grams in weight; the flesh is of good flavor, free from fiber. The fruit ripens from the end of July to the middle of September. Highly esteemed.[2]

MALDA

Durgilal (Doorgilal).—A long mango with prominent beak weighing from 675 to 900 grams and sweet flesh. Ripening from July to September. Susceptible to fruit flies. See *Kerowa.*[2]

DARBHANGA

Durma (*Derrima*).—A medinm sized, roundish, yellow mango, from 225 to 450 grams in weight, with firm flesh of exquisite flavor resembling vanilla. Season, June and July.[2]

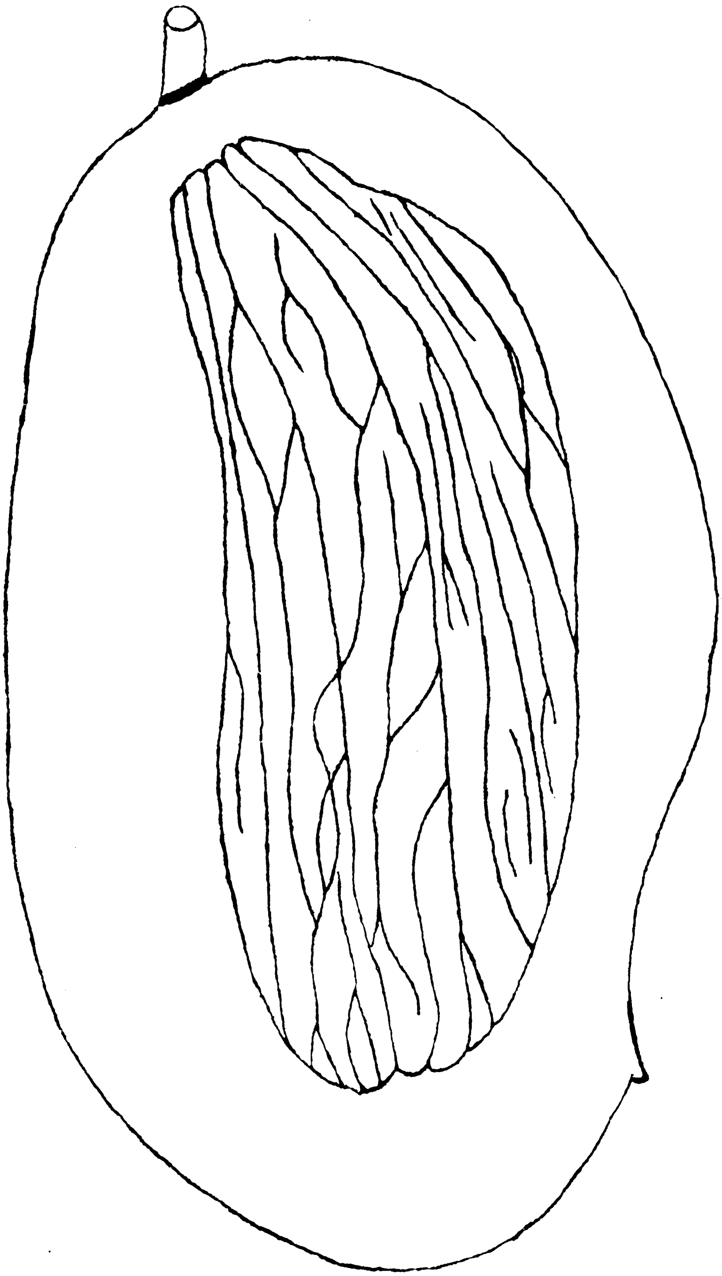


FIG. 18. *Enuria*

Maries [4] speaks of another variety similar except in having a red exterior.

Enuria (*Ennurea*) (Fig. 18).—Size large, more than 160 mm. long, 95 mm. broad, weighing 737 grams; form oblong-elliptical, asymmetrical; base rounded, dorsally falling rather abruptly from stem; stem inserted obliquely; ventral shoulder comparatively short, rounded; upper ventral side well filled out, lower distinctly concave and with a prominent beak; surface light green to yellow; flesh deep yellow, juicy but firm, of good flavor, recalling that of the Bael, *Belou marmelos* Lyons, with abundant fiber; seed large, 31 mm. thick, weighing 70 grams.

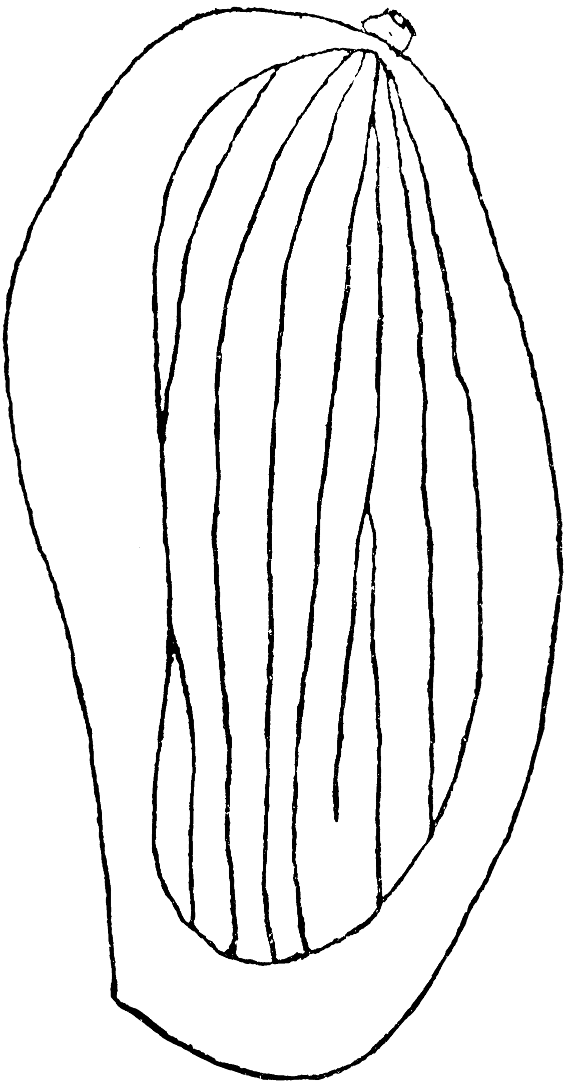


FIG. 19. *Fajri* (long)

The tree is a slow grower and a shy bearer. The fruit ripens in mid-season and is a poor keeper, but is in India considered to rank high in quality.[1]

SAHARANPUR

The above described variety does not correspond to the one of the same name introduced into Florida from India, which is very fibrous and of poor quality.

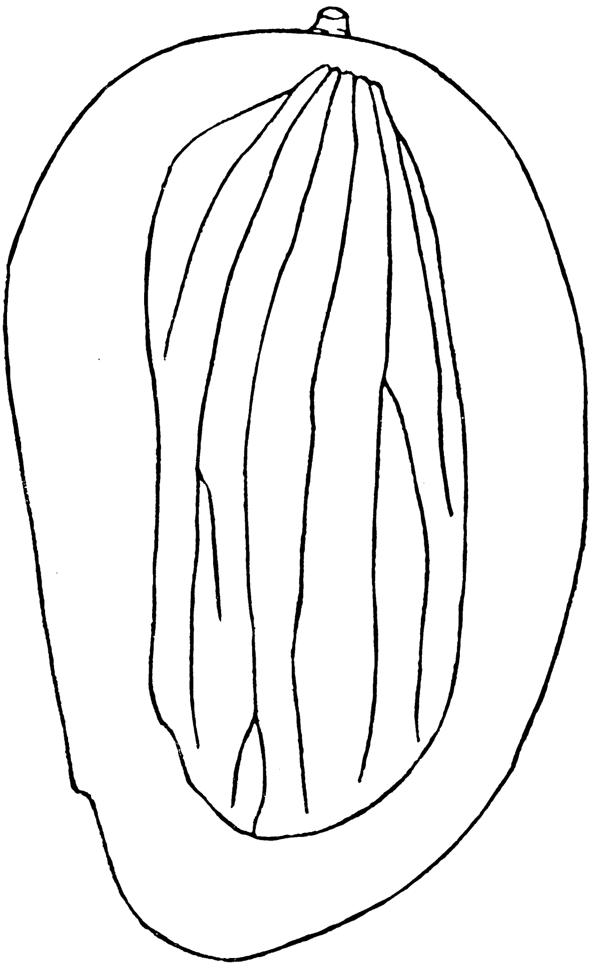


FIG. 20. *Fajri* (round)

Fajri Long (Fig. 19).—Size medium, to quite large, 140 mm. long, breadth 73 mm., weight 411 grams; form asymmetrically elliptical-oblong, flattened; stem inserted obliquely; base rounded; ventral shoulder short, dorsal shoulder falling abruptly from stem; apex broadly rounded, curved to a distinct beak; concavity on lower ventral side long and shallow; surface uneven, green, tinged with yellow and red; flesh deep yellow, sweet, of good flavor, and with few fibers; seed thin, 19 mm. thick, weighing 28 grams.

The tree is of medium vigor, cold resistant, and a shy bearer. The fruit ripens late in season and keeps well.[1]

SAHARANPUR

A variety well worthy of introduction, especially for high elevations.

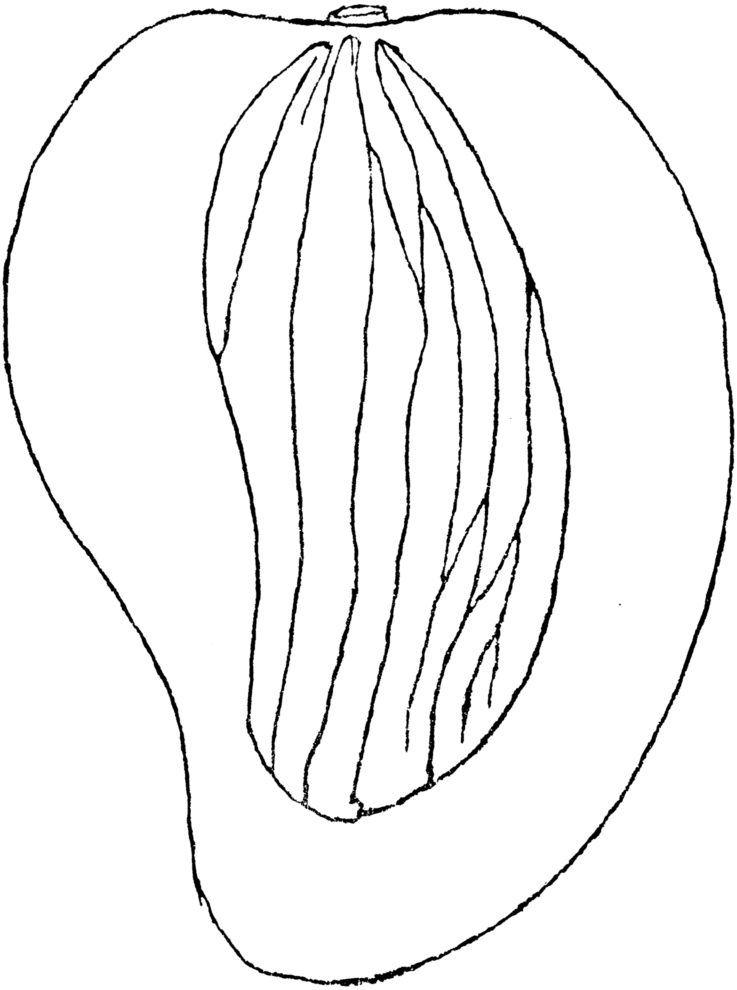


FIG. 21. *Faqirwala*

Fajri Round (Fig. 20).—Size small, weight 177 grams; form ovate-oblique; stem inserted squarely; shoulders rounded, about equal; apex broadly rounded without a distinct beak but with a prominent nak; lower light yellow, rather firm and dry, fiber not abundant; seed small, 19 mm. thick, weighing 14 grams.

The tree is of medium vigor, cold resistant and a sparse bearer. The fruit ripens late in season and is a good keeper.[1]

SAHARANPUR

The line drawing does not correspond in size with the description as given in the original notes, being considerably larger. A fruit of indifferent merit, its strong point being hardiness.

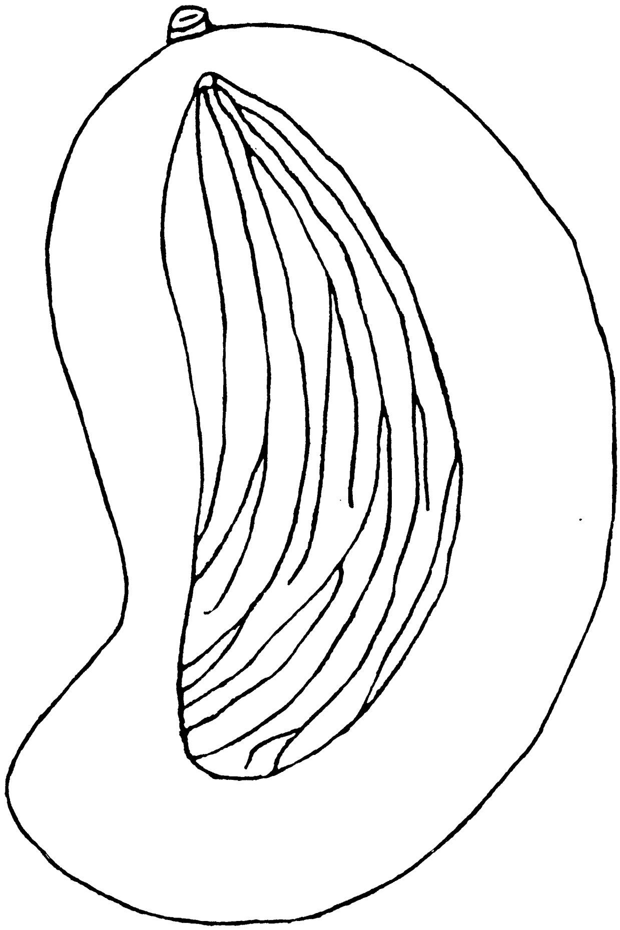


FIG. 22. *Fasli*

Faqirwala (Fig. 21).—Size large, length 130 mm., breadth 95 mm., weight 609 grams; from obliquely ovate, attractive; stem inserted squarely in a wide, shallow cavity; shoulders raised, medium broad, about equal; apex rounded; upper ventral side well filled, lower a deep concavity; surface green, tinged with yellow; flesh light yellow, juicy, subacid, of excellent quality, devoid of fiber; seed comparatively small, 19 mm. thick, weighing 50 grams.

The tree is a free grower, cold resistant, and a shy bearer. The fruit ripens late in season and keeps well.[1]

SAHARANPUR

In India this variety is rated as one of the best and should be introduced both because of its general excellence, late ripening season and probable suitability to high elevations.

Faizan.—The description of this variety is rather deficient, merely stating that the fruit is of medium size, green to yellow, of good flavor with a small seed.

The tree is of vigorous growth and cold resistant, but is a shy bearer. The fruit matures in midseason and is a good keeper.[1]

SAHARANPUR

Apparently an average fruit.

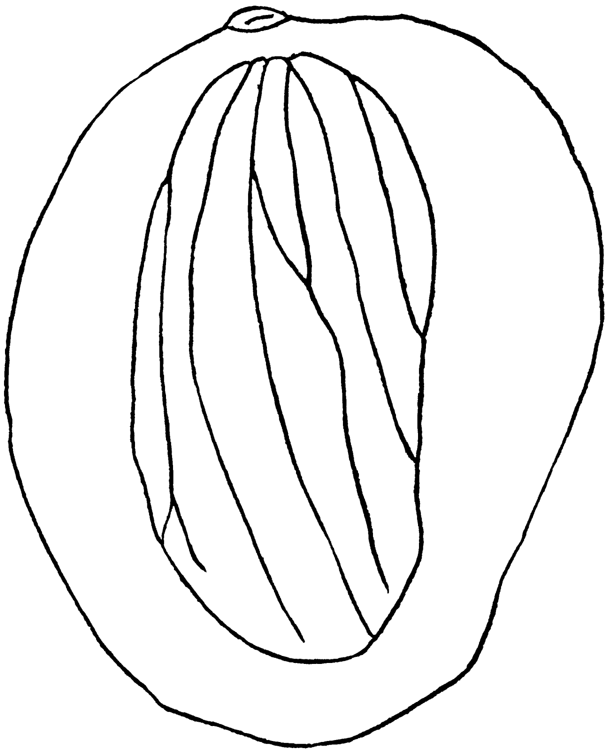


FIG. 23. *Gajria*

Fasli (Fig. 22).—Size medium, length 120 mm., breadth 70 mm., weight 312 grams; semi-reniform; base and shoulders rounded, the latter about equal; apex broadly rounded, curved into a prominent beak; cavity on lower ventral side unusually large and of rather sharp angle; surface smooth, green to yellow; flesh light yellow, juicy, sweet, without much fiber; seed medium, 20 mm. thick, weighing 32 grams.[1]

SAHARANPUR

A variety of average merit.

Fernandez.—This variety is said to be in all respects similar to the *Alfonso* but ripening in July when the season of *Alfonso* is past.[2]

BOMBAY

Fuzli (*Fuzlee Bewa*).—A large, flat, green mango, weighing from 450 to 1,800 grams; the flesh is fiberless and of good flavor. The fruit ripens from the end of July to October. Highly esteemed in India.[2]

MALDA

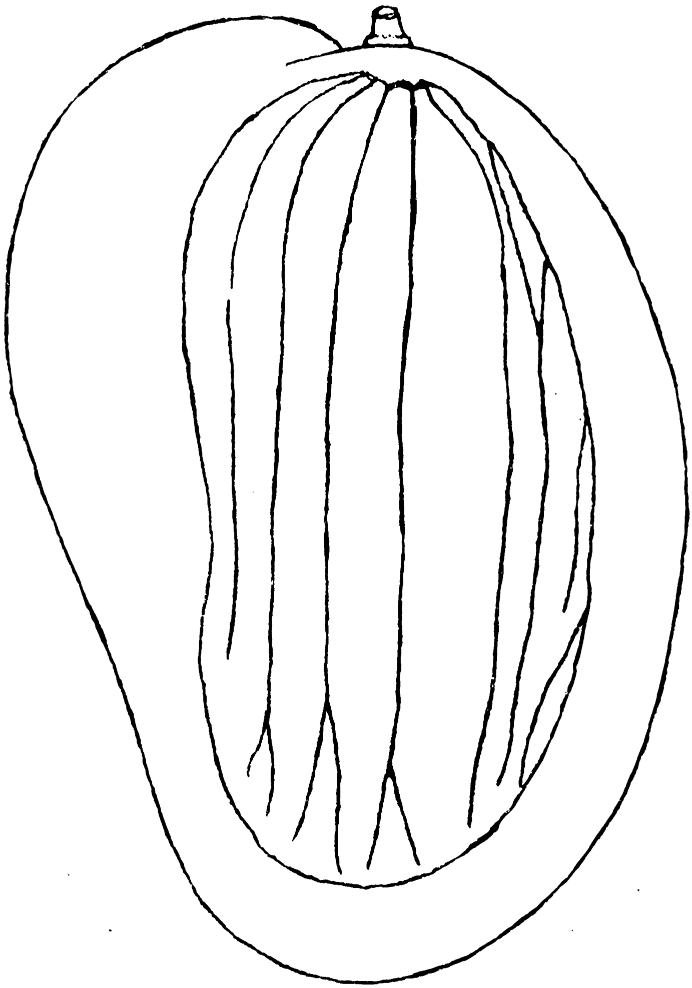


FIG. 24. *Gola*

Gajria (Fig. 23).—Size rather small, length 97 mm., breadth 78 mm., weight 291 grams; form asymmetrically short-ovoid; base rounded; ventral shoulder fairly well developed; dorsal shoulder falling away from stem in a gentle curve; apex rounded; lower ventral side scarcely depressed; surface greenish yellow; flesh light yellow, pleasantly subacid, but fibrous; seed rather large, 25 mm. thick, weighing 21 grams.[1]

SAHARANPUR

A variety of indifferent merit.

Ganeshbhog.—A small, sweet mango of ordinary quality.[2]

MALDA

Gola (Fig. 24).—Size quite large, length 130 mm., breadth 88 mm., weight 538 grams; form obliquely oval to semi-reniform; ventral shoulder high; dorsal shoulder falling away in a gentle curve; apex broadly rounded, a shallow depression on lower ventral side; surface smooth, pale green to yellow; flesh light orange yellow, sweet, juicy, of good flavor and but little fiber; seed medium large, 19 mm. thick, weighing 28 grams.

The tree is a good grower, cold resistant, but a shy bearer. The fruit ripens late in season and is a good keeper.[1]

SAHARANPUR

Except for its poor bearing qualities this would appear to be a very desirable variety, especially adapted to high elevations.

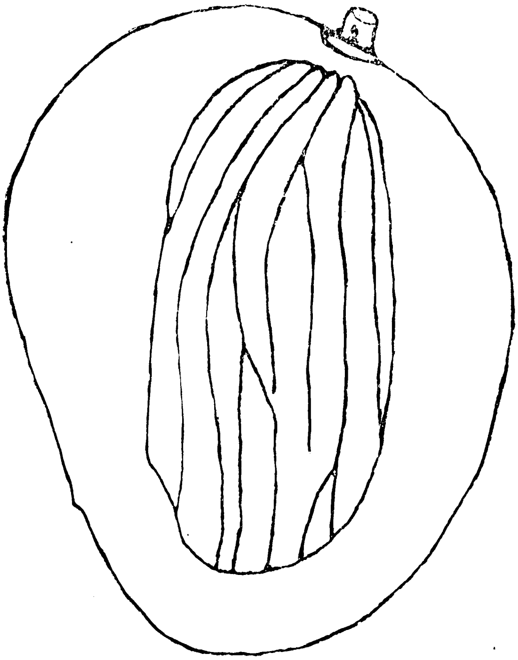


FIG. 25. *Gopalbhog*

Golab-bash (*Golab-khash*).—An elongate, yellow, thin-skinned, medium-sized mango, weighing about 225 grams; the flesh is of excellent flavor, and has a rose-like aroma.[2]

MALDA

Gopalbogh (Fig. 25).—Size small, length 85 mm., breadth 67 mm., weight 149 grams; form oval; stem inserted obliquely; base and shoulders rounded, the ventral shoulder well developed, the dorsal falling away in a rounded curve from stem; apex rounded; surface smooth, green to yellow; flesh deep yellow, juicy, very sweet, of good flavor and aroma, and but little fiber; seed medium large, 19 mm. thick, weighing 21 grams.

The tree is of good growth, cold resistant and prolific. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Notwithstanding the small size of the fruit this variety is ranked as one of the best in India and would merit importation for trial, especially in the higher altitudes. Apparently this is the *Gopalbogh* also described by Maries [4] and De [2] though the latter gives the weight as from 225 to 280 grams.

Gopal-dhoba.—An oval, green, very sweet and well flavored mango. Very similar to the *Fuzli*, and ranking as one of the best mangos in India.[2]

JAYNAGAR

Gopinath-bhog.—A mango said to be very similar to *Gopalbhog*, but, commanding a lower price, it is probably inferior to that variety. Ripening in June.[2]

MALDA

Gordon (*General Gordon*).—Average weight 260 to 370 grams; form irregularly elliptical ovate, with prominent nak 2 to 2.5 centimeters above apex; surface smooth; color chrome yellow suffused with green, tinged with orange vermillion on sun-exposed side; lenticels brownish; skin medium thick; flesh yellow; flavor richer than in the *Totapari* but less delicate; quality good; fiber medium; seed medium to rather large, monoembryonic.

Matures during June and the early part of July. The variety is moderately vigorous and fairly prolific.[5]

The Gordon was introduced from the British West Indies into Florida many years ago but has long since been discarded in favor of other, better varieties.

Gowrya Malda.—See *Malda.*

Gulsukri.—A cone-shaped, "apple-colored" fruit; the flesh is sweet, with the odor of the rose, devoid of fiber; seed very thin.[2]

MURSHEDABAD

Guria (*Gooria*).—A medium-sized, yellow fruit; the flesh is sweet, juicy, without fiber.[2]

MURSHEDABAD

Haden (Plate XVII *a*).—Size medium to fairly large, occasional fruits attaining a weight of 680 grams; form roundish-oblique, a trifle longer than broad; surface apricot-yellow overspread with rich crimson; skin thick; flesh firm, very juicy, a trifle coarse in texture, of good to very good flavor; fiber usually scant but sometimes abundant enough to be objectionable.[7]

---

[7] Description furnished by Dr. David Fairchild, United States Department of Agriculture, Washington.

The tree is productive and the fruit ripens in July.

The Haden is a seedling of the Mulgoba and originated in Cocoanut Grove, Florida, in which State it is now the leading mango.

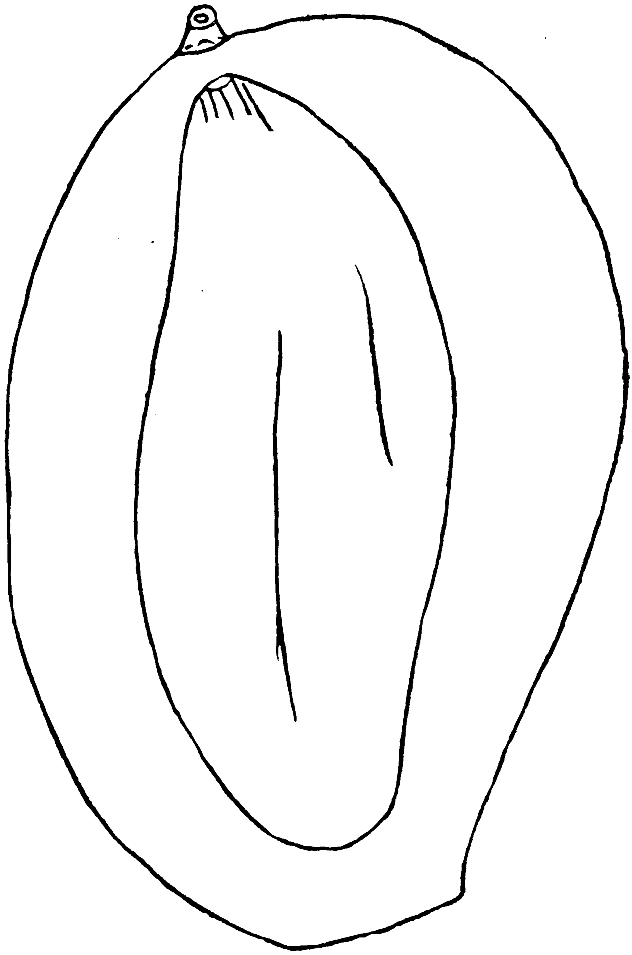
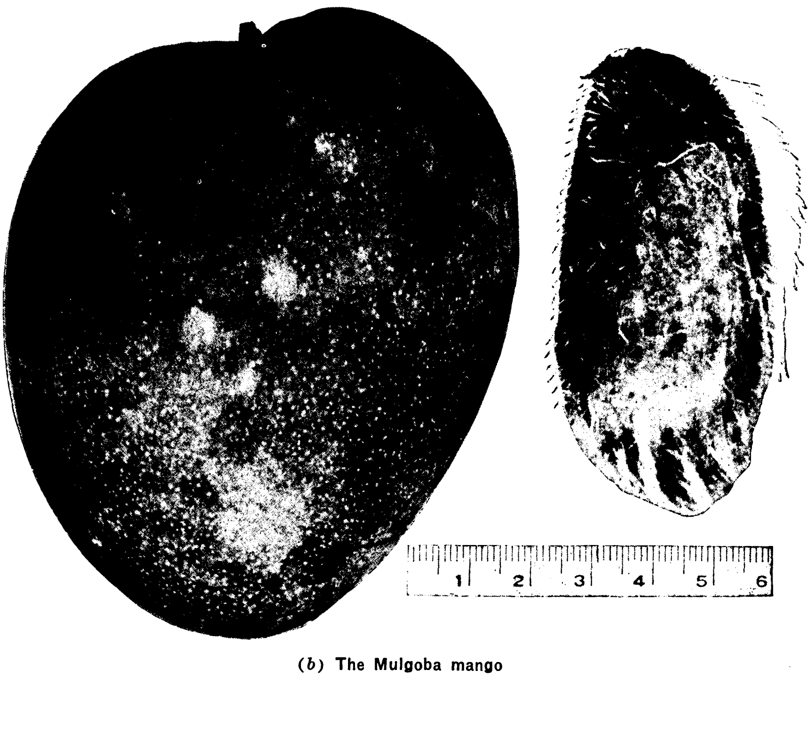


FIG. 26. *Hain Sahib*

Hain Sahib (Fig. 26).—Size medium, length 125 mm., breadth 80 mm., weight 376 grams; form obliquely oval, flattened, attractive; stem inserted obliquely; base rounded; ventral shoulder high and well developed; dorsal shoulder falling away from stem; apex broadly rounded, the curve ending in a distinct beak; upper ventral side full and rounded, with a slight depression above beak; surface smooth, light green tinged with yellow and red; flesh light yellow, juicy, pronouncedly resinous in flavor, with but little fiber; seed medium large, 19 mm. thick, weighing 32 grams.[1]

SAHARANPUR

(*a*) The Haden mango



(*b*) The Mulgoba mango

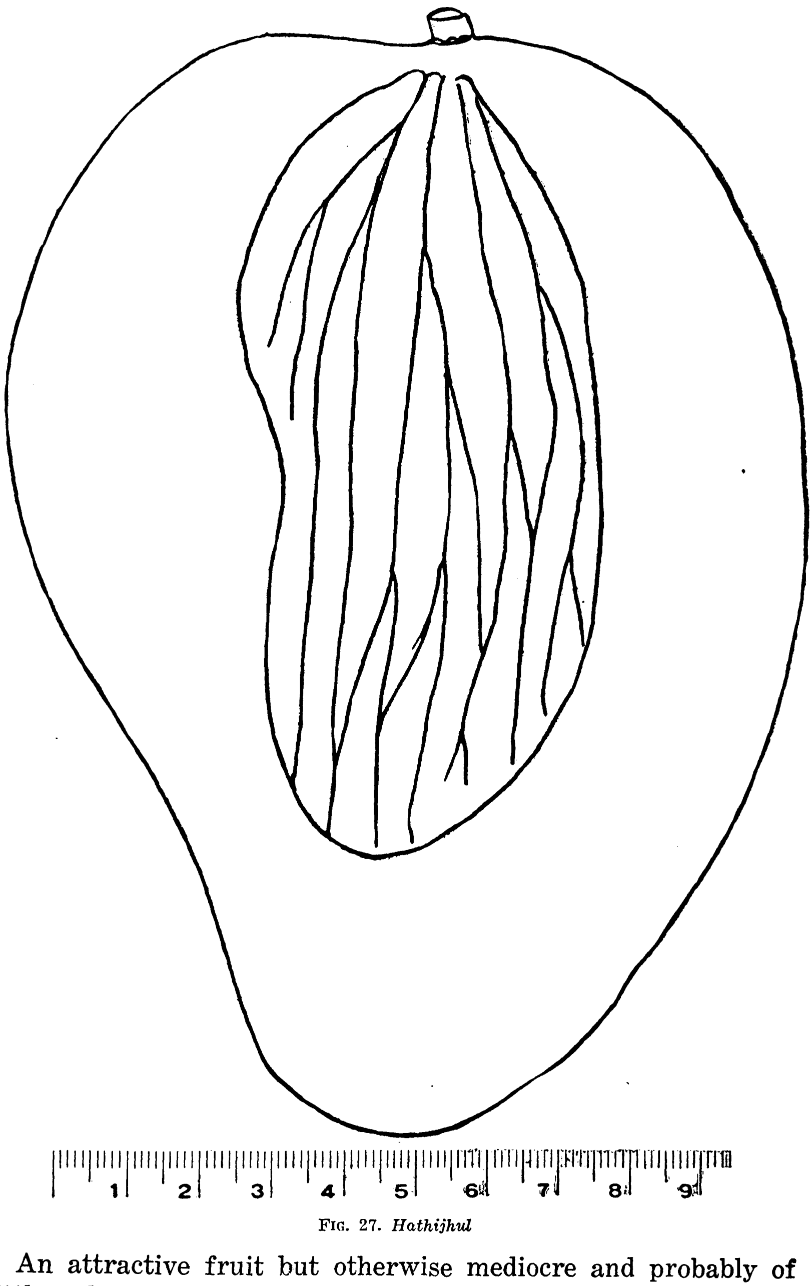


FIG. 27. *Hathijhul*

An attractive fruit but otherwise mediocre and probably of little value.

Hathijuhl (Fig. 27).—Size large, length 150 mm., breadth 110 **mm.**, weight 609 grams; form asymmetrically ovate to oblong-cordate; **stem** inserted squarely in a shallow cavity; shoulders well developed, nearly equal, the ventral broader than the dorsal; apex rounded; upper ventral side well filled out, below pronouncedly concave; surface smooth, green tinged with yellow; flesh orange yellow, very juicy, subacid, of good quality and scant fiber; seed comparatively small, thin, 25 mm. thick, weighing 57 grams.

The tree is a free grower, cold resistant, medium prolific, ripening late in season.[1]

SAHARANPUR

A variety of more than ordinary value, deserving importation, particularly for trial at high elevations.

Himsagar.—A fruit of ordinary size; the flesh is red, sweet, with a trace of acidity, of good flavor and fiberless. The tree is prolific and the fruit ripens early in season.[2]

BOMBAY

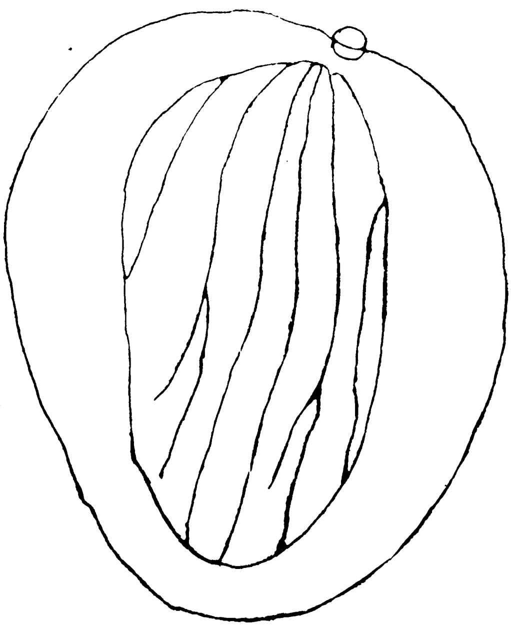


FIG. 28. *Kachamitha*

Hsapeti.—A long, flattened, medium sized mango, weighing from 225 to 450 grams, of ordinary quality.[2]

MALDA

Inerna.—A very large fruit, sometimes attaining a weight of 1,800 grams, of good flavor. Season July and August.

Maries speaks of this as having originated in Durbhanga.[4]

Itamaracá.—A small, oblate, smooth, greenish mango from 170 to 200 grams in weight; the flesh is rich yellow, juicy, subacid, spicy, aromatic and free from fiber, the seed medium large.

The tree is precocious and very prolific, and the fruit ripens in August and September. Not equal in quality to the best kinds. Valuable chiefly because of its late ripening habit.[3]

The Itamaracá is a mango of Brazilian origin, which has been imported and fruited in Porto Rico.

Ithada.—A medium sized, round fruit; the flesh is sweet and juicy containing few fibers.[2]

MADRAS

Jalibandha (large).—A medium sized to fairly large, thick-skinned, round mango with a prominent beak, weighing about 450 grams; the flesh is sweet and of good flavor. Ripens in July and August.[2]

MALDA

Possibly the variety referred to as *Jallibund* by Maries.[4]

Jalibandha (small).—An oblong, medium-sized mango, weighing about 340 grams; the flesh is a trifle fibrous, but somewhat better in flavor than the ordinary mango. Ripens in July and August.[2]

MALDA

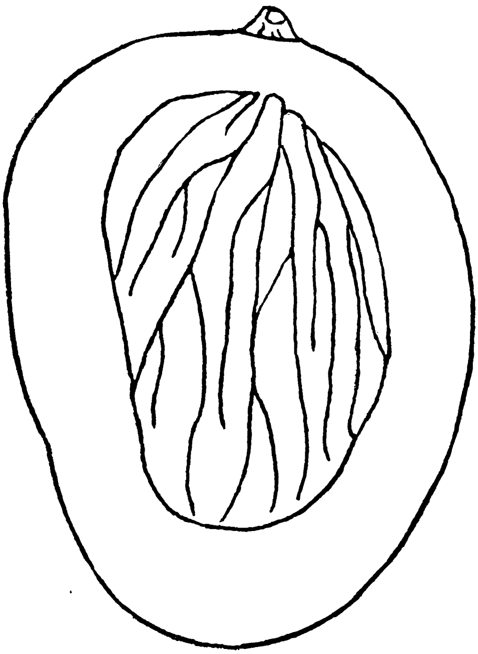


FIG. 29. *Kachmahua*

Kachamitha (Fig. 28).—Size small, length 80 mm., breadth 67 mm., form short oval; stem inserted obliquely; ventral shoulder high and prominent, dorsal shoulder short and rounded; apex broadly rounded with a trace of depression on lower ventral side; surface smooth, greenish yellow tinged with red; flesh deep yellow, juicy, very sweet, even before attaining full maturity, with but little fiber; seed small, 19 mm. thick.

The tree is a good grower, resistant to cold and prolific. The fruit ripens early in season and keeps well.[1]

SAHARANPUR

This is rated as one of the best mango varieties in India.

Kachmahua (Fig. 29).—Size small, length 82 mm., breadth 62 mm., weight 205 grams; form obliquely oval; base broadly rounded, the ventral shoulder a trifle more prominent than the dorsal; apex broadly rounded with a slight depression on ventral lower side; surface smooth, green to

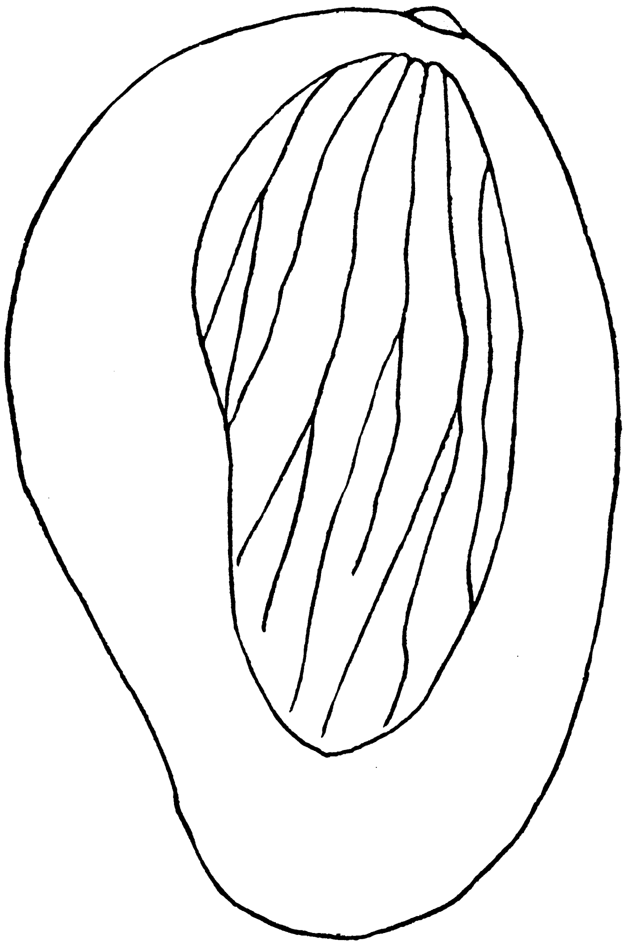


FIG. 30. *Kachmahua* (seedling)

yellow with a touch of red; flesh yellow, very juicy, sweet and of good flavor but fibrous; seed comparatively large, 19 mm. thick, weighing 21 grams.

The tree is of good growth, cold resistant and productive, and the fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Because of its small size and fiber this variety is apparently not worthy of attention.

Kachmahua Seedling (Fig. 30).—Size medium, length 123 mm., breadth 81 mm., weight 376 grams; form asymmetrically oval; base rounded, ventral shoulder prominent, dorsal falling almost abruptly from stem; apex broadly rounded; upper ventral side full, lower concave; surface smooth, light yellow; flesh yellow, juicy and sweet, with a flavor resembling raspberry, *Rubus idaeus*, drops, and with but little fiber; seed small, 19 mm. thick, weighing 21 grams.[1]

SAHARANPUR

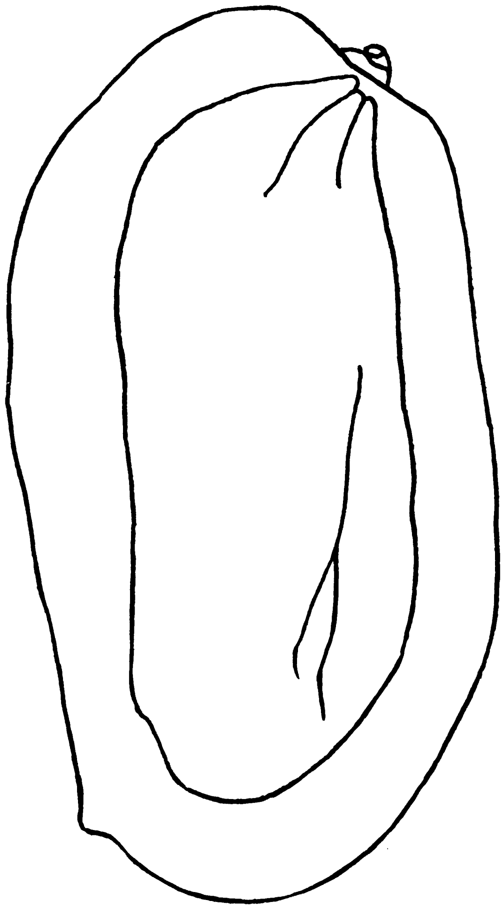


FIG. 31. *Kakaria*

An average fruit, but quite superior to the parent, it illustrates the well known trait of the Indian monoembryonic mango not to reproduce itself true to seed like the polyembryonic races.

Kakaria (Fig. 31).—Size medium, length 120 mm., breadth 65 mm., weight 333 grams; form oblong oblique; base equal; stem inserted obliquely; ventral shoulder high and quite prominent, dorsal shoulder short and then falling abruptly; apex broadly rounded, the curve ending in a distinct beak coincident with nak; surface smooth, yellowish green; flesh light yellow, very juicy, subacid, of fair flavor but very fibrous; seed large, 19 mm. thick, weighing 35 grams.[1]

The tree is of vigorous growth, cold resistant and prolific, but because of the poor quality of the fruit, notwithstanding its good keeping qualities, this variety is not recommended for importation.

SAHARANPUR

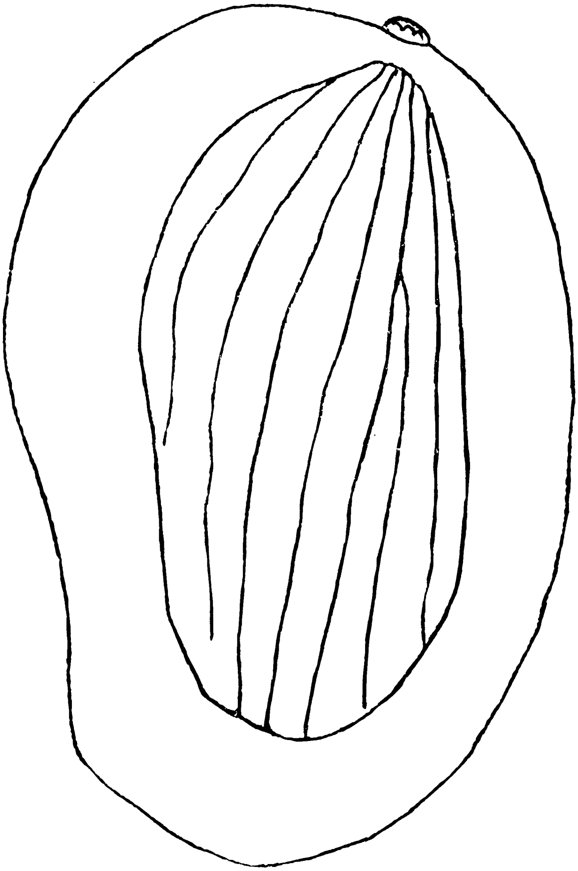


FIG. 32. *Kakria stud*

The *Kakoria* described by Maries [4] is hardly the same variety, since it is spoken of as a "most luscious, refreshing fruit," up to 450 grams in weight. The fruits would appear to be highly susceptible to decay on the tree as they are said to be seldom gathered in good condition.

Kakria Stud (Fig. 32).—Size medium, length 115 mm., breadth 75 mm., weight 298 grams; form nearly elliptical oblong, oblique; stem inserted obliquely; base rounded; ventral shoulder prominent, dorsal shoulder short;

apex broadly rounded, curving into a dull-pointed beak; lower ventral side concave; surface smooth, green; flesh deep yellow, very juicy and sweet, with few fibers; seed large, 25 mm. thick, weighing 50 grams.[1]

SAHARANPUR

A variety of average quality.

Kala (Fig. 33).—Size medium, length 105 mm., breadth 77 mm., weight 255 grams; form short-ovate, irregular; stem inserted obliquely; ventral shoulder quite high, dorsal shoulder short, rounded; apex broadly rounded; lower ventral side convex, irregular; surface uneven, green to yellow; flesh light yellow, subacid, juicy, of good flavor and but little fiber; seed large, 19 mm. thick, weighing 43 grams.

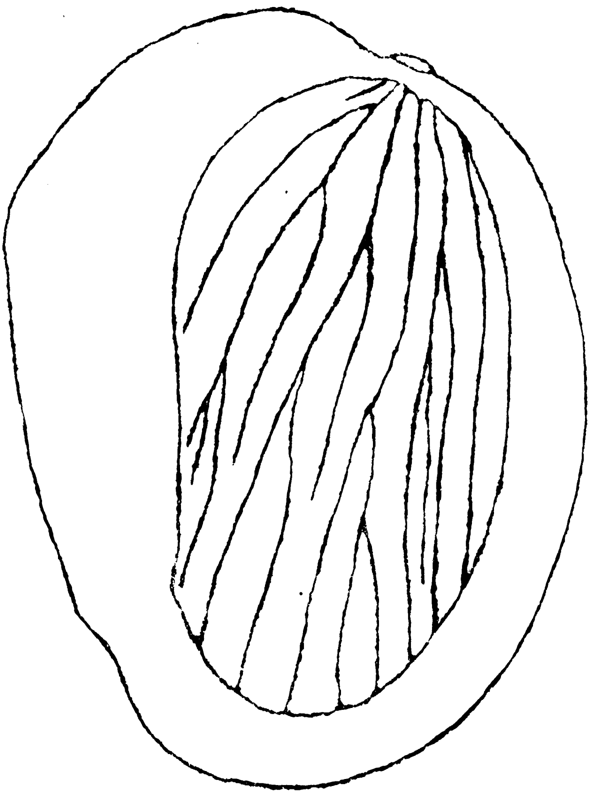


FIG. 33. *Kala*

The tree is a free grower, resistant to cold, and a shy bearer. The fruit is a good keeper and ripens in midseason.[1]

SAHARANPUR

Rather below the average mango in merit.

Kala-Alphonse.—According to Woodrow a fruit similar to *Alfonso* in flavor but smaller, containing a large seed.[6]

BOMBAY

Kalachand-bhog.—An oval mango of medium size weighing about 225 grams; the flesh is of good flavor. Ripening season, July.[2]

MALDA

Kalapahar.—A fairly large fruit up to about 400 grams in weight, green and thin-skinned; the flesh is very sweet, juicy, devoid of fiber and exquisitely flavored. Seed thin and small.[2]

MURSHEDABAD

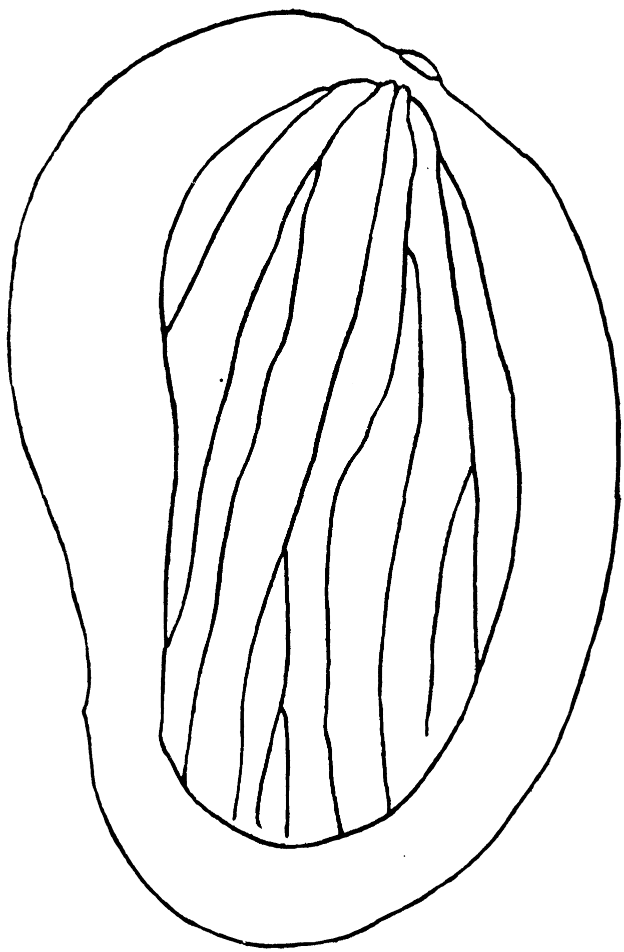


FIG. 34. *Karania*

Kalapahar (No. 2).—A large fruit weighing 900 grams, cylindrical in shape; the flesh is pale yellow, sweet and subacid, with a small seed. Rather late in season, ripening at the end of August.[2]

HAJIPUR

A different variety from the one from Murshedabad.

Kalua.—A very small, round, flattened mango; the flesh is of good flavor. Season, June.[2]

MALDA

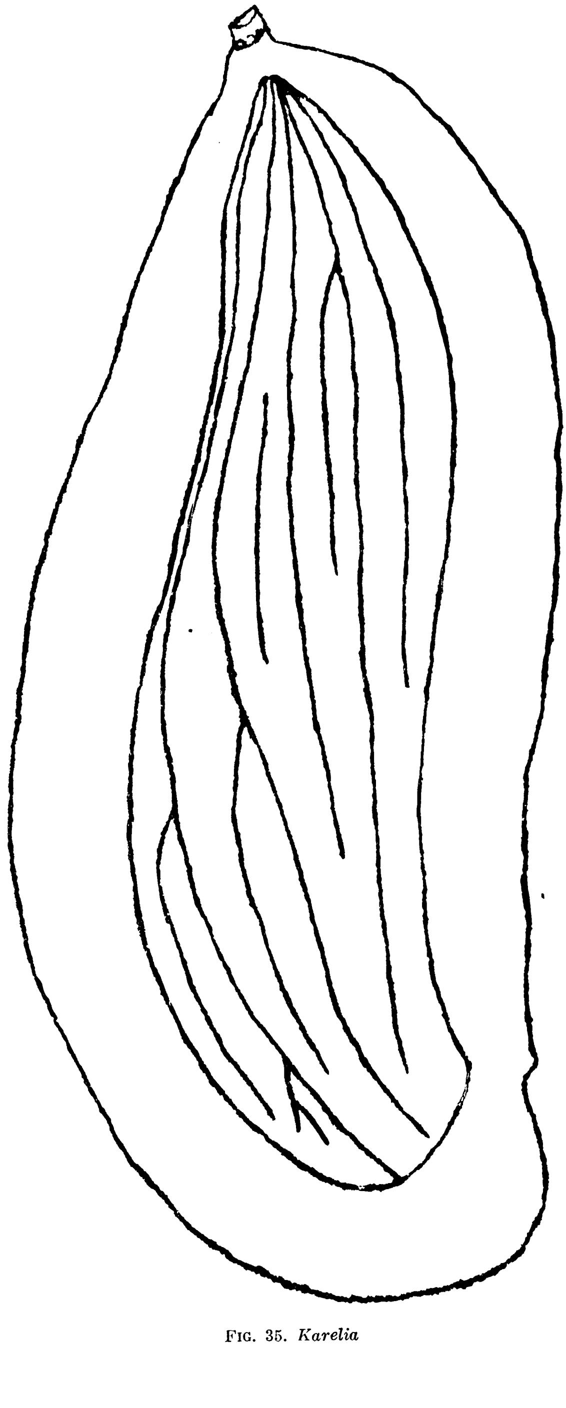


FIG. 35. *Karelia*

Kanchan-Kasha.—A long, quite large fruit, 450 to 675 grams in weight; the flesh is of ordinary quality. Season, July and August.[2]

MALDA

Kancha-Mitia.—Undescribed, but said to be similar to *Kanchan-Kasha* except that the fruit ripens in June and July.[2]

MALDA

Karania (Fig. 34).—Size medium, length 125 mm., breadth 80 mm., weight 312 grams; form obliquely ovate; stem inserted obliquely; ventral shoulder quite high and well developed, dorsal shoulder sloping; apex broadly rounded, upper ventral side well filled out, lower distinctly concave; surface smooth, green; flesh deep yellow, very juicy, aromatic, with but little fiber; seed quite large, 25 mm. thick, weighing 43 grams.[1]

SAHARANPUR

An average variety.

Karbuza.—See Kerbuza.

Karelia (Fig. 35).—Size medium large, length 170 mm., breadth 70 mm., weight 375 grams; form oblong, slender, asymmetrical; base nearly acute, ventral shoulder short and rounded, dorsal shoulder wanting, greatest width below middle; apex broadly rounded, the curve ending in a rounded beak; nak quite distinct, well up on ventral lower side which is markedly depressed; surface ribbed longitudinally (resembling the Karela, *Momordica charantia*, whence the name) green; flesh yellow, firm and rather dry, subacid, devoid of fiber; seed long and thin, 19 mm. thick, weighing 28 grams.[1]

SAHARANPUR

Quite a remarkable variety and apparently having much in common with the *Sandersha*, which see. Possibly identical with Maries' *Kurrelna.*[4]

Karpuria (*Maharaj Pasand*).—A small, oblong mango, very sweet and devoid of fiber, with the flavor of camphor, and having a large seed. Season, July and August.[2]

DARBHANGA

Kartika (*Kartika Jaffer Shah*).—Quite a large mango, weighing 680 grams, long and flattened, thin-skinned; the flesh is red, very juicy and of good flavor. A late variety ripening in October.[2]

HAJIPUR

Kathambi (*Kathambi Sobhan Ali Khan*).—Quite a large, red fruit weighing 680 grams; the flesh is reddish, firm, sweet, of excellent flavor, and contains a small seed. The fruit ripens in July.[2]

HAJIPUR

Katki.—A good mango ripening late in season to October.[2]

DARBHANGA

Kerbuza, (*Karbuza, Kharbuza*).—A name applied to a form of mangos which have the odor and aroma of the cantaloupe, *Cucumis melo* L., such as *Dula, Nowaroa* and *Mahudinagar,* which see.

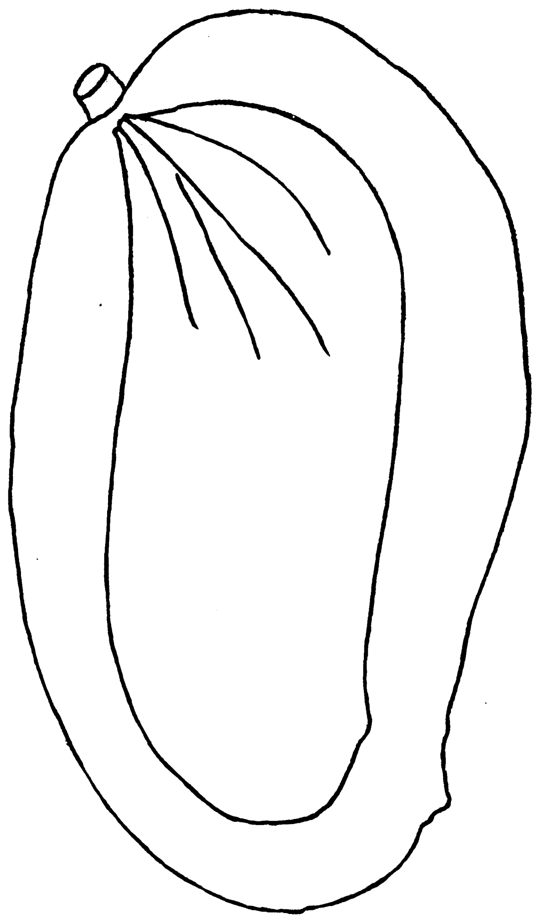


FIG. 36. *Khajya*

Kerowa.—This is a group name including 4 varieties; the *Mahbub, Nazirbhog, Durgilal* and *Anarua,* of which *Durgilal* is the best. These mangos are characterized as long, "nosy" and sweet.[2]

DARBHANGA

Khajya (Fig. 36).—Size medium, length 120 mm., breadth 70 mm., weight 354 grams; form asymmetrically ovate-oblong; stem inserted in a shallow cavity; ventral shoulder high and prominent, dorsal shoulder very short, falling abruptly; apex rounded, the curve ending in a distinct beak, with a shallow depression above; surface uneven, green to yellow, tinged with red; flesh light yellow, pronouncedly acid, of fair flavor and with abundant fiber; seed 19 mm. thick, weighing 23 grams.

The tree is of medium vigor and a shy bearer, ripening late. The fruit is a good keeper.[1]

SAHARANPUR

A mediocre variety not worthy of importation.

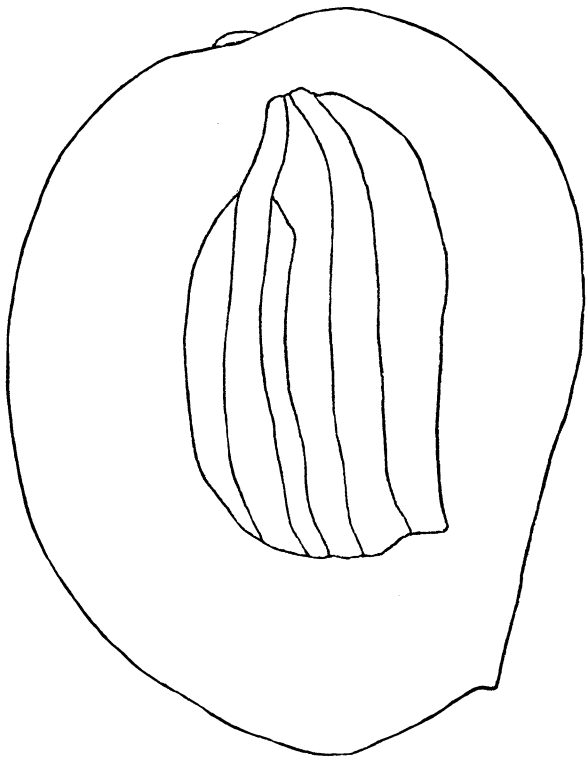


FIG. 37. *Khaparia*

Khaparia (Fig. 37).—Size medium, length 95 mm., breadth 75 mm., weight 319 grams; form short ovate, oblique; stem inserted in a shallow cavity; ventral shoulder quite well developed, dorsal shoulder short and falling away from stem in a gentle curve; apex broadly rounded; nak prominent, with a slight depression above; surface uneven, light green to yellow with a reddish tinge; flesh light yellow, juicy, subacid, of fair flavor, with but little fiber; seed 19 mm. thick weighing 35 grams.

The tree is a good grower, cold resistant, and moderately productive. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

An average good variety worthy of introduction and trial.

Khari (*Khari Budaya*).—A medium sized fruit, ripening in July and August. One of the Budaya mangos.[2]

Kharmuza.—Description very incomplete. Size medium large, weight 340 grams. In flavor it is said to resemble the cantaloupe, and to be "a first rate mango." The price quoted for the fruit would, however, denote that it is rather below the average mango in quality.[2]

MURSHEDABAD

Khoont. (*Banchore*).—A mango of medium size, weighing about 280 grams, said by woodrow to be of very good quality.[6]

POONA

Kishenbhog (*Kissenbhog*).—A roundish fruit of large size, weighing 450 grams; the flesh is "rosy pink," sweet, fiberless and of good flavor, containing a very thin seed. Season July and August.[2]

DARBHANGA

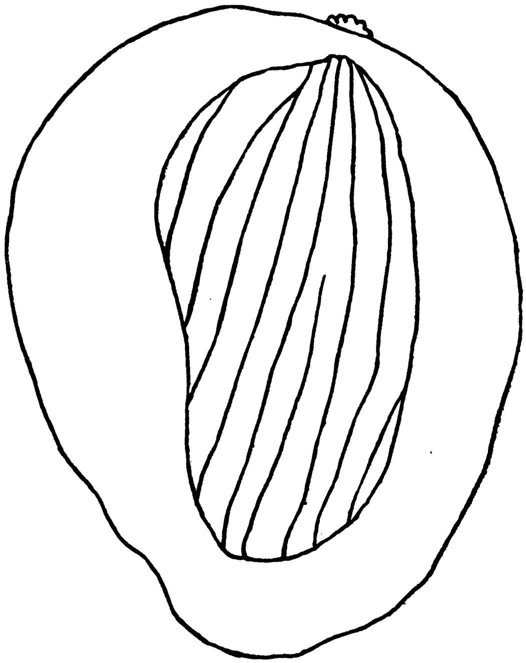


FIG. 38. *Kistapal*

Maries[4] speaks of a *Kishenbogh* from Durbhanga as of exceptional quality, which is in all probability the same variety. He also mentions another variety of the same name the fruits of which hang on the tree until the seed germinates and the plants grow out through the fruit.

Kistapal (Fig. 38).—Size small, length 85 mm., breadth 67 mm., weight 177 grams; form oval; base rounded; stem inserted obliquely; ventral shoulder full, dorsal shoulder short and rounded, apex broadly rounded; lower ventral side convex, with an irregular depression above the beak; surface smooth, yellow to reddish; flesh orange yellow, juicy, sweet, of good flavor, and but little fiber; seed rather large, 19 mm. thick, weighing 21 grams.

The tree is of medium vigor and a shy bearer. The fruit ripens late in season and is a good keeper.[1]

SAHARANPUR

Of average quality but worthy of consideration because of its lateness.

Kohitur (*Kohitoor*).—A large, oval fruit attaining a weight of 500 to 565 grams.[2]

MURSHEDABAD

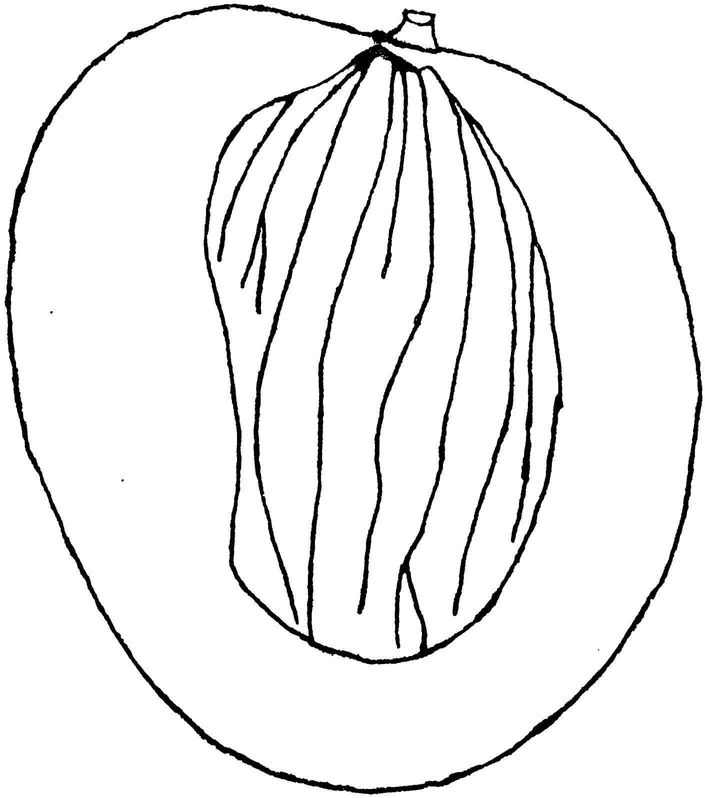


FIG. 39. *Krishnabhog*

This variety is said to be the premier mango in Murshedabad.

Krishnabogh (Fig. 39).—Size medium large, length 105 mm., breadth 90 m., weight 482 grams; form roundish oblique; base equal; stem inserted obliquely; ventral shoulder high and prominent, dorsal shoulder sloping and rounded; apex broadly rounded; lower ventral side convex; surface smooth, green to yellow; flesh deep yellow, sweet, firm and rather dry, of good flavor but fibrous; seed medium large, 19 mm. thick, weighing 35 grams.

The tree is a slow grower and a shy bearer. The fruit ripens late and keeps well.[1]

SAHARANPUR

Notwithstanding its good appearance apparently of little value for general culture.

Kuapaharia.—An average sized, oblong, thin-skinned mango weighing about 225 grams; the flesh is sweet and devoid of fiber but without distinctive flavor. Season of maturity, July and August.[2]

MALDA

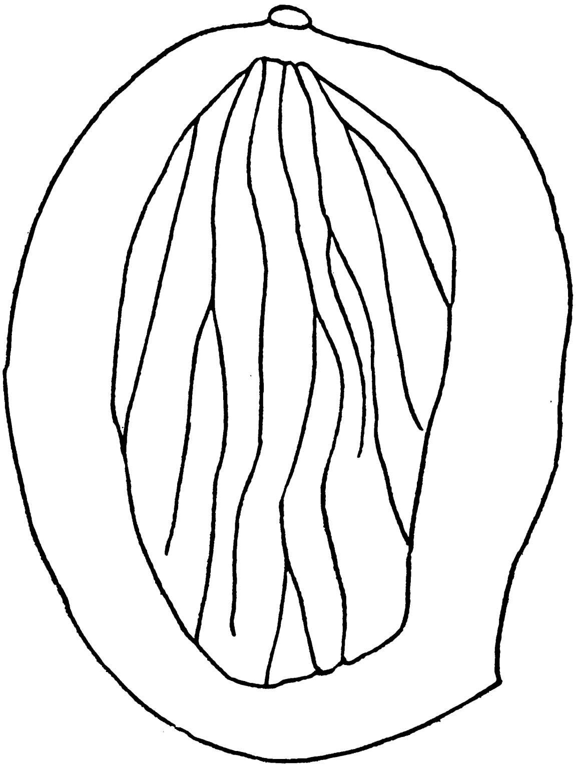


FIG. 40. *Kutna*

Kumrajali.—A very large, round mango attaining a weight of 900 to 2,700 grams; the flesh is somewhat fibrous and of indifferent flavor and quality. Ripening in July.[2]

MALDA

One of the two largest mangos in India, the other being the *Ennurriva.*

Kumukht.—A medium sized, roundish, irregularly shaped fruit, 225 grams in weight, the flesh of fine flavor. Season July.[4]

Kurpura-dagi.—A medium sized to fairly large fruit, weighing 340 to 565 grams; the flesh is sweet with an aroma recalling camphor. Ripening in July.[2]

MALDA

The fruit commands a remarkably good price and is apparently well esteemed in India. Worthy of introduction and trial.

Kutna (Fig. 40).—Size medium large, length nearly 100 mm., breadth 75 mm., weight 305 grams; form broadly oval, flattened; base broadly rounded; ventral shoulder fairly broad but not high, dorsal shoulder short, falling away in a moderate curve from stem; apex broadly rounded, the curve ending in a distinct beak; lower ventral side somewhat irregular, with a slight depression immediately above the beak; surface smooth, light green to yellow; flesh yellow, sweet and very juicy, of fair flavor and with but little fiber; seed thin, medium large, 19 mm. thick, weighing 21 grams.

The tree is of slow growth, resistant to cold, and a shy bearer. The fruit ripens late and keeps well.[1]

SAHARANPUR

Considering its shy bearing qualities the variety is of but little value.

Kysapati (*Khysapati, Khysapath*).—A large, long mango with a prominent beak, weighing 450 grams. The fruit ripens in July, is a good keeper and suitable for long distance shipment.[2]

MURSHEDABAD

De also speaks of two other varieties under this name from Malda, neither of which would appear to possess special merit. The largest is said to be a round, thin-skinned mango of medium to fairly large size, weighing from 225 to 450 grams, and ripening in June and July.

Ladua (*Maharaji-ladua*).—A fairly large, round, yellow fruit, weighing about 680 grams; the flesh is white, very sweet and juicy.[2]

HAJIPUR

Laldarma.—A large, red fruit, weighing 680 grams, the flesh is very sweet and of excellent flavor. An early ripening variety.[2]

HAJIPUR

Laljan-banka.—An elongate, flesh colored, handsome fruit of medium size, weighing from 225 to 450 grams, of indifferent quality. Season, July.[2]

MALDA

Lamba Bhadra (Fig. 41).—Size large, length 120 mm., breadth 105 mm., weight 397 grams; form almost round, oblique; stem inserted squarely in a shallow cavity; shoulders well developed; the ventral a trifle higher than the dorsal; apex broadly rounded; a slight depression on lower ventral side; surface smooth, green to yellow; flesh deep yellow, very sweet and juicy and of good flavor, with but little fiber, seed medium large, 19 mm. thick, weighing 28 grams.

The tree is of vigorous growth, hardy, but a shy bearer.[1]

SAHARANPUR

In India this variety occupies front rank for quality, and the fruit ripens late in season and is a good keeper, but is susceptible to fruit flies.

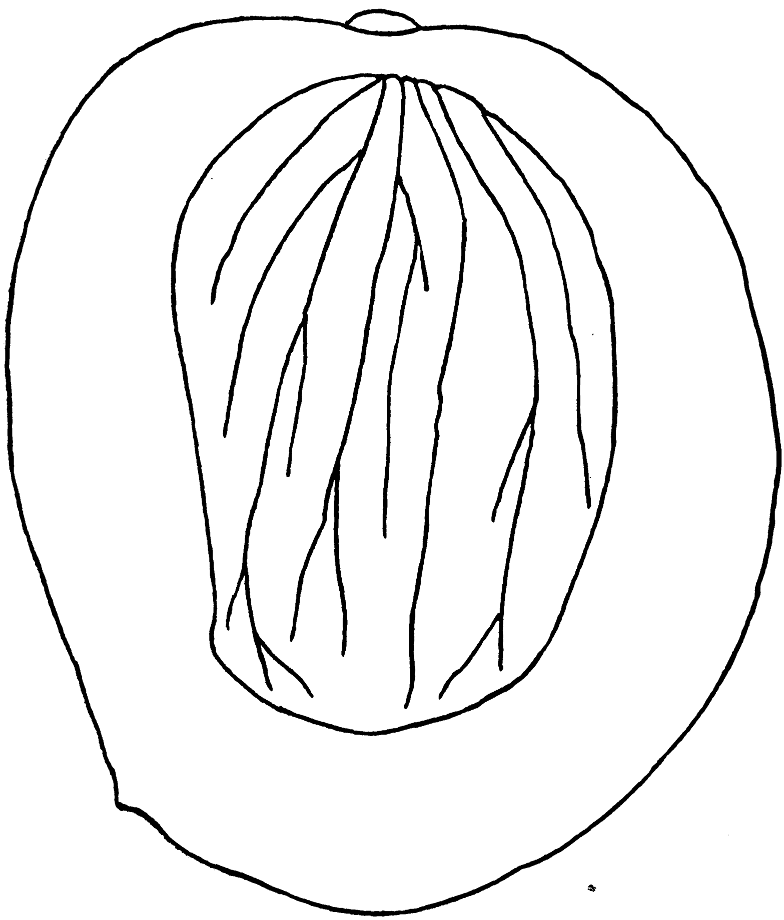


FIG. 41. *Lamba Bhadra*

Probably of little merit for general culture, but of value for a select market. Well worthy of introduction especially for trial at high elevations.

Langra.—This name in India seems to designate a group and is given to several quite distinct mango varieties, to which there is usually subjoined another name for the sake of distinction.

Langra (Fig. 42).—Size medium, length 100 mm., breadth 80 mm., weight 248 grams; form roundish oval; base rounded; shoulders rounded, the dorsal more sloping; apex broadly rounded; nak prominent; lower ventral side convex; surface smooth, light green; flesh light yellow, very sweet and juicy and of good flavor, with but little fiber; seed medium, 19 mm. thick, weighing 28 grams.

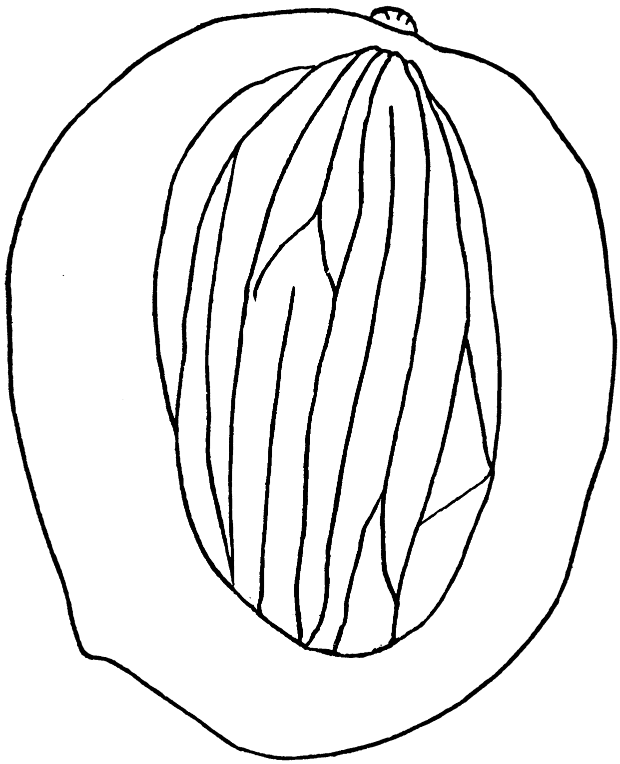


FIG. 42. *Langra*

The tree is vigorous, fairly resistant to cold and prolific. The fruit ripens in midseason and is a poor keeper.[1]

SAHARANPUR

This is considered one of the best varieties in India and unquestionably worthy of introduction.

Langra Benarsi (Fig. 43).—Size medium large, length 112 mm., breadth 83 mm., weight 390 grams; form short elliptical; base rounded; ventral shoulder well developed, dorsal shoulder sloping; apex broadly rounded; lower ventral side convex, nak prominent; surface greenish yellow; flesh pale yellow, very sweet and sirupy, somewhat resinous, and tasting as if fermented; fiber scant; seed quite large, 25 mm. thick, weighing 43 grams.[1]

SAHARANPUR

An attractive fruit but of questionable value. This variety does not correspond to *Langra Benarsi* imported and fruited by Reasoner in Florida, which see below.

Langra Benarsi.—Size very large, average weight 900 to 1,300 grams, with occasional fruits weighing 1,700 grams; form elliptical ovate, oblique,

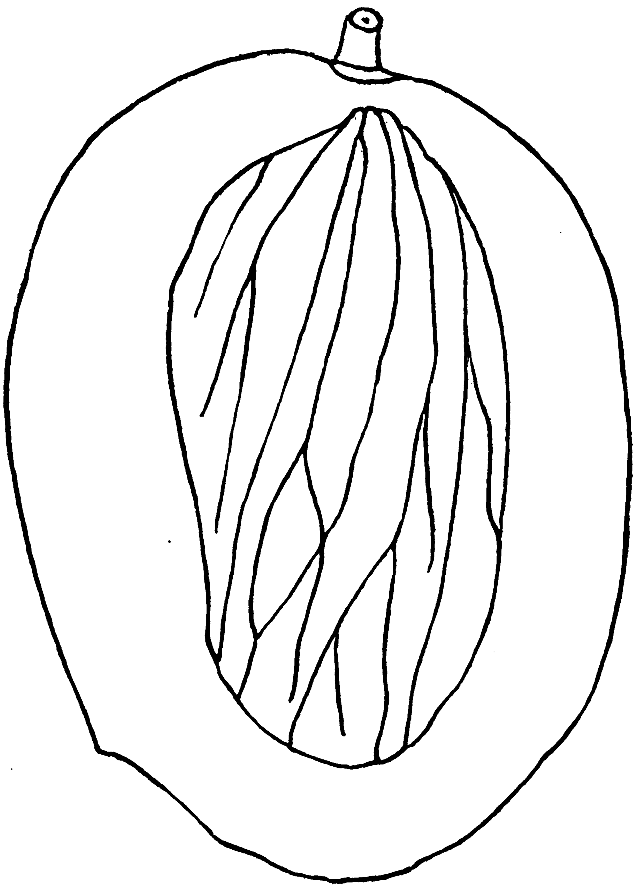


FIG. 43. *Langra Benarsi*

flattened; nak prominent, about 3 centimeters above apex; surface undulate; color dark-green marbled with light green; lenticels small, russetted; bloom whitish; skin medium thick, tough; flesh yellow, tender, juicy and very acid; quality good; fiber medium; seed comparatively small.

Not a dessert fruit, but may make a good fruit for preserving. Season, August.[6]

Langra Hardoi (Fig. 44).—Size medium large, length 105 mm., breadth 80 mm., weight 333 grams; form short elliptical; base rounded; stem inserted squarely; shoulders about equal; apex broadly rounded; lower ventral side well filled, with a trace of depression just above the prominent nak; surface smooth, light green; flesh yellow, sweet and very juicy, fine flavored, but more fibrous than *Langra;* seed medium large, 19 mm. thick, weighing 28 grams.

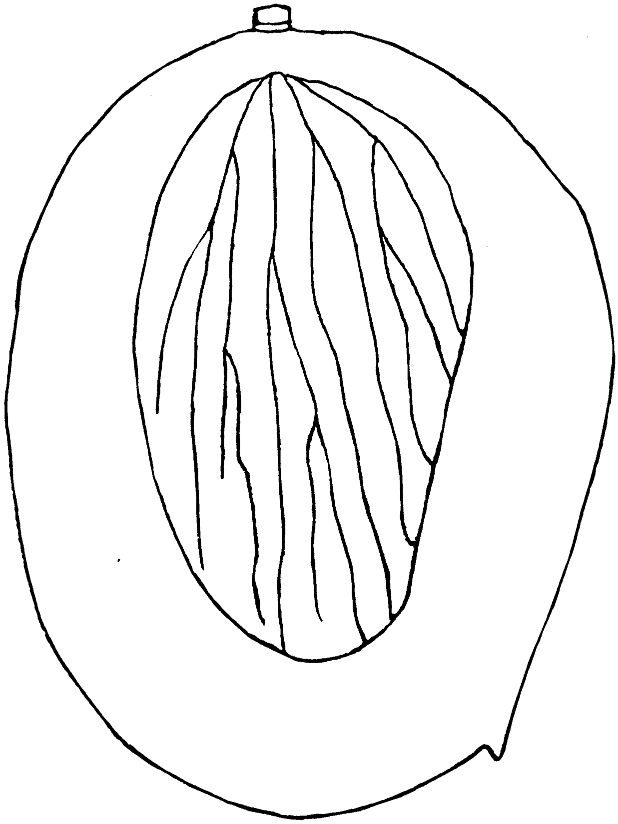


FIG. 44. *Langra Hardoi*

The tree is vigorous, resistant to cold, and prolific. The fruit matures in midseason and is a good keeper.[1]

SAHARANPUR

Well worthy of importation especially for trial in the higher altitudes.

Langra Large (Fig. 45).—Size medium, length 102 mm., breadth 78 mm., weight 319 grams; form short elliptical; base rounded, shoulders about equal, rounded; apex broadly rounded; nak prominent; surface smooth, light green; flesh yellow, juicy, very sweet and of fine flavor but somewhat fibrous; seed 13 mm. thick, weighing 28 grams.

The tree is a free grower, cold resistant, but a shy bearer. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

Apparently the least desirable of all the Langra varieties The different Langras are all strikingly similar and are probably seedlings of common parentage. *Langra Large* would appear to be a misnomer since it is really smaller than all but one.

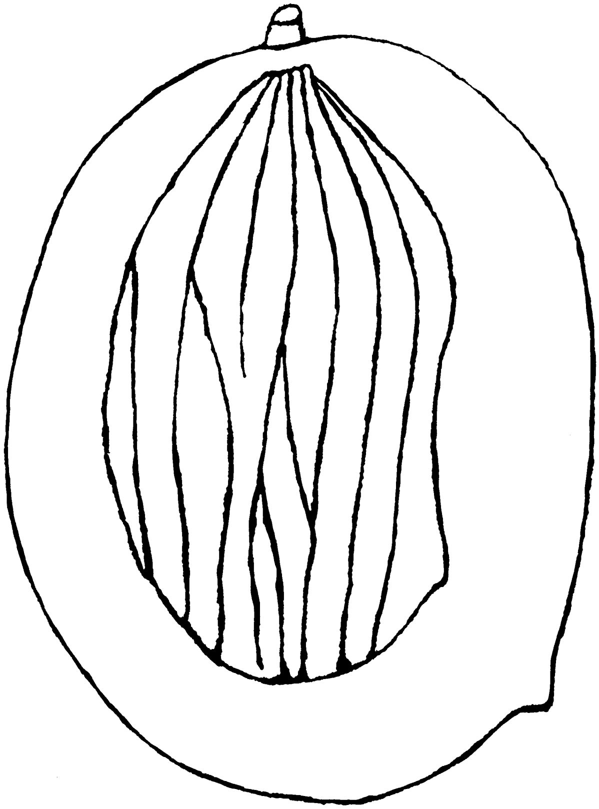


FIG. 45. *Langra* (large)

Langra Stud. (Fig. 46).—Size large, length 128 mm., breadth 90 mm., weight 560 grams; form oval, attractive; base rounded, stem inserted obliquely; ventral shoulder well developed, dorsal shoulder short, falling in a long curve; apex rounded; nak prominent; surface yellowish green; flesh orange yellow, sweet, but of a "fermented" flavor, with few fibers; seed 25 mm. thick, weighing 28 grams,[1]

SAHARANPUR

An attractive fruit but of inferior quality. Probably of little value.

Larua.—A small, round mango with sweet, but insipid, fibrous flesh.[2]

DARBHANGA

Latkampi.—A medium sized, yellow fruit, weighing about 225 grams; the flesh is yellow, very sweet, containing a small seed. Season of ripening, July.[2]

HAJIPUR

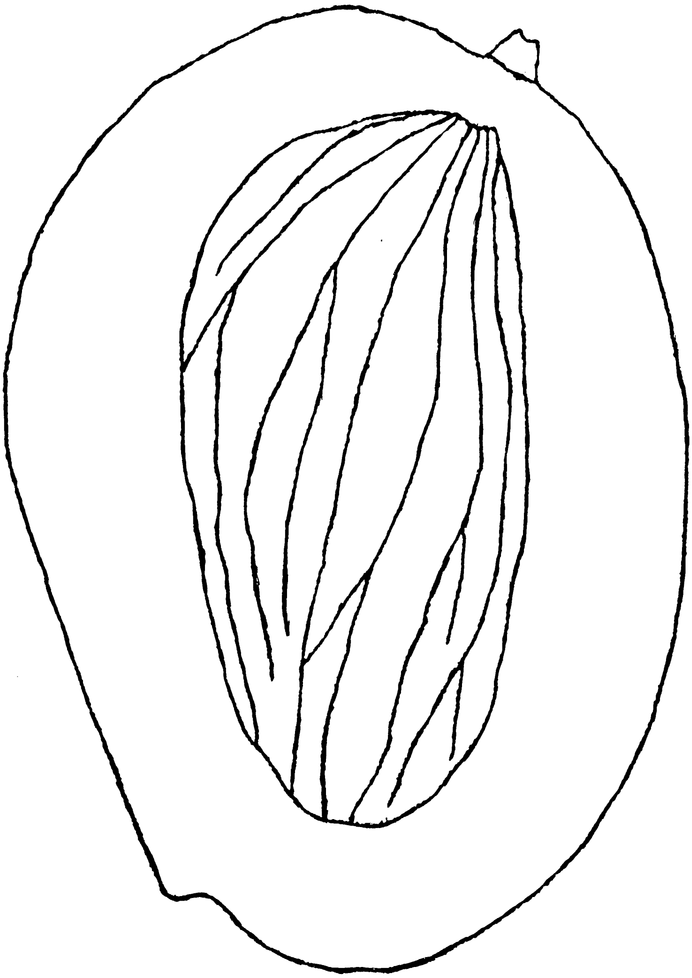


FIG. 46. *Langra* (stud)

Lerrua.—This variety is by Maries spoken of as the most highly colored and beautiful of all the Indian mangos. The quality is not mentioned.[4]

Madhua.—A medium sized, oval fruit weighing 237 grams, of good appearance; the flesh is of good flavor. Ripening season early in July.[2]

MALDA

Madkupia.—A cylindrical fruit with very sweet flesh and a small seed.[2]

HAJIPUR

Madras. (Fig. 47).—Size medium, length 85 mm., breadth 73 mm., weight 227 grams; form roundish oblique; base rounded; ventral shoulder well developed, dorsal shoulder short and sloping; apex truncate, with a prominent beak; lower ventral side conspicuously depressed; surface smooth, brownish yellow to reddish green; flesh yellow, juicy, of fair flavor, with but little fiber; seed small, 19 mm. thick; weighing 21 grams.

The tree is a free grower and prolific. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

An average variety of doubtful value.

Maharaji-ladua.—See *Ladua.*

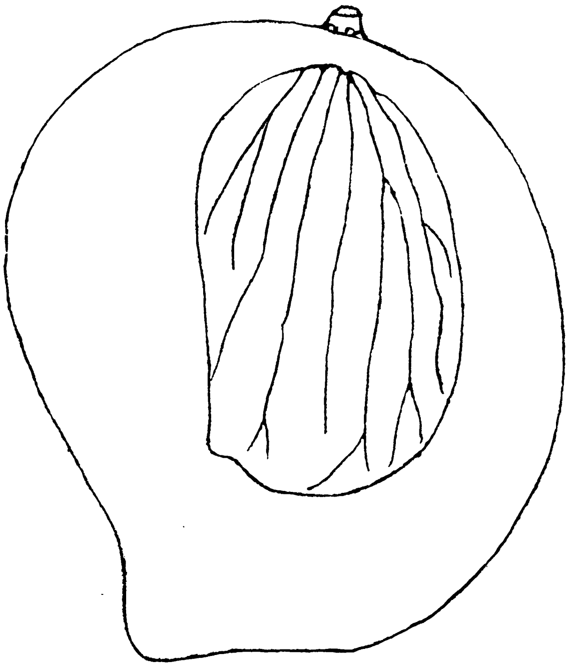


FIG. 47. *Madras*

Maharaj-pasand.—A small round, pink fruit weighing about 113 grams; the flesh is light yellow, of rich camphor flavor, containing a small seed. Ripens in July.[2]

HAJIPUR

Mahbub (*Mahbub Kelwa*).—An elongated, red to yellow, small fruit about 225 grams in weight; the flesh is juicy and sweet with a trace of acidity, and of excellent flavor. Ripening early in season.[2]

HAJIPUR

Mahudinagar (*Mohedenugger*).—A mango weighing from 225 to 450 grams, said to possess the aroma and flavor of the cantaloupe, *Cucumis melo;* the flesh very sweet but somewhat "tough" and fibrous.[2]

DARBHANGA

Majgaon.—A large, green fruit; the flesh is light sulphur yellow and moderately sweet.[2]

BOMBAY

Malabar Bombay.—A cylinder shaped, thick skinned mango, sometimes exceeding 230 mm. in length, the flesh is light sulfur in color, sweet and juicy.[2]

MURSHEDABAD

Malda.—According to Maries [4] *Malda* would appear to be a group name rather than a variety name, and containing among others another type called *Gowrya Malda,* the mangos of which are among the best in India. The fruit is not described in detail, but the skin is said to be very thin and the covering of the seed so thin that in cutting a fruit the knife often passes through the seed. The aroma and flavor differs from that in all other Indian mangos.

Firminger also speaks of the *Malda* as one of the finest mangos in India and obtainable in Calcutta.[8]

The mangos of the Malda groups seldom ripen before July and sometimes not until October.

Martinique.—A short-oblong, flattened fruit quite similar to *Sans Pareille.* Of poor quality.[3]

Originated in Martinique and has been imported and tested in Porto Rico. Not worthy of cultivation.

Mejidi.—Description very fragmentary. The fruit is said to be sweet and juicy, but fibrous. It is a good keeper and suitable for long distance shipments.[2]

MURSHEDABAD

Mithua.—A small fruit, very sweet, of excellent flavor and having a small seed. Very prolific, ripening early in season.[2]

HAJIPUR

Misribhog.—An oval fruit of medium size, from 225 to 340 grams in weight; the flesh is very sweet and of good flavor. Season of ripening, July.[2]

MALDA

Misrikund.—A small fruit weighing 85 to 115 grams, oval and flattened; the flesh is sweet, fiberless and exquisitely flavored.[2]

MURSHEDABAD

De also speaks of another *Misrikund* from Malda, a round mango, weighing from 225 to 450 grams; the flesh is of excellent flavor. Ripens in June.

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[8] Firminger's Manual of Gardening, 1904.

Mohun-bhog.—A large, roundish fruit, weighing from 450 to 900 grams; the flesh is free of fiber, sweet and of good flavor. Ripening in July and August.[2]

MALDA

Mohun Thakur.—A large mango of irregular shape, weighing 450 to 675 grams, ripening in October.[2]

DARBHANGA

By Maries [4] spoken of as one of the best mangos in India and also recommended by De in his Treatise on the Mango.

Mombasa.—Size medium, length 98 mm., breadth 70 mm., weight 217 grams; form oval to reniform; base rounded; stem inserted obliquely; ventral shoulder high and well developed, dorsal shoulder sloping; apex broadly rounded; lower ventral side depressed; surface uneven, green; flesh light yellow, very juicy, similar in flavor to *Langra*, with but little fiber, seed 19 mm. thick, weighing 35 grams.[1]

SAHARANPUR

Of average merit.

Mullgoa.—Size large, weight averaging 680 grams; form roundish-oblique, shoulder even; apex rounded; nak about 3 centimeters above apex; surface rather rough; color green marbled with yellow; lenticels numerous, russetted; skin thin, tough; flesh pale yellow, tender and juicy; flavor sprightly acid, aromatic, with a trace of turpentine; quality good to very good, fiber short, mainly on ventral edge of seed, seed small.

Season, August and early in September.[5]

This variety was introduced into Florida and Porto Rico several years ago, and has proven to be of medium vigor and precocious, a regular but not prolific bearer. It is inferior in quality to several other kinds and has failed to attract attention in Porto Rico and Florida. A rather late ripening season is its strongest recommendation.[3]

Mulgoba (Plate XVII*b*).—Size large, average weight 350 to 425 grams, occasional fruits weighing 575 grams; form roundish oblique, reniform; nak usually prominent, well up on the ventral surface; surface smooth; color yellow, beautifully blushed with red; lenticels numerous; skin thick, tough; flesh rich apricot yellow, tender and melting; aroma rich and pleasant; quality exceedingly good; fiber very scant, short and coarse; seed medium large, monoembryonic.

Season, latter part of July and early half of August.[5]

The tree is very vigorous and of symmetrical growth but lacking in precocity, and has not proved to be either a constant or prolific bearer. From the observations of the writer this is to a large measure due to imperfect fertilization of the flowers. The defect might be overcome by the discovery of some variety whose pollen is more potent than its own, trees of which should then be planted among the *Mulgoba* trees.

The *Mulgoba* was the first Indian mango introduced into Florida and was at first extensively planted, but because of its shy bearing qualities it has been discarded in favor of more precocious productive sorts. In appearance and quality the *Mulgoba* is exceptionally good and while commercially unprofitable it is well worthy of a place in a private collection of mangos.

Munshiwala.—A medium large fruit, weighing 340 grams, round, thick-skinned; the flesh is whitish and sweet, containing a small seed. Of late fruiting habit ripening until the middle of October.[2]

HAJIPUR

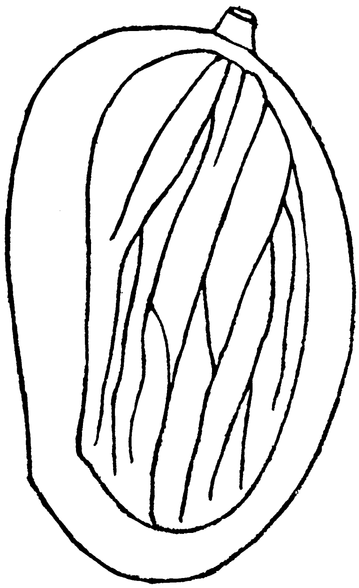

FIG. 48. *Najibabadi*

Najibabadi (*Najibabadi amin*) (Fig. 48.).—Size small, length 72 mm., breadth 45 mm., weight 163 grams; elliptical to reniform; base rounded; ventral shoulder short, dorsal shoulder sloping from stem in a long curve; apex broadly rounded; surface smooth, light green to yellow tinged with red; flesh light yellow, juicy, subacid, of fairly good flavor but fibrous; seed comparatively large, 19 mm. thick, weighing 21 grams.

The tree is a free grower, cold resistant, but a shy bearer. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Not worthy of introduction.

Nakua-daghi.—An undescribed variety bearing fruits about 450 grams in weight, ripening in September.[2]

MALDA

Naspati (Fig. 49).—Size medium large, length 73 mm., breadth 92 mm., weight 305 grams; form obliquely oblate; stem inserted in a shallow cavity; ventral shoulder quite high and broad, dorsal shoulder shorter and sloping; apex almost flat; surface smooth, pale yellow; flesh yellow, of good flavor; seed small, 19 mm. thick, weighing 21 grams.

The tree is a slow grower, cold resistant, but a sparse cropper. The fruit ripens late in season and keeps well.[1]

SAHARANPUR

The notes on this variety are contradictory, one stating that the fruit is fibrous, dry and insipid in flavor while in another series it is ranked as one of the best mangos in India.

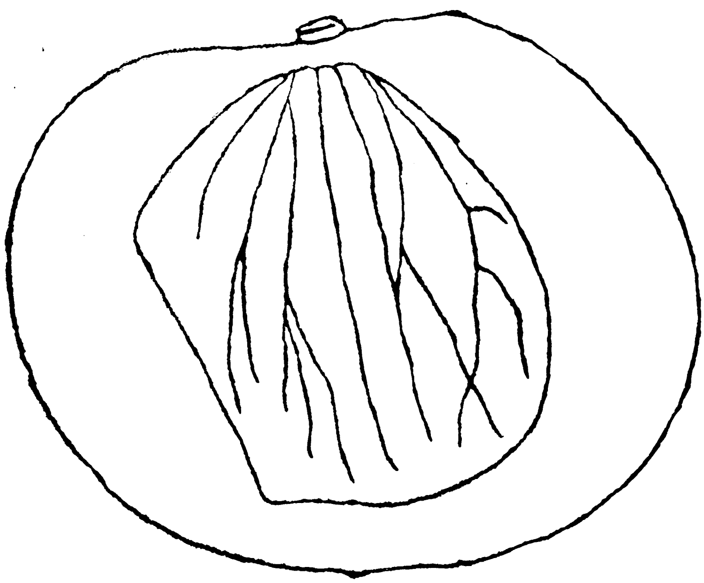

FIG. 49. *Naspati*

Nayab (Fig. 50).—Size small, length 80 mm., breadth 60 mm., weight 142 grams; form elliptical; stem inserted obliquely, ventral shoulder short and poorly developed, dorsal shoulder sloping; apex broadly rounded, the nak prominent; surface orange yellow to brown; flesh light orange, subacid, and somewhat resinous, melting, of good flavor and but little fiber; seed comparatively large, 19 mm. thick, weighing 21 grams.

The tree is of slow growth, cold resistant, but a shy bearer. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

An inferior variety; not worthy of introduction.

Nazim-pasand.—A fruit of medium size, weighing 225 to 280 grams, roundish in shape and yellow in color. Ripens in June and July. The tree is of upright growth and habit.[2]

MURSHEDABAD

Nazirbhog.—A long mango with prominent beak and sweet flesh. See *Kerowa.*[2]

DARBHANGA

Nazuk-badan.—A long, yellow fruit of medium size, weighing from 225 to 335 grams. A very poor keeper.[2]

MURSHEDABAD

Nim (*Nim-Chowdhury*).—An oval, green to yellowish fruit; the flesh is very sweet and of rich flavor, free from fiber. Considered to be one of the best local varieties.[2]

JAYNAGAR

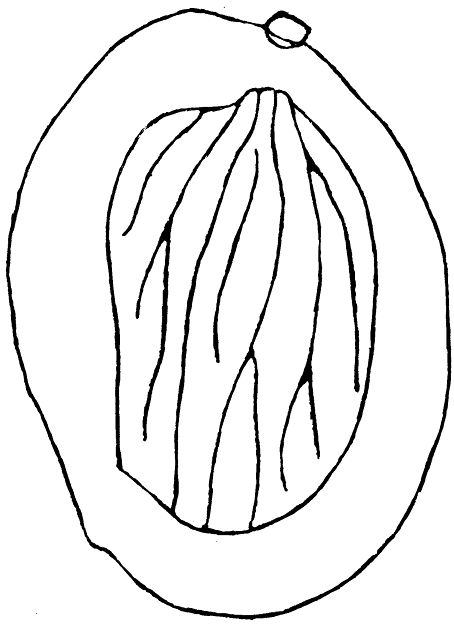

FIG. 50. *Nayab*

Nowaroa.—An obscure variety said to have the flavor and aroma of the cantaloupe, *Cucumis melo* L.[2]

DARBHANGA

Nucka (Fig. 51).—Size medium, length 92 mm., breadth 68 mm., weight 213 grams; semi-reniform; base rounded; ventral shoulder rounded, dorsal shoulder sloping; apex broadly rounded, the curve ending in a prominent beak; surface smooth, yellowish to brownish; flesh yellow, juicy, aromatic, of good flavor but fibrous; seed rather large, 19 mm. thick, weighing 35 grams.

The tree is of slow growth, resistant to cold, and a sparse cropper. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

A mediocre variety not worthy of importation.

Nur-Fuzli.—An undescribed variety said to be very similar to the *Fuzli.*[2]

MALDA

Nursing-bhog.—A round fruit attaining over 450 grams in weight; the flesh is sweet and of good flavor.[2]

MURSHEDABAD

Maries speaks of a variety of this name as having blue fruits weighing 675 grams. The leaves unusually large, 75 centimeters long.[4]

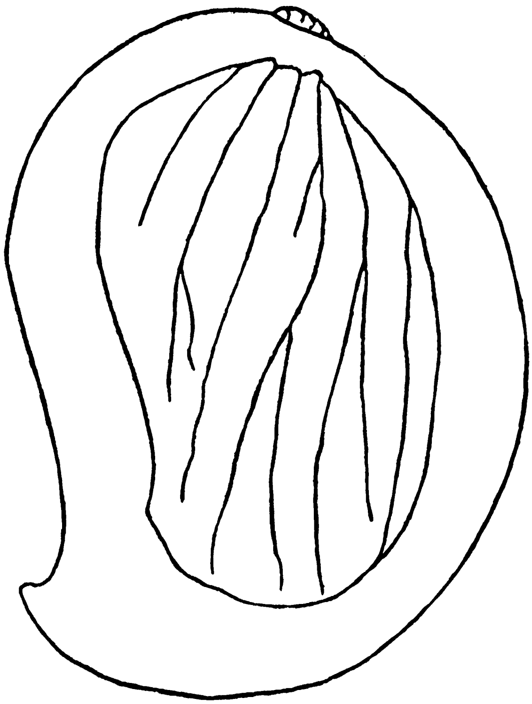

FIG. 51. *Nucka*

Ogee.—A large mango, weighing 870 grams, compressed towards base, with a large distinct beak, the lower ventral side unusually incurved; surface golden yellow; the flesh is sweet, but the flavor indifferent.[6]

BOMBAY

Paddojola.—A round yellow mango, the flesh sweet and of good flavor.[2]

JAYNAGAR

Pairi (Paheri, Pirie, Peary).—Size medium to large; weight 270 grams; form roundish, oblique, flattened; nak prominent, about 2.5 centimeters above apex; surface moderately smooth; color golden yellow marbled with green, garnet red on sun-exposed side toward base; lenticels small, russet or yellow; bloom bluish white; skin thick and tough; seed small; fiber almost entirely absent; flesh rich yellow, very tender, melting and juicy; flavor sweet, rich and aromatic; quality excellent.

The *Pairi* is a vigorous grower and of good habit. Season July.[5]

According to Burns[9] the *Pairi* mango is the second most important mango about Bombay, India, of which there are at

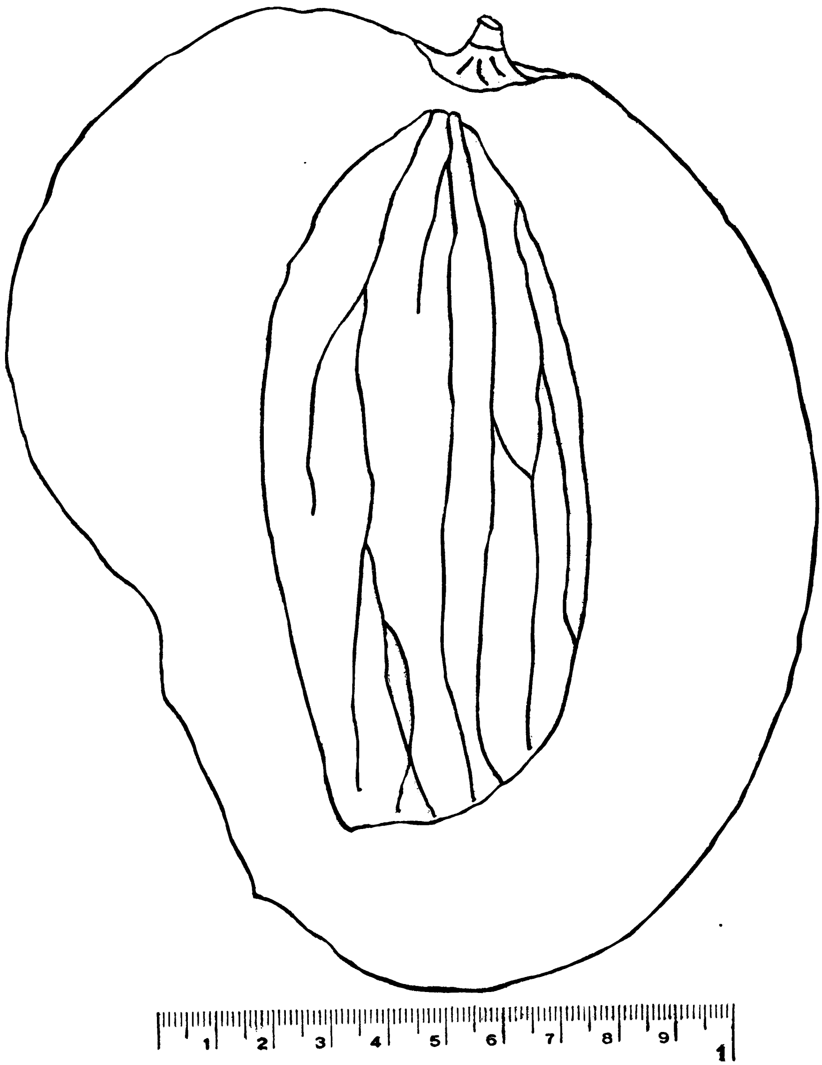

FIG. 52. *Pansera*

least two sub-varieties, the *Moti-Pairi*, larger than the ordinary *Pairi*, and *Kagdi-Pairi*, which has a thin, glossy skin.

[9] Agr. Journ. India, Vol. VI, Pt. 1, 1911.

Unfortunately the *Pairi* is of every poor keeping quality and while it is highly recommended for planting for home consumption, the *Pairi* is not recommended for long distance shipments.

Among the mangos imported in Hawaii and Porto Rico, *Pairi*, ranks first in flavor and quality. Higgins states that this variety is resistant to the Mediterranean fruit fly, *Ceratitis capitata*, in Hawaii, and while not expressly stated the same inference is drawn relative to the American Fruit fly, *Anastrepha fraterculus*, from Kinman's bulletin on "The Mango in Porto Rico."

Pakria.—A small yellow mango weighing 200 grams, free from fiber, and of excellent flavor.[6]

POONA

Pansera (Fig. 52).—Size large, length 170 mm., breadth 135 mm., weight 560 grams; form asymmetrically ovate; a shallow cavity at base; ventral shoulder well developed, dorsal shoulder sloping away from stem in a wide curve; apex broadly rounded, with an irregular depression on the lower ventral side; surface uneven, greenish; flesh yellow, very sweet, juicy and melting, and of a pleasant flavor but fibrous; seed comparatively small, 25 mm. thick, weighing 35 grams.[1]

SAHARANPUR

Notwithstanding its reputed fibrousness this variety would appear to be worthy of introduction and trial because of its large size.

Patel (*Cowasjee patel*).—A large fruit averaging 875 grams in weight. Apparently this is an acid fruit since Woodrow states that it is valuable chiefly for cooking.

The tree is of vigorous growth and of upright habit.[6]

POONA

Pere Louis.—Size small; form roundish oblong, reniform, swollen at nak; nak 2.5 centimeters above apex; surface greenish yellow to deep yellow with a suggestion of red; lenticels small, numerous, brownish; bloom bluish white; skin medium thick; flesh yellow, tender and juicy; flavor sweet and rich; quality good; fiber rather abundant, fine; seed large, monoembryonic. Season, July.[5]

This moderately vigorous variety was introduced from the British West Indies to Florida many years ago, but was found to possess little merit and is no longer cultivated.

Peters (*Peter, Peters No. 1*).—Average weight 250 to 280 grams; form almost spherical, asymmetrical, with prominent nak about 20 to 25 millimeters above apex; surface moderately smooth; color oil green to olive yellow, turning to cadmium yellow and orange chrome on sun-exposed side; lenticels numerous; bloom bluish white; skin thick and tough; flesh orange yellow, tender and melting; flavor exceedingly rich and sweet, but lacking in sprightliness; aroma distinct, fiber almost entirely absent, confined to ventral side of seed; seed small, monoembryonic.

Season, late in July and early part of August.

The variety is a vigorous grower, prolific, and of good habit.[5]

This variety which has been introduced and fruited in Florida, where it has failed to gain popularity, seems to correspond with the *Peter* spoken of by De [2] and Firminger.[8] Of handsome appearance it is inferior in quality to many other kinds and therefore not recommended for general culture.

Phaykalbayan.—Description very incomplete, merely stating that the fruit weighs 225 grams and is highly colored, near vermilion, the flesh of good flavor.[2]

MURSHEDABAD

Phulia (*Phoolia*).—An oval fruit, weighing about 450 grams; ripening in July and August.[2]

MALDA

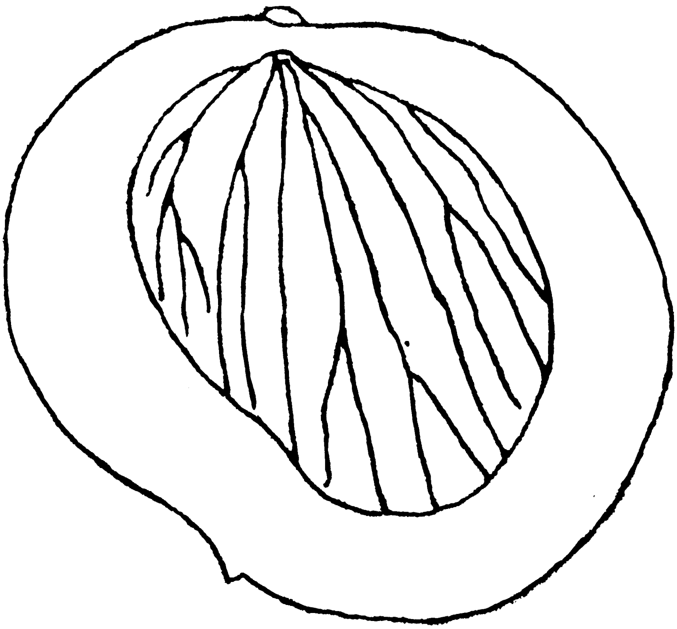

FIG. 53. *Payasi*

Pirgachia.—A large fruit weighing 900 grams, surface green; the flesh is sweet and free from fiber.[2]

MURSHEDABAD

Polla.—An oblong, yellow, medium-sized fruit weighing 225 to 340 grams; the flesh is sweet and devoid of fiber. Season June.[2]

MALDA

Putu (*Pootoo*).—A cone-shaped, green, thick-skinned fruit; the flesh is of poor quality.[2]

MADRAS

Payasi (*Payasee*) (FIG. 53).—Size small, length 80 mm., breadth 82 mm., weight 195 grams; form round oblique; base almost flat; stem

The Sandersha mango

inserted obliquely ventral shoulder high, dorsal shoulder compressed; apex broadly rounded, nak prominent, high up on ventral side; surface uneven, yellowish brown to bright yellow; flesh yellow, juicy, acid, with but little fiber; seed rather large, 19 mm. thick, weighing 35 grams.

The tree is of medium vigor and a shy bearer. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Apparently a variety of little merit. Not worthy of introduction.

Punia (Fig. 54).—Size small, length 87 mm., breadth 45 mm., weight 92 grams; form oblong reniform; base rounded, ventral shoulder narrow, dorsal shoulder wanting; apex rounded, nak well up on ventral side; surface smooth, yellow, with a reddish tinge; flesh deep yellow, rather dry, resinous, lemon scented, fibrous; seed large, 19 mm. thick, weighing 28 grams.

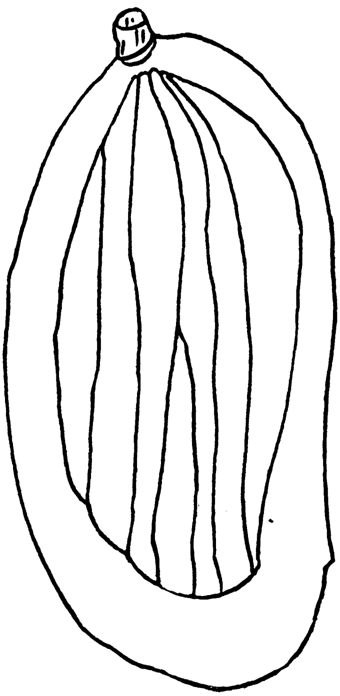

FIG. 54. *Punia*

The tree is a slow grower, and prolific. The fruit ripens late in season and is a good keeper.[1]

SAHARANPUR

This variety is rated high in India though it would appear to have very little to recommend it, productiveness excepted.

Raj-Bhog.—A roundish mango of medium size weighing about 225 grams; the flesh is of good flavor. Season, July.[2]

MALDA

Raja-pasand.—The fragmentary description states this to be a very large mango; the flesh pink and of excellent flavor, containing a thin seed.[2]

MURSHEDABAD

Rarhi.—A medium sized, elongate, flattened, thin skinned fruit, weighing 225 grams; the flesh is whitish and sweet. Season, September.[2]

HAJIPUR

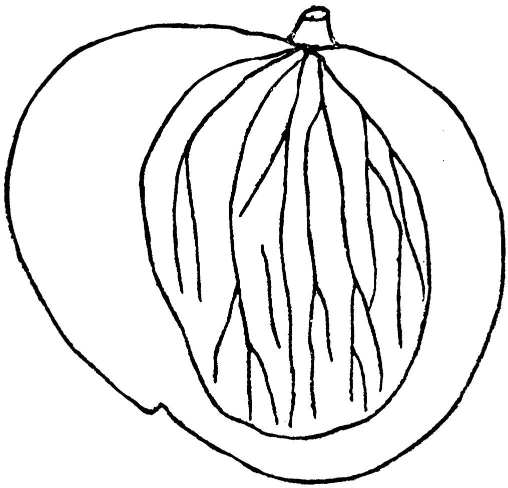

FIG. 55. *Romani*

Romani (Fig. 55).—Size small, length 60 mm., breadth 60 mm., weight 241 grams; form obliquely heart-shaped; stem inserted obliquely in a shallow cavity; ventral shoulder broad, dorsal shoulder narrow, and sloping from stem in a wide curve; apex rounded; surface smooth, yellowish green; flesh light yellow, very juicy, resinous and fibrous; seed 19 mm. thick, weighing 32 grams.[1]

SAHARANPUR

Apparently a variety of poor quality.

Rung-bahar.—A large, attractive fruit weighing from 900 to 1,125 grams; the flesh is of good quality. Ripens in October.[2]

MALDA

Sabza.—A fairly large, cylindrical, yellow mango, weighing 340 to 450 grams; the flesh is sweet and of good flavor and contains a thin seed. The fruit is a good keeper and ripens in July and August.[2]

DARBHANGA

Safeda.—Said to be very similar to the *Sabza* which see.[2]

DARBHANGA

Salibunda (Fig. 56).—Size medium large, length 105 mm., breadth 93 mm., weight 305 grams; form roundish oval; base rounded; stem inserted squarely; ventral shoulders well developed, ventral shoulder broader than the dorsal; apex broadly rounded; surface smooth, yellowish red; flesh yellow, very juicy, with "a fermented, mouldy flavor" and but little fiber.

The tree is of medium vigor, resistant to cold, and prolific. The fruit ripens in midseason and is a very good keeper.[1]

SAHARANPUR

Though of average quality because of its appearance and productiveness, the variety may merit attention especially for high elevations.

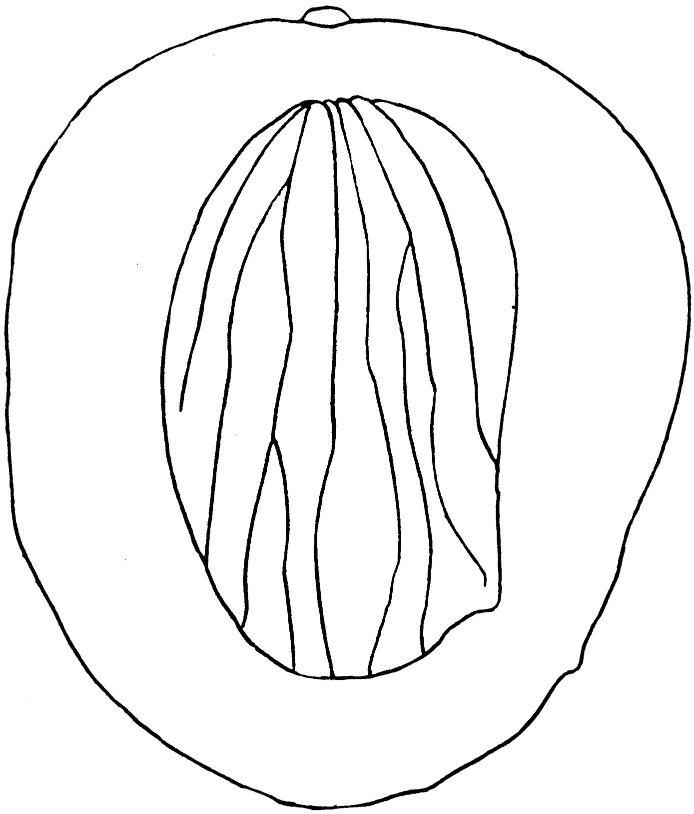

FIG. 56. *Salibunda*

Sandersha (*Sundersha, Soondershaw*). (Plate XVIII.)—Size very large, average weight 575 grams, occasionally attaining a weight of over 1,300 grams; form oblong-oval, flattened, compressed and tapering toward base; apex rounded, terminating in a distinct beak at nak; nak distinct, about 2.5 centimeters above apex; surface smooth; color clear yellow with a pinkish blush on sun-exposed side; lenticels small, numerous, russetted; skin moderately thick; flesh rich, reddish yellow, juicy and tender; flavor mild, sweet and aromatic, but inclined to be acid near the seed; fiber almost absent; seed long, comparatively small, monoembryonic.

Season very late, the fruit ripening late in August and the early part of September. The tree is of moderately vigorous growth, precocious, prolific, and of good habit.[5]

The *Sandersha* lacks the luscious richness of the best mangos, but because of its pleasing appearance, late ripening, precocity, productiveness and good keeping qualities it has attained the position as one of the leading varieties in Florida and is specially recommended for introduction.

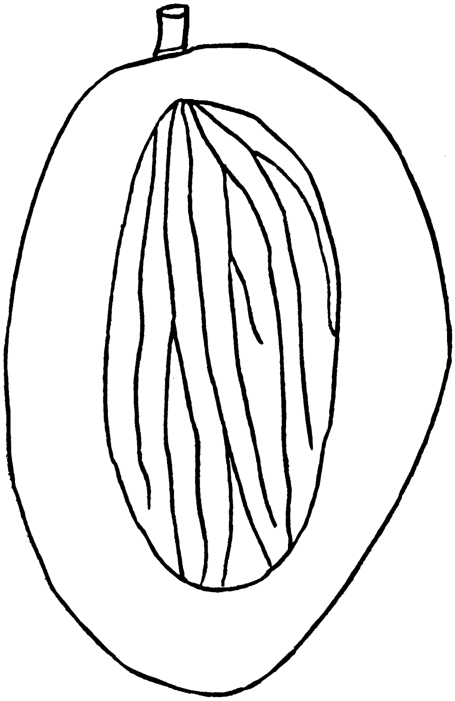

FIG. 57. *Sanduria*

Sanduria (FIG. 57).—Size small, length 85 mm., breadth 60 mm., weight 135 grams; form oblong-oval, asymmetrical; base rounded, shoulders narrow, the dorsal more so than the ventral; apex rounded; lower ventral surface convex; surface smooth, yellow, tinged with red; flesh yellow, rather dry, very sweet, of good flavor and but little fiber; seed medium large.

The tree is of medium vigor, resistant to cold and prolific. The fruit ripens in midseason and is a good keeper.[1]

SAHARANPUR

Because of its small size not suitable for general culture.

Sans Pareille.—A fairly large mango averaging 325 grams in weight, smooth and dull yellowish bronze in color; the skin thin and fairly tough; the flesh is tender, very juicy, rich and sweet but of a strong and unpleasant flavor, fiberless, with a small, thin seed.

The tree is of slow growth but prolific, the fruit ripening in June and July.[3]

According to Kinman this variety was imported to Porto Rico from Martinique, but has been found inferior and is not recommended for general planting.

Sarat-bhog.—A long, fairly large mango about 450 grams weight, in flavor very similar to the *Fuzli.* Ripens in September and October.[2]

MALDA

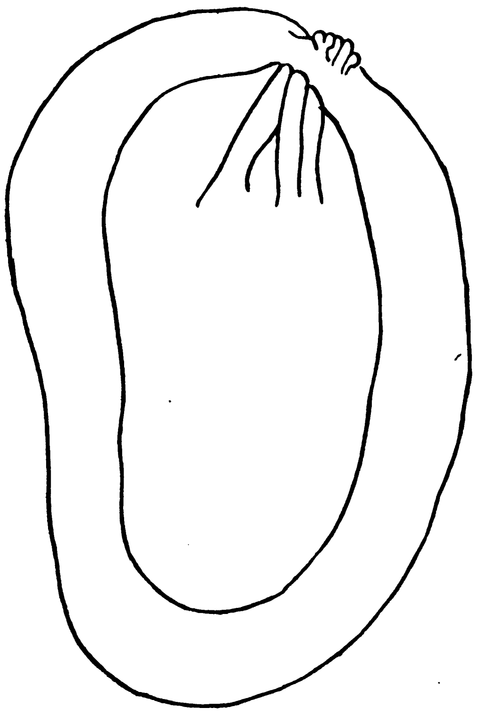

FIG. 58. *Sharbati Black*

Up to 1904 the original tree had not been propagated from.

Sarda.—A small, yellow fruit; the flesh sweet, juicy and "cool." The original tree is very prolific, but had not been propagated from up to 1904.[2]

MURSHEDABAD

Sarvati.—The fragmentary description states that the fruit is large, juicy, somewhat acid, without fiber and of very good flavor.[5]

MURSHEDABAD

Sauna.—A oblong, reddish mango of subacid, agreable taste, ripening in July and August.[2]

MALDA

Seha.—An oblong mango with reddish, sweet but somewhat fibrous flesh of good flavor; the seed rather large. Ripening in July.[2]

DARBHANGA

Shah-pasand.—A large, attractive, roundish, thin skinned mango; the flesh is sweet, of good flavor and fiberless. The fruit ripens late in June. Susceptible to fruit flies.[2]

DARBHANGA

Possibly a different variety from the *Shah-pusund* of Maries described below.

Sha-pusund.—A large, irregular shaped fruit, attaining a weight of 900 grams, of fair quality.[4]

According to Maries the tree is hardy and a good bearer, and the variety is therefore grown quite extensively in India.

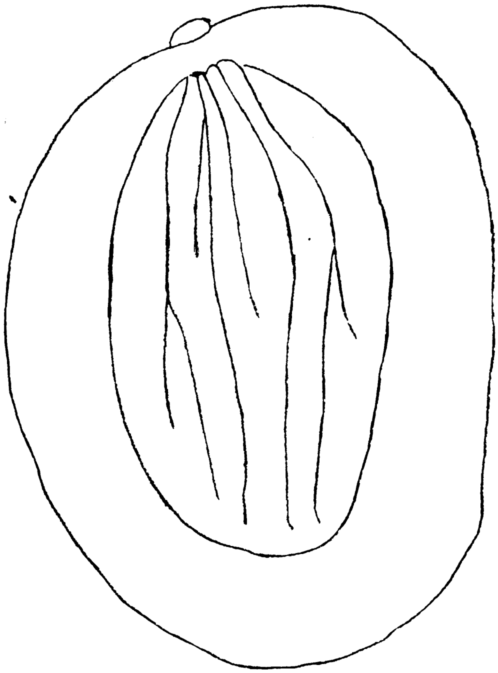

FIG. 59. *Sharbati Brown*

Seohind (*Gopal-Larooa*).—A round, large fruit of "apple color" frequently exceeding a weight of 900 grams.[2] .

MURSHEDABAD

Sharbati Black (Fig. 58).—Size small, length 98 mm., breadth 62 mm., weight 177 grams; semi-reniform; stem inserted obliquely; ventral shoulder high and well developed, dorsal shoulder falling from stem in a sloping curve; apex broadly rounded, lower ventral side markedly depressed; surface smooth, black (according to another annotation yellow and red); flesh yellow, very juicy and sweet, of good flavor and but little fiber; seed rather large, 19 mm. thick, weighing 28 grams.

The tree is of medium vigor, and prolific. The fruit ripens early in season and is a good keeper.[1]

SAHARANPUR

Notwithstanding its small size apparently well worthy of introduction.

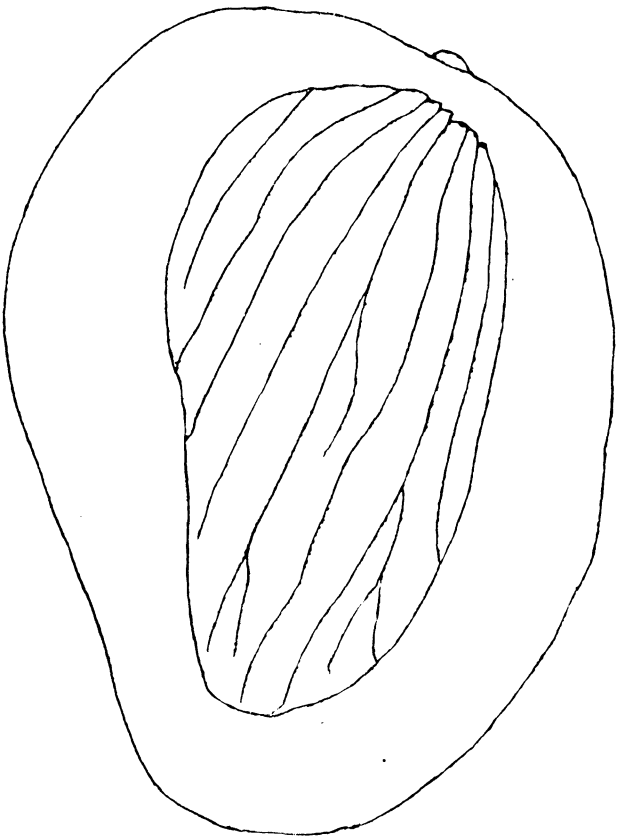

FIG. 60. *Singapuri*

Sharbati Brown (Fig. 59).—Size small, length 88 mm., breadth 65 mm., weight 234 grams; form asymmetrically short-elliptical; stem inserted obliquely; ventral shoulder high but narrow; dorsal shoulder sloping from stem in a wide curve; apex broadly rounded; surface smooth, brown (according to another annotation light green to yellow); flesh light yellow, juicy, sweet, of good flavor but rather fibrous; seed medium; 19 mm. thick, weighing 21 grams.

The tree is of medium vigor, resistant to cold and prolific. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

Apparently below the average mango in usefulness.

Shridahan.—A medium sized, flattened fruit weighing 225 grams, light orange colored; flesh very sweet and of excellent flavor. Season of maturity, July.[2]

HAJIPUR

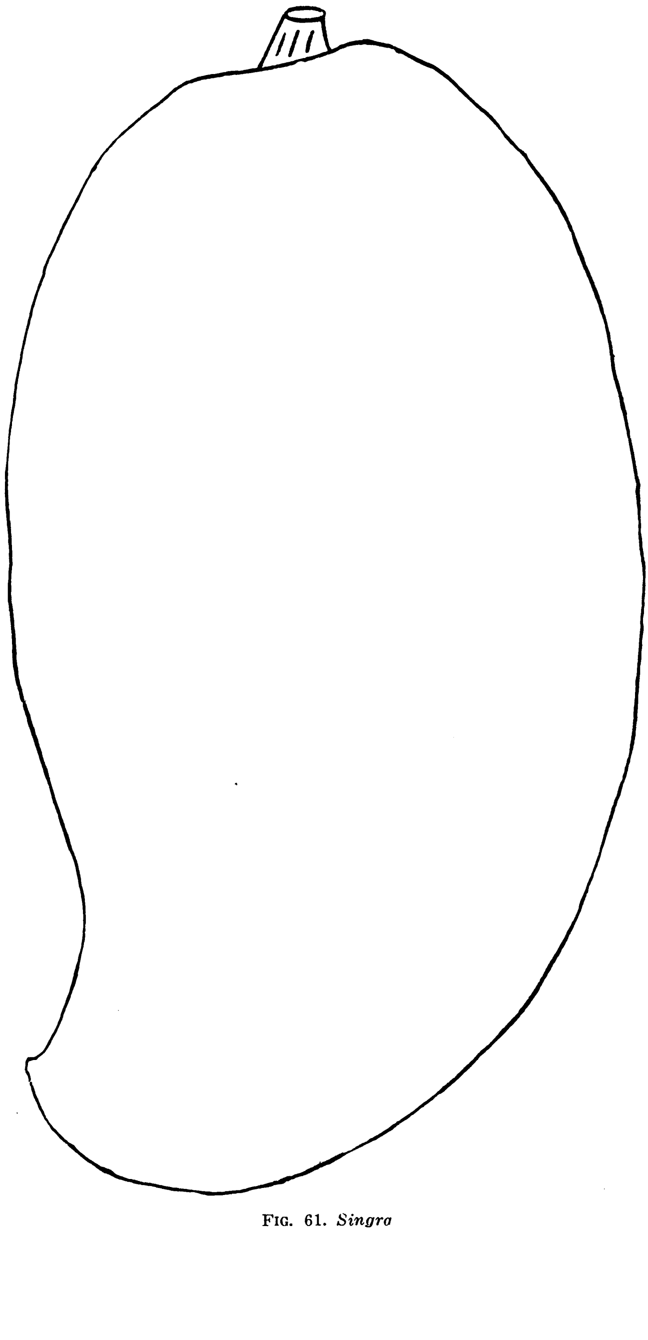

FIG. 61. *Singra*

Sinduria (*Sinduria Bhogwan Singh*).—A medium large fruit, weighing 450 grams; the flesh very sweet and juicy, containing a small seed.[2]

HAJIPUR

Singapuri (*Singapore*) (Fig. 60).—Size medium large; length 110 mm., breadth 83 mm., weight 347 grams; form ovate to sub-reniform, asymmetrical; base rounded; stem inserted obliquely; ventral shoulder quite high and well developed; dorsal shoulder short and rounded; apex broadly rounded, with a slight depression on lower ventral side; surface uneven, light green to yellow, orange colored at base; skin thick; flesh light orange, fairly juicy, sweet, somewhat aromatic, in flavor resembling the loquat, *Eriobotrya Japonica*, and with but little fiber; seed medium large, 25 mm. thick, weighing 43 grams.

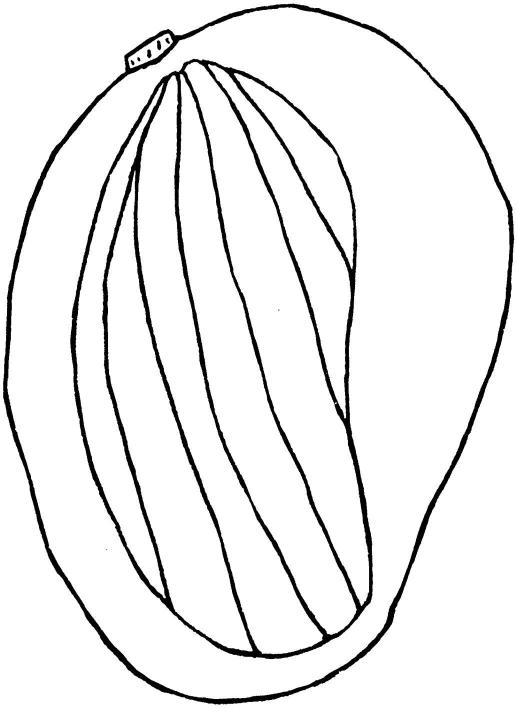

FIG. 62. *Stalkart*

The tree is of slow growth, cold resistant, but a sparse bearer. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

Well worthy of introduction, especially for higher altitudes. This is evidently the *Singapore* of Firminger,[8] and apparently is a variety well worthy of introduction.

Singra (Fig. 61).—Size large, length 155 mm., breadth 85 mm. weight 432 grams; form oblong to semi-reniform; basal cavity small; stem inserted obliquely; ventral shoulder rather compressed and sloping, dorsal shoulder higher but narrow; apex curving into a prominent beak, above which is a marked depression; surface smooth, green to light orange; flesh light yellow, firm and somewhat dry, melting, devoid of fibers, and with a distinct blackberry, *Rubus nigrobaccus*, flavor.[1]

SAHARANPUR

An interesting variety seemingly well worthy of introduction.

Sokhta.—A long, slender mango with red, firm flesh.[2]

HAJIPUR

Souria (*Souria budaya, Durbhanga budaya*).—A medium large, flattened, thin-skinned, attractive mango, weighing 280 to 450 grams; the flesh is free of fiber, of excellent flavor, and contains a small, thin seed.[4]

DARBHANGA

According to Maries this is an exceptionally good variety.

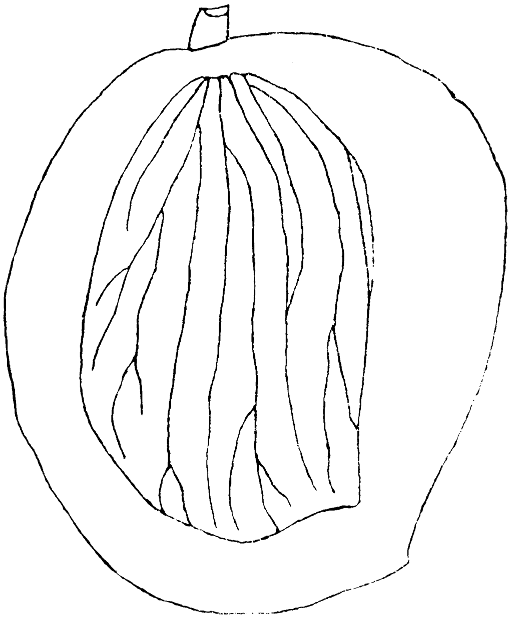

FIG. 63. *Strawberry*

Stalkart (Fig. 62).—Size small, length 93 mm., breadth 63 mm., weight 198 grams; form ovate to sub-reniform, oblique; base rounded; stem inserted obliquely; ventral shoulder high, dorsal shoulder falling from stem in a gentle curve; apex broadly rounded; lower ventral side depressed; surface smooth, green to yellowish red; flesh deep yellow, juicy, sweet, with but little fiber; seed 25 mm. thick, weighing 28 grams.

The tree is a free grower, resistant to cold and prolific. The fruit ripens early and keeps well.[1]

SAHARANPUR

This variety is quite similar to the *Bombay* and is in India considered one of the best in quality. Notwithstanding its small size it is probably well worthy of introduction.

Strawberry (Fig. 63).—Size small, length 77 mm., breadth 66 mm., weight 198 grams; form short ovate, asymmetrical; stem inserted almost squarely; ventral shoulder prominent, dorsal shoulder very short; apex

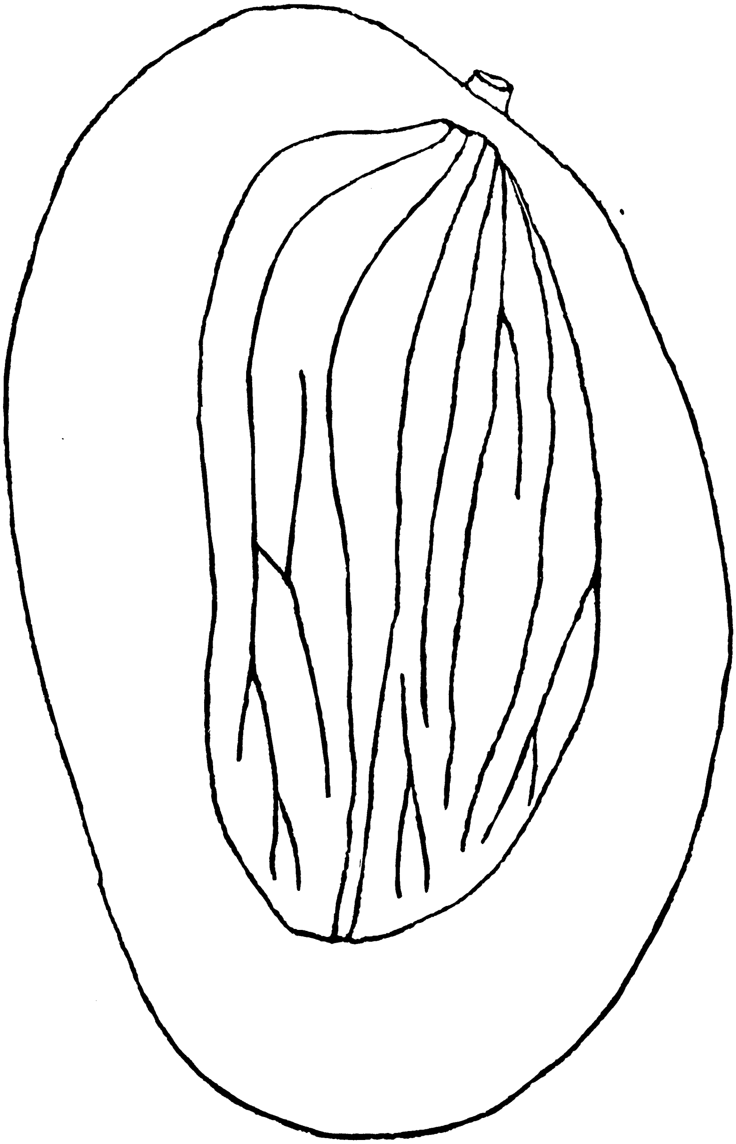

FIG. 64. *Sufaida No. 1*

broadly rounded, the curve ending in a distinct beak; surface smooth, brownish yellow to reddish; flesh yellow, juicy, subacid, flavored like the strawberry, *Fragraria vesca*, with but little fiber; seed small, 21 mm. thick, weighing 21 grams.

The tree is of vigorous growth but a shy bearer. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

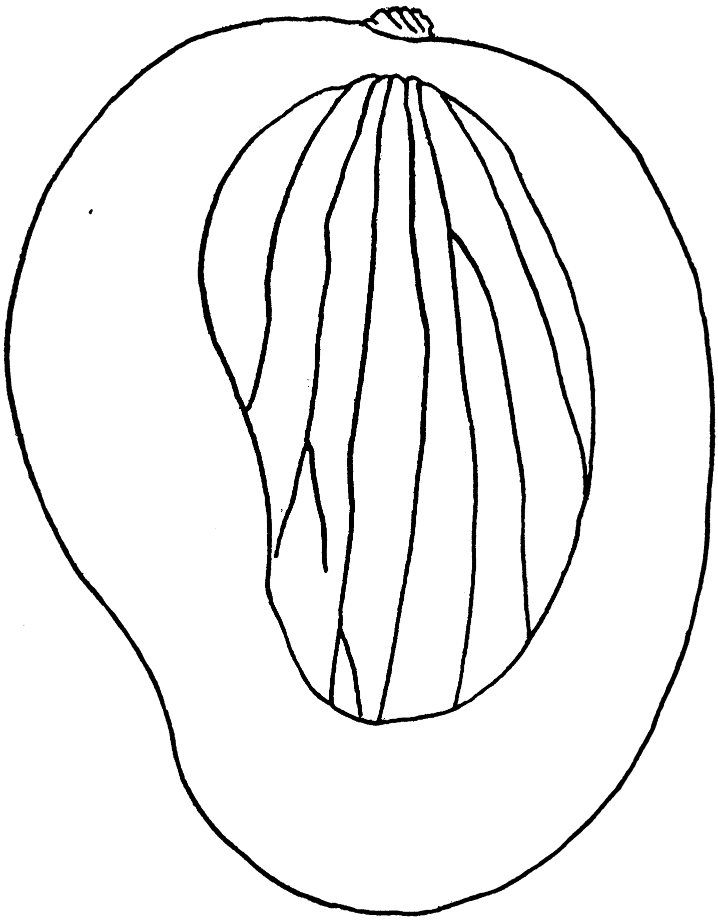

FIG. 65. *Sufaida No. 2*

Rather below the average mango in desirable qualities.

Subja.—A medium sized, cylinder-shaped mango, weighing 225 to 340 grams; the flesh is richly and pleasantly flavored. Season, the latter part of July.[2]

MALDA

Sufaida No. 1 (Fig. 64).—Size large, length exceeding 150 mm., breadth

95 mm., weight 595 grams; sub-reniform; stem inserted obliquely, base about flat, or broadly rounded; ventral shoulder high and prominent, dorsal shoulder sloping from stem; apex broadly rounded; surface smooth, yellowish green; flesh yellow, firm, very sweet, of excellent flavor; seed comparatively small, 20 mm. thick, weighing 42 grams.

The tree is a slow grower but a prolific cropper. The fruit ripens late and is a good keeper.[1]

SAHARANPUR

The *Sufaida* described by Kinman from Porto Rico[3] is apparently the same variety, for the descriptions tally quite well. In Porto Rico the fruit ranges from 780 to 1,020 grams, occasionally attaining a weight of 1,130 grams.

According to Kinman the surface is never reddish and the bloom is white and heavy and quite persistent; the skin very

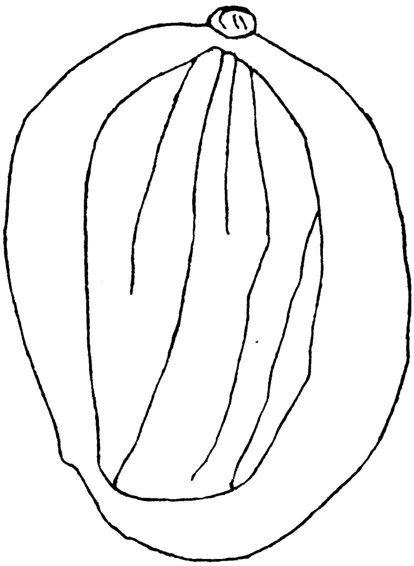

FIG. 66. *Sufaida Malihabad*

thin and easily torn, but separating easily from the flesh; the flesh dark yellow or orange near the apex, becoming lighter yellow near the seed and towards the base, sweet, fairly rich, with a pleasant, refreshing flavor, and scant, short, stiff and coarse fiber.

In Porto Rico the tree has been found to be a vigorous grower and a regular but not prolific cropper. The fruit ripens from the latter half of August until late in September. A defect found with this variety in Porto Rico is the frequent splitting of the fruit on the trees before ripening.

In India this variety ranks as one of the best, and is well worthy of introduction.

Sufaida No. 2 (Fig. 65).—Size large, length 120 mm., breadth 95 mm., weight 454 grams; form ovate to semi-reniform; stem inserted nearly squarely; shoulders moderately developed, the ventral being most prominent; apex broadly rounded, with a pronounced depression on lower ventral side; surface smooth, yellowish green; flesh yellow, juicy, somewhat acid, with but little fiber; seed quite large, 25 mm. thick, weighing 57 grams.

The tree is of medium vigor and prolific. The fruit ripens late and keeps well.[1]

SAHARANPUR

Somewhat inferior to No. 1, but above the average mango in desirable qualities, this variety well merits importation.

Sufaida Malihabad (Fig. 66).—Size small, length 72 mm., breadth 53 mm., weight 100 grams; form short oval; base rounded, shoulders rounded, the ventral the most prominent; apex broadly rounded, nak rather prominent, well above apex; surface greenish yellow; flesh pale yellow, not very sweet, resinous, but with few fibers; seed thin, 7 mm. thick, weighing 14 grams.[1]

SAHARANPUR

An inferior variety of little if any value.

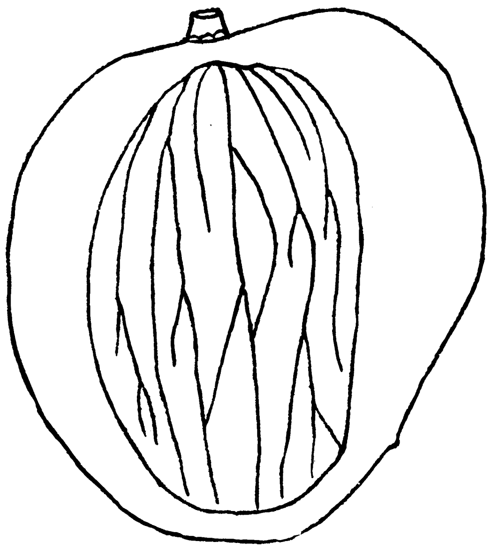

FIG. 67. *Sunahra*

Sunahra (Fig. 67).—Size small to medium, length 68 mm., breadth 65 mm., weight 212 grams; form asymmetrically heart shaped; stem inserted in a shallow cavity; ventral shoulder quite prominent, dorsal shoulder short and rounded; apex broadly rounded; surface smooth, yellowish green; flesh orange yellow, juicy, very sweet, similar in flavor to *Gopalbogh*, and rather fibrous; seed 19 mm. thick, weighing 21 grams.

The tree is of medium vigor and a shy bearer. The fruit ripens late and is a good keeper.[1]

SAHARANPUR

An average mango, valuable chiefly because of its late ripening.

Sundali (*Chandani*).—A fruit of ordinary size; the flesh is firm, very sweet, fiberless, having the odor of sandalwood, *Santalum album,* containing a small seed.[2]

MURSHEDABAD

Sundershah (FIG. 68).—Size medium, length 85 mm., breadth 56 mm., weight 213 grams; form ovate-elliptical to sub-reniform; base rounded; stem inserted squarely, shoulders about equal, rounded; apex broadly rounded, with a trace of depression on lower ventral side; surface uneven, green to yellow; flesh deep yellow; very juicy, resinous, of fair flavor and quality, very fibrous; seed large, 19 mm. thick, weighing 50 grams.

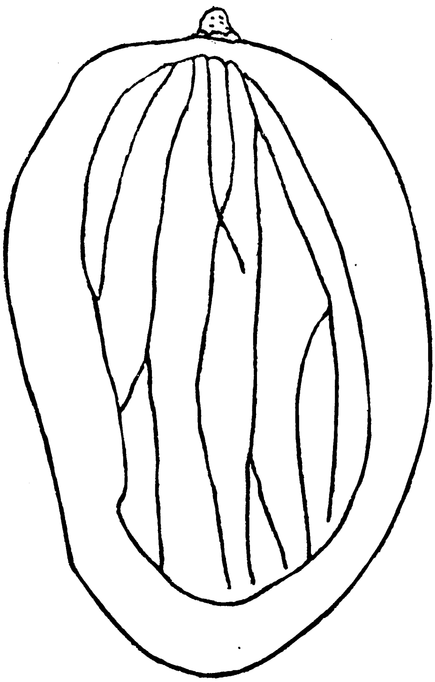

FIG. 68. *Sundershah*

The tree is a free grower, cold resistant and prolific. The fruit ripens in midseason and is a poor keeper.[1]

SAHARANPUR

This variety is very distinct from the *Sandersha* (Plate XVIII) introduced and fruited in Florida. Since that variety was introduced from Bangalore, while the one above was described from Saharanpur, India, there may be two varieties in India with the same name, though an error in labeling might also account for the difference in the description of these two kinds. The *Sundershah* from Saharanpur is apparently a very inferior mango of little if any merit.

Sukul (*Sukul-Ka-Bhaduiya*).—A medium large, elongate, thick-skinned fruit weighing 450 grams; the flesh is orange colored, juicy and sweet, fibrous and contains a small seed. A late variety, ripening in September and October.[2]

HAJIPUR

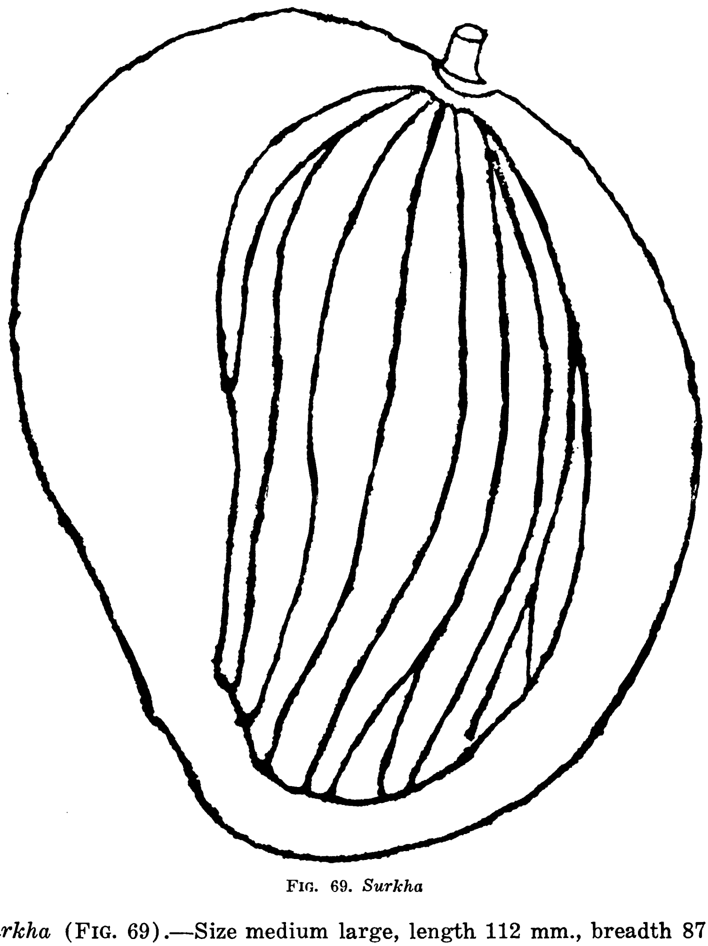

FIG. 69. *Surkha*

Surkha (FIG. 69).—Size medium large, length 112 mm., breadth 87 mm., weight 241 grams; semi-reniform, attractive; stem inserted obliquely; ventral shoulder high and well developed; dorsal shoulder sloping in a wide curve from stem; apex broadly rounded; ventral lower side slightly depressed; surface smooth, yellow to reddish; flesh yellow, juicy, of good, spicy flavor, fibrous; seed rather large, 25 mm. thick, weighing 50 grams.

The tree is medium vigorous, resistant to cold and prolific. The fruit ripens late in season and is a good keeper.[1]

SAHARANPUR

Notwithstanding its reputed fibrousness the *Surkha* is considered one of the best varieties in India, and would appear well worthy of introduction, especially for the higher elevations.

Talabi.—The incomplete description states that the fruit has a yellow surface; the flesh is a rich yellow, sweet, juicy, with a peculiar aromatic flavor. The fruit ripens late in the season.[2]

MURSHEDABAD

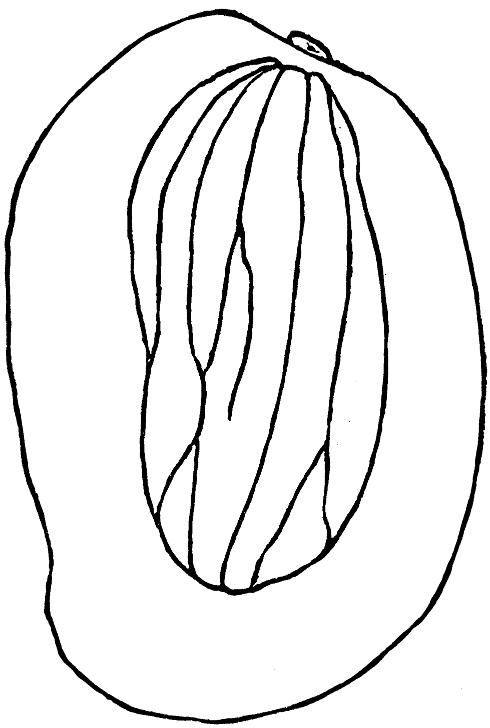

FIG. 70. *Tamancha*

Tamancha (Fig. 70).—Size small, length 95 mm., breadth 65 mm., weight 191 grams; form oblong to semi-reniform; stem inserted obliquely; ventral shoulder fairly high but short, dorsal shoulder low and rounded; apex broadly rounded, the curve ending in a rather conspicuous beak; nak prominent with a pronounced depression above; surface uneven, yellowish green, tinged with yellow; flesh light yellow, juicy, sweet with a trace of acid, fibrous; seed rather large, 19 mm. thick, weighing 35 grams.

The tree is a free grower, and a shy bearer. The fruit ripens in midseason and keeps well.[1]

SAHARANPUR

A variety of but little merit.

Tars.—A large mango, weighing 450 to 675 grams, belonging to the "Budayas."

According to Maries it is of good quality and ripens in September.[4]

Tehfaringa,—A cylindrical, medium-sized fruit, weighing from 225 to 340 grams; the flesh is sweet even in the unripe state, and is sweet and of good flavor when mature. Ripens in July.[2]

MALDA

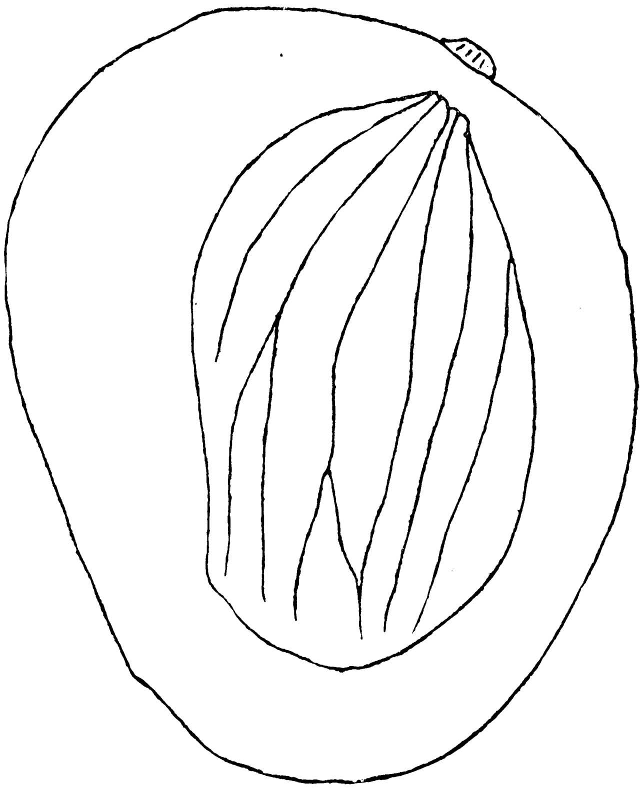

FIG. 71. *Zarda* (seedling)

Terha Kellua.—A large, ill shaped mango with obliquely inserted stem, weighing 450 to 675 grams.[4]

MALDA

Tisiphoal.—In all respects very similar to the *Subja* which see.[2]

MALDA

Tota.—There are two kinds grown under the above name, similar except in size. In the large fruited variety the fruit is 450 grams in weight, elongate, light sulfur colored and thin-skinned; the flesh is fiberless and contains a small seed. The fruit ripens early in June.[2]

MURSHEDABAD

Totapari.—Size fairly large, length 130 mm., breadth 92 mm., weight 418 grams; form obliquely oval; base rounded; stem inserted squarely; ventral shoulder short and rounded, dorsal shoulder sloping from stem in a wide curve; apex rounded, the curve ending in a prominent, rounded beak and a correspondingly prominent depression above; surface uneven, light green to brownish; flesh light yellow, rather firm and dry, acid and of spicy flavor, fibrous; seed 19 mm. thick, weighing 28 grams.[1]

SAHARANPUR

Though several discrepancies are apparent between the above notes by Hartless from India and Kinman's description of "Totafari" from Porto Rico, it seems probable that both refer to the same variety. According to Kinman the skin is thick and tough, and the flesh very juicy, free from fiber, subacid, spicy and of agreeable flavor. The fruit is a good keeper and well adapted for marketing at a distance.

The tree is of vigorous growth, open and of spreading habit, precocious, and a regular and prolific bearer. "The fruits are sometimes attacked by fruit flies, though seldom seriously."[1]

Zarda (Seedling) (FIG. 71).—Size medium large, length 105 mm., breadth 85 mm., weight 312 grams; form obliquely short-ovate; base rounded, stem inserted obliquely; ventral shoulder broad and well developed, dorsal shoulder short and sloping away from stem in a rounded curve; apex rounded; surface smooth, yellow; flesh light orange, juicy, subacid, of pleasant flavor and but little fiber; seed rather large, weighing 35 grams.[2]

SAHARANPUR

A mango of average quality.

ADDENDA [a]

Afonza.—A fairly large fruit, 115 mm. long, 100 mm. broad, weighing 570 grams, the ventral shoulder high; surface greenish yellow with dark lenticels; the flesh pale yellow and sweet, with few fibers.

By Woodrow considered distinct from *Alfonzo* or *Alphonse*.

Bada-mawa.—A small fruit, 90 mm. long, 70 mm. broad, weighing 170 grams; the surface green to yellowish; the flesh sweet and rich, without acidity.

Badshaha.—A medium sized mango, 120 mm. long, 85 mm. broad, weighing 395 grams; surface pale yellow; the flesh of good flavor but fibrous.

Banchore, No. 1.—A small fruit, 75 mm. long, 65 mm. broad, weighing 140 grams; shoulders equal, apex rounded, surface a dark, creamy yellow, with a deep crimson blush on the sun-exposed side; the flesh is of excellent flavor.

A variety from Alandi-Keir, Poona.

Banchore, No. 2.—A small mango, 85 mm. long, 70 mm. broad, weighing 198 grams; surface green to yellowish; the flesh is sweet without acidity.

Bhopaly.—A medium sized mango, 100 mm. long, 80 mm. broad, weighing 395 grams; shoulders equal and apex rounded; surface yellowish green; the flesh in dark yellow, of good flavor without fiber.

Possibly a variety diffrent from the *Bhupali* previously mentioned.

Bhunga.—A fruit of medium size, 85 m. long, 70 mm. broad, weighing 225 grams; shoulders equal, the beak small; surface and flesh is yellow. Susceptible to weevils (fruit flies?)

Bishop.—A rather large mango, 135 mm. long, 115 mm. broad, weighing 510 grams; ventral shoulder high, the beak small; surface yellowish, with small, pale yellow dots; the flesh is brownish, paler near the skin, darker in the center, sweet and rich, without acidity, with few fibers.

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[a] Since the foregoing article was written the writer has obtained access to *The Mango in Southern California* by F. W. Popenoe, published in 1911, which contains a descriptive list of mangos, including those described by Woodrow in *The Mango.* In order to make the present list more complete the following descriptions have been adapted from this publication. Except where stated otherwise all are varieties from India and are probably found in the country about Bombay. The names of many indicate that they were christened by the Portuguese, who possibly first propagated them.

Bolo.—A medium sized fruit, 100 mm. long, 90 mm. broad, weighing 370 grams; surface yellow; the flesh pale yellow with a few strong, dark fibers near the skin.

Cobria.—A small, roundish mango, 70 mm. long and broad, weighing 170 grams; surface yellow; the flesh is pale yellow, of good flavor, devoid of fiber.

Colleca.—A medium sized fruit, 110 mm. long, 65 mm. broad, weighing 285 grams; shoulders nearly equal; surface yellowish green; the flesh is yellowish and sweet, without fiber.

A good mango for cooking according to Woodrow.

Costa.—A medium sized mango, 90 mm. long, 70 mm. broad, weighing 240 grams; ventral shoulder slightly higher than the dorsal; surface yellowish green; the flesh is cream yellow, pleasantly flavored.

Custodio.—A large mango, 150 mm. long, 105 mm. broad, weighing 795 grams; ventral shoulder high, the beak small; surface yellowish green; the flesh is pale yellow and fiberless. Season beginning in July.

Dalbed.—A fruit of medium size, 110 mm. long, 70 mm. broad, weighing 300 grams; base rounded, with ventral shoulder higher than the dorsal, the beak medium; surface yellowish to greenish; the flesh is deep yellow and very sweet, but fibrous.

Deorukhia.—A rather small mango, 100 mm. long, 65 mm. broad, weighing 200 grams; ventral shoulder higher than the dorsal, the beak small; surface orange yellow; the flesh is deep yellow and of very fine flavor. The tree is vigorous and of upright habit.

Diniz.—A mango of medium size, 90 mm. long, 75 mm. broad, weighing 310 grams; shoulders equal; surface dark green; the flesh is yellow, soft and creamy, without acidity.

D'Joao.—A medium large mango, 115 mm. long, 90 mm. broad, weighing 365 grams; the ventral shoulder high.

A popular fruit according to Woodrow.

Dulce.—A fruit of medium size, 110 mm. long, 80 mm. broad, weighing 340 grams; the shoulders equal and the surface pale greenish to yellow; the flesh is sweet, "piquant," and fiberless.

Fernandez.—A small fruit, 80 mm. long, 62 mm. broad, weighing 170 grams; the shoulders are sloping and the surface yellowish green, bright red on sun-exposed side, with small, yellow dots; the flesh is yellow, distinctly subacid, of excellent flavor and nearly free from fiber; the seed small.

By Woodrow considered a very superior variety, but which was found in Florida to be of but little value.

Fernandino No. 1.—A medium sized mango, 100 mm. long, 72 mm. broad, weighing 270 grams; ventral shoulder higher than the dorsal, surface pale yellow with bright crimson on sun-exposed side; the flesh is pale yellow, subacid and fibrous.

Fernandino No. 2.—A fruit of medium size, 110 mm. long, 85 mm. broad, weighing 285 grams; ventral shoulder higher than the dorsal; surface green; the flesh is white (?)

Woodrow considers this a cooking mango of especial value.

Frederico.—A medium sized mango, 90 mm. long, 72 mm. broad, weighing 225 grams; the ventral shoulder higher than the dorsal; the flesh fiberless.

Woodrow remarks that it should be picked green and that it is a valuable fruit for preserving.

Furtado No. 1.—A medium large mango, 100 mm. long, 80 mm. broad, weighing 325 grams; surface smoth, yellowish green; the flesh is deep orange yellow, rather coarse, "puffy."

Furtado No. 2.—A roundish mango of medium size, 85 mm. long, 75 mm. broad, weighing 225 grams; the ventral shoulder slightly higher than the dorsal; the beak distinct; surface blotched in green and yellow; the flesh dark yellow.

Gadgya.—A large mango, 115 mm. long 100 mm. broad, weighing 510 grams; beak small but distinct; surface greenish yellow; flesh pale yellow, subacid, with few fibers.

Goa.—A small mango, 80 mm. long 72 mm. broad, weighing 200 grams; ventral shoulder higher than the dorsal, surface pale yellow; the flesh sweet and very soft.

Goradya.—A medium large mango, 105 mm. long, 100 mm. broad, weighing 340 grams; ventral shoulder higher than the dorsal; surface "very rough, with large obtuse projections;" the flesh is sweet but fibrous.

Jaffna.—An oblong mango of medium size, surface green; the flesh golden yellow and of good flavor and quality; the seed medium to large. The tree is of vigorous growth, precocious and prolific.

The most popular mango in Ceylon, this variety should be imported and tried.

Jamshedi.—A roundish, large mango indented at apex; surface green, with large pale green or yellowish spots; the flesh is yellow with a brownish tinge, and a "strong, excellent, distinct" flavor; free from fiber.

Jeepria.—A medium large mango, 110 mm. long, 80 mm. broad, weighing 340 grams; shoulders sloping; surface green; the flesh white.

Woodrow says this is a good cooking mango.

Kabutria.—A small mango 110 mm. long, 65 mm. broad, weighing 200 grams; the shoulders about equal, the beak small but distinct; surface greenish yellow, red on sun-exposed side; the flesh is deep yellow of rich "piquant" flavor, devoid of fiber.

Kaelia.—A fairly large mango, 95 mm. long, 80 mm. broad, weighing 395 grams; ventral shoulder higher than the dorsal, the beak small; surface greenish yellow; the flesh is deep yellow with "luscious" flavor and few fibers.

Kagdi-Alphonse.—A mango of medium size, 95 mm. long, 80 mm. broad, weighing 285 grams; "left shoulder from the stalk falling slightly, then rising; right shoulder gently falling;" surface greenish yellow, suffused with crimson; skin thick; the flesh "deep yellow, fine, creamy."

Kala-Alphonse.—A medium large mango, 115 mm. long, 85 mm. broad, weighing 395 grams; ventral shoulder higher than the dorsal; surface dark green, red on sun-exposed side; the flesh is dark yellow, "creamy," of "luscious" flavor and devoid of fiber.

Kalia.—A medium sized fruit, 100 mm. long, 80 mm. broad, weighing 255 grams; ventral side higher than the dorsal; the beak small but distinct; surface dark green, yellowish on the shoulders; the flesh is pale yellow, and very sweet.

Khatkia.—A long, slender, small mango, 115 mm. long, 65 mm. broad, weighing 200 grams; shoulders rounded; the flesh is sweet and of good flavor but fibrous.

According to Woodrow a popular mango, "to be sucked."

Khoont.—A medium sized fruit, 95 mm. long, 80 mm. broad, weighing 225 grams; surface blotchy, from dull red to yellow; the flesh is dark yellow, "creamy" and of good flavor.

By Woodrow pronounced a very fine fruit.

Maharajah.—A roundish oblique, flattened mango, 105 mm. long, and 80 mm. broad; surface moderately smooth, greenish yellow, with numerous yellow dots; skin thick and tenacious; the flesh is a rich yellow, sweet and of good flavor, but very fibrous.

Mangalore.—An oblong, flattened fruit, 100 mm. long, and 90 mm. broad; surface moderately smooth, yellow, marbled with green, and numerous yellow dots; skin thick and tenacious; the flesh is deep yellow, juicy, mild and subacid, but somewhat fibrous.

Moria.—A medium sized mango, 90 mm. long, 80 mm. broad, weighing 225 grams; ventral shoulder higher than the dorsal, the beak small, pointed; surface yellowish green, reddish on shoulders; the flesh is very sweet, but somewhat fibrous.

Musarata.—A fairly large mango, 105 mm. long, 85 mm. broad, weighing 425 grams; ventral shoulder higher than the dorsal; surface green, yellow on sun-exposed side; the flesh is cream colored of rich, fine flavor.

Naralaya.—A medium sized mango, 100 mm. long, 80 mm. broad, weighing 297 grams; ventral shouder higher than the dorsal, the beak very small; the flesh pale yellow, subacid, somewhat fibrous.

Narayan (*Narayan Ropra*).—A fruit of medium size, 95 mm. long, 90 mm. broad, weighing 283 grams; shoulders about equal, rounded, the beak small; surface green shading to yellow at base; the flesh is deep yellow, of fine flavor but fibrous.

Nawsharwani.—A fairly large mango, 120 mm. long, 105 mm. broad, weighing about 450 grams; shoulders well developed, the beak pointed.

Nowshari.—A large mango, 125 mm. long, 105 mm. broad, weighing 565 grams; surface greenish, yellowish towards base.

By Woodrow said to be a fine mango about which definite information is lacking.

Pakria.—A small fruit, 100 mm. long, 65 mm. broad, weighing 200 grams; shoulders rounded; surface pale yellow; the flesh is pale yellow, of delicious flavor and fiberless.

Pandria.—A medium sized, roundish mango, 80 mm. long, and broad, weighing 255 grams; shoulders rounded; surface greenish yellow; the flesh is sweet but fibrous.

Pia Posha.—A fairly large, elongate mango, 135 mm. long, 80 mm. broad, weighing 400 grams; shoulders not prominent, the beak large; surface rich cream, suffused with pale crimson on sun-exposed side; the flesh is pale yellow, very sweet, and agreeably flavored, but fibrous.

Ragu.—A long, slender mango, 150 mm. long and 55 mm. broad; shoulders not prominent, "a large depression in place of beak; surface yellow; the flesh is deep yellow, with agreeable flavor and no fiber.

Rajia.—A small fruit, 80 mm. long, 65 mm. broad; weighing 200 grams; ventral shoulder higher than the dorsal; surface yellowish green, with a reddish tinge on sun-exposed side; the flesh is deep yellow, rich and sweet in flavor, without fiber.

Rajpuri.—A medium sized, roundish mango, averaging 280 grams in weight; surface yellow, pinkish on sun-exposed side; the flesh is of delicate texture and richly flavored, with few fibers.

This variety has been tried out in Florida where it has failed to attract much attention.

Rupee.—A large, short oblong to roundish mango, up to 125 mm. long; surface pale green; skin tender and easily bruised; the flesh is golden yellow, of delicious flavor, free from fiber, containing a small seed.

The tree is a weak grower and a shy bearer. The fruit ripens late in season, is one of the best flavored varieties in Ceylon, and brings a rupee each, but is a poor keeper and shipper, and is not recommended for general planting.

Ryotya.—A medium sized, mango, 85 mm. long, 70 mm. broad, weighing 230 grams; shoulders equal, "exactly obovate;" surface creamy yellow, bright crimson on sun-exposed side; the flesh is creamy yellow, of excellent flavor and fiberless.

Woodrow speaks of this as "a really fine fruit, handsome and prolific."

Salgada.—A large mango, 130 mm. long, 115 mm. broad, weighing 700 grams; dorsal shoulder very prominent, higher than the ventral; surface greenish yellow on shoulders, shading to yellow towards apex; the flesh is sweet and of agreeable flavor.

Salgadina.—A small mango, 85 mm. long, 70 mm. broad, weighing 200 grams; ventral shoulder higher than the dorsal; surface a rich crimson shading to yellow; the flesh is deep yellow.

Shendria.—A small fruit, 105 mm. long, 60 mm. broad, weighing 200 grams; ventral shoulder moderately prominent, higher than the dorsal, which falls abruptly; surface deep yellow, "spotted and flushed with carmine;" the flesh is richly flavored, with few fibers near the skin.

Shrawani (*Shrawani Alphonse*).—A fairly large fruit, 120 mm. long, 95 mm. broad, weighing 400 grams; ventral shoulder higher than the dorsal, which fails abruptly; surface yellow; the flesh is deep yellow, of fine flavor, containing a large seed.

St. Aime.—A large, roundish mango, 100 mm. in circumference, weighing 425 grams; ventral shoulder higher than the dorsal; surface greenish yellow; the flesh is deep orange yellow, coarse in texture but of rich flavor.

Sucretino.—A medium sized fruit, 100 mm. long, 80 mm. broad, weighing 340 grams; shoulders not prominent; surface green at base, shading to yellowish at apex; the flesh is pleasantly subacid.

Surkhya.—Apparently a synonym of *Surkha* described by Hartless.

Woodrow speaks of this as a very prolific, attractive sort.

NAPIER GRASS: A PROMISING NEW FORAGE PLANT FOR THE PHILIPPINES

By P. J. Wester, *Agricultural Advisor*

Napier grass, *Pennisetum purpureum*, is a coarse, perennial grass attaining a height of up to 5 meters or more if allowed to grow unchecked. It is a native of tropical Africa, and was first domesticated in Rhodesia in 1909. Since then it has gradually found its way to many other parts of the world and is now grown in the United States, Cuba and Queensland and probably other lands. In Florida it is being planted very extensively.

In passing through Hawaii on his way to the Philippines in 1918, the attention of the writer was called to the Napier grass at the Hawaii Agricultural Experiment Station, Honolulu, and a few cuttings were obtained there and brought to Manila, where they were planted at the Singalong Experiment Station, from whence material subsequently was mailed to Zamboanga for distribution in Mindanao-Sulu.

Another lot of cuttings was brought from Singalong to Lamao in 1919, where the Napier grass now has been grown under field conditions for a year, during which time it has shown itself well adapted to the climate and soil, and to be more drought resistant than any other forage plant yet introduced into the Philippines. (Plate XIX.) In the rainy season it makes a very heavy growth, and while a comparative test has not been made it is apparent that in yields of green fodder Napier grass is greatly superior to all other forage plants now grown in the Archipelago, including Guinea grass, Para grass, and Japanese forage cane. In Cuba, Napier grass is reported to yield over 550 tons of green forage per hectare per year.

Seeds are difficult to germinate but cuttings grow as readily as sugar-cane points, and should be handled much in the same way. Shorter cuttings will grow, but in order to insure a good stand it is best to plant cuttings from 15 to 20 centimeters long, each cutting with one to two joints. Also, where the internodes are long it is best to cut the canes so that the topmost joint is not more than 5 centimeters below the top end of the cutting.

After the field has been plowed and harrowed it should be marked off into rows 1.25 to 1.50 meters apart and the cuttings planted from 40 to 60 centimeters apart in the row. Where material is abundant whole canes may be laid flat in a shallow furrow and covered with soil, but where material is scarce it is better to plant cuttings, and then push them diagonally into the soil so that the top-ends are about even with the surface of the land.

After planting the field should be kept free from weeds until the grass is strong enough to take care of itself. After the cutting of forage has begun it is well to give the field an occasional cultivation if weeds become troublesome.

In order to avoid waste in feeding, Napier grass, because of its coarse growth, should not be allowed to grow more than 80 to 100 centimeters tall between each cutting, for otherwise the lower, woody ends of the grass will be rejected by the animals. Frequent cuttings of the grass will give a greater tonnage of good feed per unit area than a few cuttings per year.

Depending upon the quality of the soil and the distribution of the rainfall, six to nine cuttings of green fodder can be made during the year after the plants are established.

In the moist regions of the Philippines, like Tayabas, the Bicol Provinces, Samar, Leyte, and Mindanao, the Napier grass may be planted any time of the year, but in the provinces having a long dry season, like Cavite, Batangas, Tarlac, and Ilocos, the planting should be deferred until the rains arrive.

Napier grass is well relished by horses, cattle, and carabaos. The food value of this grass as compared with green corn fodder is shown in the following analysis according to a circular issued by the United States Department of Agriculture:

Constituents	Napier grass	Green corn
	Per cent	*Per cent*
Water	61.81	79.0
Protein	2.92	1.7
Carbohydrates	17.29	12.0
Fat	.29	0.5
Fiber	14.77	5.6
Ash	2.92	1.2

Merker grass is another variety of the same species, *Pennisetum purpureum,* less coarse than the Napier, of which seed recently has been received from Mr. C. V. Piper, agrostologist in charge of forage crop investigations, Bureau of Plant Industry, United States Department of Agriculture, who writes that both the Napier and Merker grasses will stand continuous moderate pasturing when they are well established.

Cuttings of Napier grass are obtainable by application to the Director of Agriculture, Manila.

PLATE XIX

Napier grass growing at the Lamao Experiment Station

TRADE OPPORTUNITIES IN TROPICAL AGRICULTURAL PRODUCTS FOR THE PHILIPPINES IN THE UNITED STATES

By P. J. WESTER, *Agricultural Advisor*

As supplementing the paper previously published on this subject [1] and to bring the information therein more up-to-date the following statistics on tropical agricultural products imported into the United States during the Calendar year 1918, are quoted from *Foreign Commerce and Navigation of the United States for 1918*, published by Bureau of Foreign and Domestic Commerce, United States Department of Commerce. Imports of tropical agricultural products into the United States which could be produced in the Philippines:

Article.	Value U. S. Dollars.
Sugar and molasses	394,824,461
Silk, unmanufactured	341,874,668
Coffee	261,248,507
Rubber, crude	215,821,132
Tea	80,740,578
Jute and jute products	78,325,916
Cotton	71,886,290
Tobacco and tobacco products	51,609,315
Sisal hemp	39,553,701
Coconut oil	35,380,099
Soya bean oil	24,019,226
Peanut oil	21,984,678
Abaca	19,255,282
Copra	16,544,613
Corn	10,966,911
Tung oil	8,120,529
Camphor	5,548,870
Cassava starch	5,014,316
Palm oil	4,317,324
Rice	4,218,513
Coconuts	4,053,282
Shredded coconuts	3,972,016
Kapok	3,673,285
Cottonseed oil	3,672,984
Castor beans	3,485,047
Pepper	3,269,678
Brazil nuts	2,987,190
Cinchona products	2,708,180
Tampico fiber	2,523,330
Peanuts	2,368,960
Vanilla beans	2,104,048
Lime citrate	1,583,261
Cloves	1,376,211

[1] See this *Review*, Vol. XIII, p. 5, 1920.

Article.	Value in U. S. Dollars.
Gutta-percha, crude	1,068,698
Beeswax	891,606
Sesame oil	694,241
Nutmegs	603,939
Ginger, dried	570,856
Castor oil	504,969
Ipecac	292,046
Sunn hemp	290,249
Indigo	285,925
Honey	279,860
Cassia and cinnamon oil	277,280
Ramie	225,960
Citronella and lemon grass oil	200,498
Mace	171,507
Sago	169,198
Coca leaves	167,957
Palm kernels	142,523
Cinnamon	103,662
Total	1,735,973,375

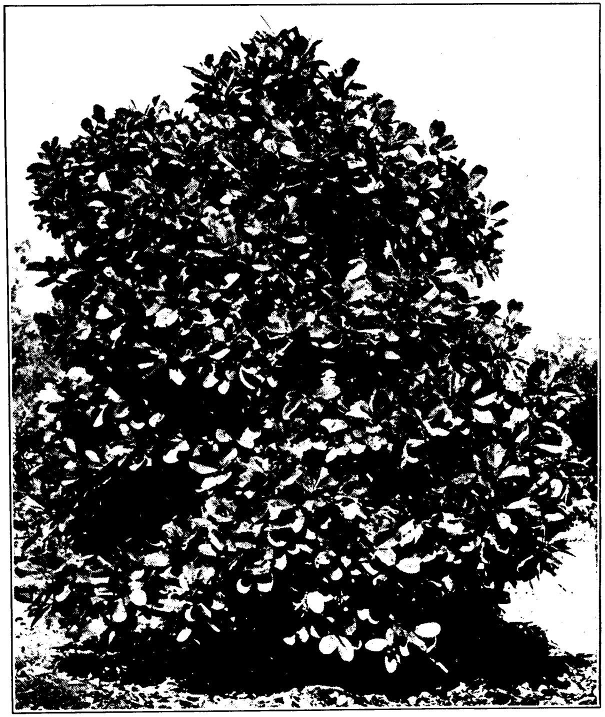
The foregoing are of course not complete statistics of all tropical agricultural products imported into the United States in 1918. As stated they include only items that could be produced in the Philippine Archipelago and do not include minor imports; those of less than $100,000 in value.

One of the items not discussed in the aforementioned article, but which deserves mention is camphor. This product is no longer obtainable from Japan in quantities to satisfy the American market and large camphor plantations have been made in Florida. So far as known these plantations are an economic success, but the soil in the Philippines is so much richer than in Florida that there can be no question but that with the cheap labor obtainable in these Islands, camphor could be produced cheaper here than in Florida. Capital seeking investment in camphor plantations would find Bukidnon and Lanao in Mindanao more favorable for the cultivation of camphor on a large scale than any other part of the Philippines.

Copra and coconut oil have also been discussed and the production of both is well established, but the Philippines do not yet export any shredded or desiccated coconut, though the United States are importing nearly eight million pesos worth annually. There seems here to be one more neglected opportunity to increase our revenues. The imports into the United States of shredded coconuts come chiefly from Ceylon.

The palm oil imports are increasing rapidly in quantity. Africa is the source of this oil and very large, hitherto unknown oil palm forests have recently been discovered in Liberia within 50 miles of the coast and the construction of a railroad to tap this new "oil field" is already under discussion.

PLATE XX



(*a*) Katmon, *Dillenia philippinensis.* Lamao Experiment Station, 1920

(*b*) Lipoti, *Eugenia currani.* Lamao Experiment Station, 1920

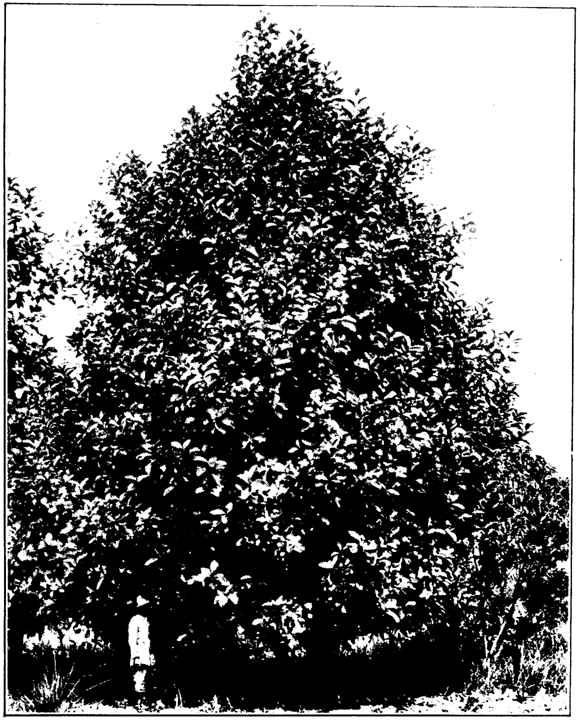
There is considerable difference of opinion among those who have studied the African oil palm, as to whether or not plantations of this palm will pay. Some claim that the planter cannot meet the low cost of production of oil obtained from the African jungle where there are no expenses for cultivation. But this was once upon a time one of the arguments against plantation rubber, the production of which has completely overshadowed the wild forest product and that within a generation. There are said to be large oil palm estates in Sumatra already, and if the conservative Dutch are investing in oil palm plantations they are probably a pretty safe investment.

A LIST OF THE TROPICAL FRUITS AT THE LAMAO EXPERIMENT STATION

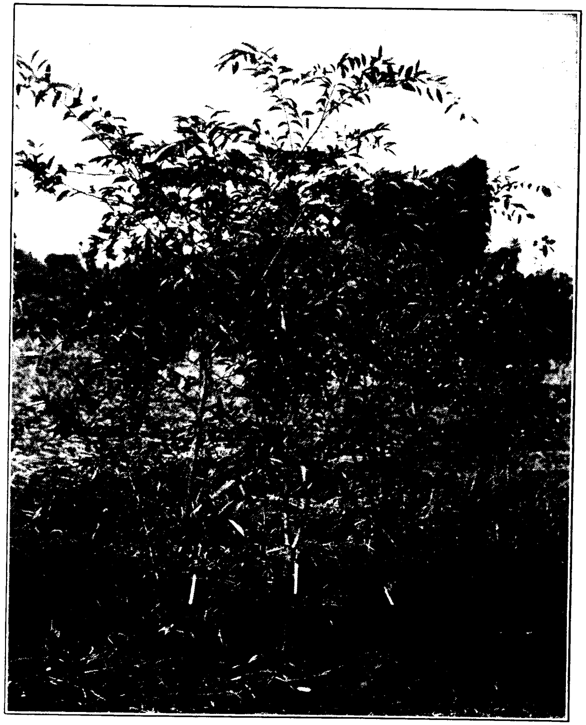
By P. J. WESTER, *Agricultural Advisor*

A list of the tropical fruits in the collection at the Lamao Experiment Station was published in this REVIEW, Vol. VIII, p. 69, but so many new species have been added to the collection since that date and others have perished that the following list of the species in the orchards at the end of 1920 may be of interest. Those marked with an asterisk (*) have fruited.

**Aberia gardneri* Clos. KETEMBILLA.
**Achradelpha mammosa* O. F. C. CHICO-MAMEY.
**Achras zapota* L. CHICO.
Acrocomia sclerocarpa Mts. COROZO.
Adansonia digitata L. BAOBAB.
**Anacardium occidentale* L. CASHEW.
Anacolosa luzoniensis Merr. Galo.
**Ananas sativus* Schult. PINEAPPLE.
**Annona cherimolia* Mill. CHERIMOYA.
—*diversifolia* Saf. ILAMA.
*—*glabra* L. MAMON.
—*marcgravi* Mts. PONHE.
*—*montana* Mf. MARON.
*—*muricata* L. GUANABANO.
—*purpurea* M. S. SONCOYA.
*—*reticulata* L. CUSTARDAPPLE.
*—*senegalensis* Pers. ANIGLI.
*—*spinescens* Mts. ALAGADISSO.
*—*squamosa* L. SUGARAPPLE.
*—sp. (hybrid cherimoya x sugaraple). ATEMOYA.
*—sp. (hybrid cherimoya x sugarapple x custardapple). CUATEMOYA.
**Antidesma bunius* Spr. BIGNAY.
**Artocarpus communis* For. BREADFRUIT.
—*elastica* Rwt. GOMIHAN.
*—*integra* L. JAK.
—*lancaefolia* Rxb. KLEDANG.
—*odoratissima* Bco. MARANG.
—*polyphoema* Pers. LEMASA.
—*rigida* Bl. MANDALIKA.
—sp. MITNAI. (Plate XXI*a*.)
**Averrhoa bilimbi* L. KAMIA.
*—*carambola* L. CARAMBOLA.
Baccaurea dulcis M. Arg. BURUNG.



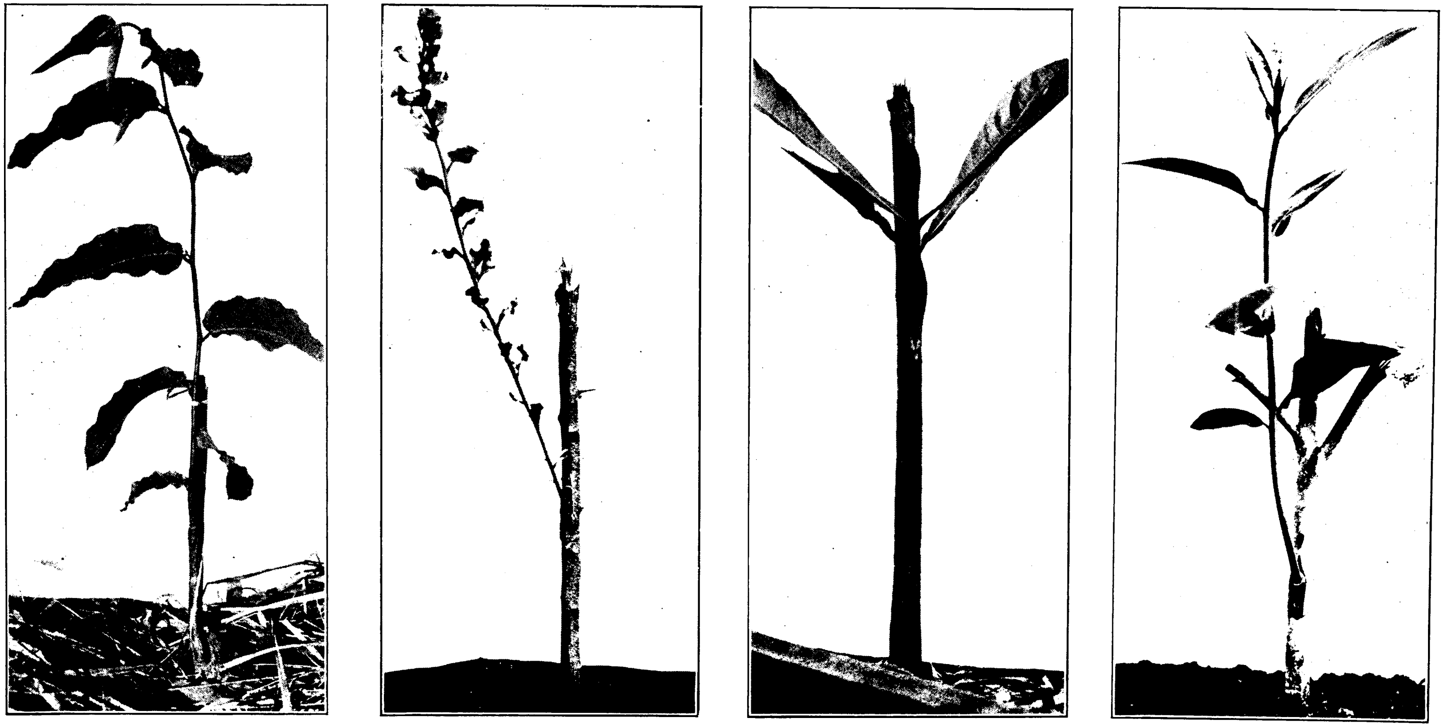
(*a*) Mitnai, *Artocarpus* sp. Lamao Experiment Station, 1920



(*b*) Miaray, *Citrus miaray*, budded on Kalamondin. Lamao Experiment Station, 1920

**Belou marmelos* Ls. BAEL.
**Blighia sapida* Koen. AKEE.
Bouea macrophylla Grif. GANDARIA.
Britoa acida Bg. BRITOA.
Buchanania latifolia Rxb. LONEFO.
Byrsonima crassifolia HBK. NANCE.
Calamus sp. LITOKO.
Canarium commune L. KANARI.
—*moluccana* Bl. BAGEJA.
—*ovatum* Eng. PILI.
Capparis micracantha DC. DAUAG.
**Carica papaya* L. PAPAYA.
**Caryophyllus jambos* Stokes. YAMBO.
**Carissa grandiflora* DC. TUNGULU.
*—*carandas* L. KARANDA.
*—sp. PERUNKILA.
Casimiroa edulis Lal. MATASANO.
**Cecropia palmata* Willd. YARUMA.
Ceratonia siliqua L. CAROB.
**Chrysophyllum cainito* L. CAIMITO.
*—*oliviforme* Lam. CAIMITILLO.
**Chrysobalanus icaco* L. ICACO.
**Citrus aurantifolia* Swg. LIME.
*—*aurantifolia aromatica* Wes. DALAYAP.
*—*aurantium* L. SOUR ORANGE.
*—*excelsa* Wes. LIMON REAL.
*—*excelsa davaoensis* Wes. SUSONG BABAY.
*—*hystrix* DC. KABUYAO.
—*hystrix boholensis* Wes. KANSI.
*—*limonia* Osb. LEMON.
*—*longispina* Wes. TAMISAN.
*—*maxima* Merr. POMELO.
*—*medica* L. CITRON.
—*miaray* Wes. MIARAY. (Plate XXI*b*.)
*—*mitis* Bco. KALAMONDIN.
*—*nobilis* Lour. MANDARIN.
*—*nobilis papillaris* Bco. TIZON.
*—*sinensis* Osb. ORANGE.
*—*webberi* Wes. KALPI.
*—*webberi montana* Wes. GUYOD.
**Claucena lansium* Sk. WAMPI.
Coccoloba uvifera L. UVERO.
—sp. CORICA.
Cubilia blancoi Bl. KUBILI.
Cudrania tricuspidata Bu. CHESANG.
Cynometra cauliflora L. LAMUTA.
**Dillenia indica* L. HONDAPARA.
*—*philippinensis* Rfe. KATMON. (Plate XX*a*.)
*—*mindanaensis* Elm.
**Diospyros discolor* Willd. MABOLO.
*—*ebenaster* Retz. ZAPOTE.
Diplodiscus paniculatus Turcz. BAROBO.
Dracontomelum edule Sk. LAMIO.

**Elaeis guineensis* Jq. DENDÉ.
Eriobotrya japonica Ly. LOQUAT.
**Erioglossum edule* Bl. KALAYO.
**Eugenia claviflora* Rxb. BALUBAT.
*—*currani* C. B. R. LIPOTI. (Plate XX*b*.)
—*dombeyi* Sk. GRUMICHAMA.
—*edulis*. ARGENA.
*—*javanica* L. MAKOPA.
—*malaccensis* L. TERSANA.
—sp. ARAHIS.
—sp. INOGUG.
*—*uniflora* L. PITANGA.
Euphoria cinerea Rdk. ALPAY.
—*longana* Lam. LONGAN.
—*nephelioides* Rdk. ALUAO.
Feijoa sellowiana Bg. FEIJOA.
Feronia limonia Swg. VILATTI.
Ficus sycomorus L. SYKAMORE.
**Flacourtia cataphracta* Rxb. PANIALA.
—*ramontchi* l'Her. SERALI.
*—*sepiaria* Rxb. BITUNGOL.
**Fortunella japonica* Swg. KUMQUAT.
Garcinia benthami Pre. BUNAG.
—*binucao* Cy. BINUKAO.
—*dulcis* Kurz. BANITI.
—*mangostana* L. MANGOSTEEN.
—*prainiana* King. CHERPU.
—*venulosa* Cy. KATURI.
—*vidalli* Merr. ANTOL.
—sp. KADIS.
**Genipa americana* L. GENIPA.
Gnetum gnemon L. BANAGO.
—*indicum* Merr. BULSO.
Gourliea decorticans Gz. CHANAR.
**Grewia asiatica* L. PHALSA.
**Hibiscus sabdariffa* L. ROSELLE.
**Inocarpus edulis* For. KAYAM.
Lansium domesticum J. LANZON.
Licania platypus Fri. SANSAPOTE.
Litchi chinensis Sonn. LITCHI.
**Lucuma nervosa* A. DC. CANISTEL.
*—*salicifolia* HBK. BORACHO.
Macadamia ternifolia Muell. DAMIA.
**Malpighia glabra* L. MALPI.
Mammea americana L. MAMEY.
Mangifera caesia J. BAUNO.
—*foetida* Lour. BACHANG.
*—*indica* L. MANGO.
*—*odorata* Grif. HUANI.
Melicocca bijjuga L. MAMONCILLO.
Mimusops elengi L. KABIKI.
—*kauki* L. PEKOLA.
Monstera deliciosa Lbn. CERIMAN.



From left to right, shield budded plants of Banauak, *Uvaria rufa;* Bitungol, *Flacourtia sepiaria;* Genipa, *Genipa americana;* and Talisay, *Terminalia catappa,* on Dalinsi *Terminalia edulis.* Lamao Experiment Station

From left to right, shield budded plants of Banago, *Gnetum gnemon;* Duhat, *Eugenia jambolana;* Ketembilla, *Aberia gardeneri;* and Pangi, *Pangium edule.*
Lamao Experiment Station

**Morus alba* L. MULBERRY.
**Musa paradisiaca* L. BANANA.
Myrciaria floribunda Bg. MYRCIA.
**Nephelium lappaceum* L. RAMBUTAN.
Palaquium philippinense C. B. R. ALAKAO.
Pangium edule Rwt. PANGI.
Passiflora quadrangularis L. GRANADILLA.
**Pereskia aculeata* Mill. PERESKIA.
**Persea americana* Mill. AVOCADO.
Phoenix dactylifera L. DATE.
**Phyllanthus acidus* Sk. IBA.
*—*emblica* L. NELLI.
Pithecolobium dulce Bth. KAMANCHILE.
**Psidium cattleianum* Sab. CATTLEY.
—*friedrichsthalianum* Ndz. COS.
*—*guajava* L. GUAVA.
*—*laurifolium* Bg. LAURIVA.
**molle* Ber. GUISARO.
**Punica granatum* L. POMEGRANATE.
**Rheedia edulis* P. T. BERBA.
—*madrono* P. T. MADRONO.
—sp.
Rollinia emarginata Sch. MIRIM.
*—*orthopetala* A. DC. BIRIBA.
—sp. PINHO.
**Sandoricum koetjape* Merr. SANTOL.
**Sarcocephalus esculentus* Afz. CEFALUS.
Sideroxylon mastichodendron Jq. MASTIC.
**Spondias cytherea* Sonn. HEVI.
—*lutea* L. MOMBIN.
*—*pinnata* Kurz. LANNO.
—*purpurea* L. CIRUELA.
—*tuberosa* Arr. IMBU.
**Sterculia foetida* L. BANGAR.
—*oblongata* R. Br. PANGAO.
Strychnos spinosa Lam. TRYNO.
**Syzygium cumingi* Sk. DUHAT.
**Tamarindus indica* L. TAMARIND.
**Terminalia edulis* Bco. DALINSI.
Tetrastigma harmandi Pl. AYO.
**Triphasia trifolia* P. W. LIMONCITO.
**Uvaria rufa* Bl. BANAUAK.
**Vangueria madagascariensis* Gm. VOAVANGA.
**Vitis rotundifolia* Mx. GRAPE, MUSCADINE.
—*vinifera* L. GRAPE, VINIFERA.
Ximenia americana L. BUOL.
Zalacca clemensiana Merr. KAUBI.
—*edulis* Rwt. SALAK.
Ziziphus jujuba L. JUJUBE.
—*mistol* Gri. MISTOL.

Altogether, the collection now includes 189 species and subspecies of fruits. It contains also many varieties of citrus fruits, mangos, avocados, and pineapples, and a large number of Philippine citrus forms as yet undetermined, and many species related to the different fruit trees brought together as being of possible use in breeding work and for stocks.

A large number of the Annona hybrids which made an extraordinarily rapid growth when young proved to be very short-lived, but some of those who have survived have this year been abundantly productive. It is still too early to recommend any of these hybrids for extended culture, but enough has been accomplished to show the big opportunities present for blending the numerous, divergent qualities of the Annonaceous plants. It has also emphasized the need of quantity production of hybrids in order to attain rapidly results of permanent worth.

NOTES ON GRAFTING TROPICAL FRUITS

By P. J. WESTER, *Agricultural Advisor*

Until quite recently very few tropical fruits were grafted, or propagated asexually in other ways, and as a result the great majority of them still remain in what might be called the "edible" stage. For many of them have not progressed much beyond being edible. To be sure, so many of the tropical fruits are such recent discoveries that there has been little or no time to improve them. Large numbers are not even domesticated, or else they are grown in a desultory fashion. But one never knows when a tree of these "wild" or semi-cultivated species may be found that in eating quality is so superior to its sister trees as the celebrated "Concord" grape is superior to the wild unimproved Labrusca grapes of the Eastern United States, the "Scuppernong" to the wild Muscadines of the South, or as the paper shell pecan nuts are in advance of the thick spelled pecans of the forest.

As has been related from time to time in previous issues of this REVIEW grafting experiments covering a wide range of species have been conducted at the Lamao Experiment Station for several years in order that we may be ready to take advantage of the discovery of superior individual fruit trees.

Once the details were worked out, shield budding was found so almost universally successful in vegetatively propagating the various species that other methods of graftage have been almost lost sight of at Lamao. As in the case of the Lanzon, *Lansium domesticum,* they have been employed as a last resort. But experience during the past season has shown that cleft grafting especially, may be used to great advantage where the buds do not sprout readily, and where the bark is so thin and brittle that shield budding is tedious and slow.

As a case in point, shield buds of Binukao, *Garcinia binucao,* failed to make a good growth after having "taken," while cleft grafted, scion and stock united rapidly and the top started growth promptly. The scions should be well matured, but other considerations are apparently of no importance. Baniti, *G. dulcis,* scions, inserted on Binukao stocks remained alive for 6 months, but failed to grow. By the employment of rather large buds the Baniti can be shield budded without difficulty (Plate XXIV). In fact, the grafting of *Guttiferous* plants does not present any very great difficulties, and if a vigorous congenial stock for the mangosteen can be found, the extensive culture of this delicious fruit is assured.

The Pitanga, *Eugenia uniflora,* has quite unexpectedly been found to cleft graft without the slightest difficulty (Plate XXIV). Which should make possible the rapid dissemination of the large, blackfruited, excellent varieties grown now to a limited extent in South Florida.

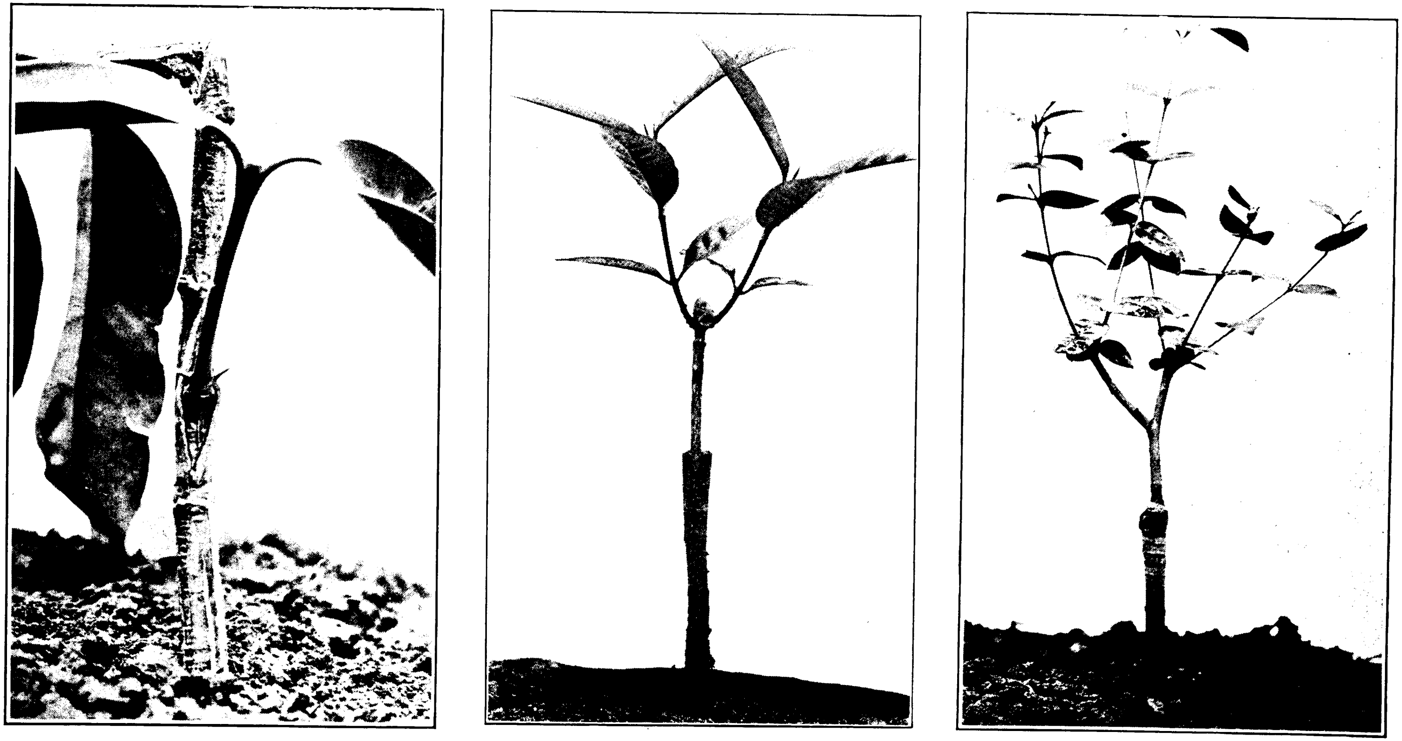
The Imbu, *Spondias tuberosa* Arr., of which a few scions were inserted on the Philippine Lanno, *Spondias pinnata* Kurz., was found to cleft graft without difficulty on this species by using mature, nonpetioled scions (Plate XXV), but it failed to grow on the Hevi, *Spondias cytherea.* The Hevi has been shield budded with some success, but quite possibly cleft grafting may here also be found preferable to shield budding.

A Ciruela, *Spondias purpurea,* cleft grafted on a Lanno, *S. pinnata,* made a very vigorous start (Plate XXV), but a root borer unfortunately killed the plant shortly after it was photographed. Further experiments will be made during the next year.

Some writers in foreign publications seem to prefer grafting to budding in Annonas and related plants. But from several years experience with numerous species of these plants the writer feels sure that any difficulty in budding Annonas can easily be overcome by the use of nonpetioled or naked, well matured scions, and by cutting large buds, for small buds are rapidly callused over.

All Flacourtias have been found easy subjects and are best propagated by shield budding (Plate XXII). The Pangi, *Pangium edule,* a tree of robust growth also belonging to the *Flacourtiaceae* is likewise readily shield budded if nonpetioled budwood, and large buds are used.

Of little practical value perhaps it may be of interest to know that the Talisay, *Terminalia catappa,* is without difficulty shield budded on the Dalinsi, *Terminalia edulis.* As representing the *Rubiaceae,* the *Genipa, Genipa americana,* has been found easily shield budded. Readers of the *Review* may recall that an analysis by the Bureau of Science, Manila, showed this fruit to contain an unusually large amount of pectin and that a very good jelly can be made from it (Plate XXII).



From left to right, shield budded plant of Baniti, *Garcinia dulcis;* cleft grafted plants of Binukao, *Garcinia binucao;* and Pitanga, *Eugenia uniflora.* Lamao Experiment Station

From left to right, cleft grafted plant of Banago, *Gnetum gnemon;* Ciruela, *Spondias purpurea,* cleft grafted on Lanno, *Spondias pinnata;* and Imbu, *Spondias tuberosa,* cleft grafted on Lanno. Lamao Experiment Station

That interesting plant the Banago, *Gnetum gnemon* L., the nuts of which contain 50 per cent starch, is readily both shield budded and cleft grafted (Plates XXIII and XXV). Provided that the scions are fairly well matured, the plant is not particular in other details. The Bulso, *Gnetum indicum* Merr., cannot be grafted on the Banago.

For fuller details relative to propagation of the above mentioned and numerous other species see Bulletin No. 32, "Plant Propagation and Fruit Culture in the Tropics."

CURRENT NOTES—FOURTH QUARTER

By P. J. WESTER, *Agricultural Advisor*

MORE INFORMATION ABOUT ADLAY

So little information is available relative to adlay, *Coix lacryma-jobi* L. var. *mayuen*, that additional observations are of more than ordinary interest.

According to "Jaarverslag van den Landbouwvoorlichtingsdienst over 1919, "in trials at Fort de Kock, on the west coast of Sumatra, and in Buitenzorg, Java, adlay yielded at the rate of 3,528 and 2,867 kilos of grain to the hectare respectively." As may be noted in the last issue of this REVIEW, a yield of 3,625 and 1,634 kilos was obtained in two trials in the Philippines.

The following analysis made in Java is quoted from the aforesaid publication:

	Per cent.
Moisture	14.00
Albumen	11.25
Fat	2.22
Carbohydrates	70.40
Crude fiber	1.55
Ash	.58

In hulling the grain the waste was found to be in one instance 30 per cent and in another 47.5 per cent, the latter figure being remarkably high. The above figures may be compared with those quoted in the last issue of this REVIEW.

VEGETATIVE PROPAGATION OF PARA RUBBER

If the interest of rubber planters in the now already old discovery that Para rubber can be grafted may be measured by the rather perfunctory reception of this news by periodicals on tropical agriculture, they are apparently not aware of the tremendous importance of this discovery to the plantation rubber industry. Yet, as a matter of fact, it marks a new epoch in the history of cultivated Para rubber. If one may judge rubber in the light of experience with vegetative propagation of the cultivated fruits, it is not too much to say that the discovery of a practicable method of propagating rubber vegetatively will do more to increase the rubber yield per unit area than any other advance made in rubber culture since rubber was domesticated. Vegetative propagation is a standard practice wherever fruit growing has become an important industry. We might say that of all contributions made in the course of the evolution and the development of the fruit industry it has been the most powerful lever we have had, and have, in raising fruit growing to the important position it holds today in world economics. How many growers of oranges in California, of grapefruit in Florida, of pecans in the Gulf States, or of peaches in Georgia would revert to the ancient practice of planting seedling orchards? How many vineyardists would want to set out seedling grapes? Cinchona has long been grafted in the Dutch plantations in Java, and grafted coffee plantations are gradually being extended in that country. As a result of the discovery of a practicable method of budding cacao a few years ago, experimental plantings of budded cacao are now being set out in Trinidad. So we may confidently anticipate the arrival of the day at no distant date when seedling rubber plantations shall be ancient history.

In vegetative propagation of rubber van Helten was first to "arrive" with the so-called "Forkert" budding. Then Bodde succeeded with the patch budding method and Maas finally found that rubber could be shield budded, and he also experimented with cleft- side- and crown-grafting.[1]

All three methods of budding have given satisfactory results in the trials quoted by Mr. Maas, though the shield buds inserted would seem to be too few on which to base definite conclusions. Crown- and side-grafting yielded more satisfactory results than cleft-grafting.

Considering the ease and rapidity with which the work in the various modes of graftage can be performed, in the light of the experience in grafting numerous species of tropical plants at Lamao it seems probable that shield budding (the inverted T-method) crown- and side-grafting eventually will supersede all other methods of grafting rubber.

EXCELSA COFFEE IN TRINIDAD

In view of the growing interest in planting coffee, of which kinds Excelsa has been especially recommended to the planters

[1] Medeelingen van het Algemeen Proefstation der A. V. R. O. S., Rubberserie No. 21, Maas, J. G. J. A., De Vegetative Voort-planting van Hevea **Brasiliensis.**

in Batangas and Cavite, we quote the following form a belated number of the *Tropical Agriculturist* (Ceylon):

VARIETIES OF COFFEE FROM TRINIDAD

A sample of coffee, stated to have been derived from *Coffea excelsa*, was received in December, 1917. According to the *Bulletin of the Department of Agriculture, Trinidad and Tobago* (1918, 17, 62) this species of coffee, which occurs wild in the French Congo, was introduced into Trinidad in 1905 or 1906. Plants raised from seed at the St. Clair Experiment Station, Port-of-Spain, at that time, have done well, and in 1916 and 1917 they fruited heavily. The yield from twenty-three trees in the latter year was 205 pounds, or nearly 9 pounds per tree. This species has done much better at the Station than *C. robusta*, and can apparently withstand very adverse conditions. Planters in Trinidad are now giving their attention to this form of coffee, 74 pounds of seed and 718 plants being sold from the Experiment Station in 1917, and 1 pound of seed and 1,991 plants in 1918, whilst 9,000 plants in stock were already booked up.

The sample received at the Imperial Institute consisted of beans freed from the parchment and skin. The beans were of greyish-yellow colour and varied considerably in size. The general shape of the beans was oval with one flat side, but many were rounded.

The sample was in good condition but contained a few damaged beans.

The coffee was examined at the Imperial Institute with the following results:

	Per cent.
Moisture	8.5
Caffeine	1.20
Total nitrogen	2.18
Ash	3.2

Average weight of a single bean, 0.16 grams. Number of beans required to fill a 50 cc. cylinder, 204.

The results of the chemical examination show that the coffee is of normal composition.

A firm of brokers to whom a sample of the coffee was submitted regarded the coffee as of the Robusta variety mixed with Arabica sorts. They described it as dull and dingy, but expressed the opinion that with greater care in preparation, the appearance and quality could be much improved. The firm valued the coffee at 80s. per cwt. in London, adding that the prices of Robusta coffee generally fluctuate with those of coffees from Brazil.

A second firm of brokers also considered the sample to represent a Robusta coffee, of hard bean and fair size. They regarded the appearance of the raw beans as attractive, but distinctly dull. The coffee gave a very dull "roast" and the liquor closely resembled that of Liberian coffee, which would make it unattractive for the British trade. In spite however of these drawbacks the firm estimated the value of the coffee at about 75s. per cwt. in London (May 1918), adding that in normal times there would be a good market for such coffee for the export trade from the United Kingdom. The prices for this class of coffee were at the time from 10s. to 15s. per cwt. above the pre-war values.

For comparison with the above valuations the following quotations for Robusta and Liberian coffee in the London market on the same date (May 1918) may be given:

	Per cent.
Robusta coffee plantation	70s.–80s.
Liberian coffee:	
East Indian	75s.–85s.
African (fair)	60s.–65s.
Java and Sumatra	75s.–90s.
Brazilian Santos:	
Superior	74s.–75s.
Prime	75s.–76s.
Extra	77s.–78s.

There is little doubt that coffee from *C. excelsa* as represented by this sample would be readily saleable in the London market under normal conditions at prices similar to those ruling for Liberian and Robusta coffees. The Acting Director of Agriculture in forwarding the sample stated that *C. excelsa* thrives better than other varieties under certain conditions of climate and soil, and its cultivation in Trinidad may therefore deserve consideration.

FOR MORE AND BETTER PHILIPPINE HATS

The following is quoted from the Report of the Porto Rico Agricultural Experiment Station, 1919:

> The value of hats exported from the port of Mayaguez has amounted to over $500,000 annually for several years. Most of these hats are made from the native straw and are not of the highest quality. The station has introduced and is extending the planting of the *Carludovica palmata*, from which the Panama hat is made. It aims to change in a few years the hat-weaving industry by the use of this kind of fiber to the exclusion of the native palm. A hat worth twice the value of one made from the native straw can be made with the same amount of labor.

The above remarks apply with equal force to the Philippine Islands, and since we export some 500,000 pesos worth of hats than Porto Rico, the Philippines would gain proportionately more by the use of Panama hat fiber in place of bamboo and other hat material.

To introduce this new hat material among the old hat makers might be difficult. On the other hand, it is believed that the introduction of the culture of the *Carludovica* and its employment as a superior hat material in place of the native fibers among the native population could be easily accomplished by the Bureau of Education through its agricultural and industrial schools.

In this connection, it must be remembered that the *Carludovica* does not grow where there is a long dry season, such as in Bulacan, Tarlac, and Pangasinan. It must be planted where the rainfall is abundant and well-distributed throughout all months of the year. Nor will it grow well at high elevations, and should not be set out commercially above an an altitude of 500 meters. It grows best in fertile, friable, loamy soils, rich in humus, moist, but well drained. Heavy clay soils are unsuited to this plant. Partial shade favors its development.

Climatically the Bicol provinces, Tayabas and part of Laguna, the moist Visayas, such as Samar and Leyte, Agusan, Davao, and Cotabato are particularly suited to the *Carludovica.*

The Panama hat palm, by the way, is not a palm, as the name implies, but a stemless plant belonging to the *Cyclanthaceae,* attaining a height of 1 to 2 meters with fan-like, plaited leaves, somewhat resembling a small leaf of the *Anahao* palm, *Livistona rotundifolia.*

For a commercial plantation the field should be thoroughly cleared of all native vegetation, particularly joint weeds, such as cogon, and plowed and harrowed.

The plants should be set out 1.5 to 2 meters apart in the row, the rows being 2.5 to 3 meters apart, or at the rate of not less than 1,666 plants to the hectare.

The *Carludovica* is difficult to propagate from seed, but is readily propagated by division of the old plants, as one plant sends out numerous suckers which, together with the mother plant, soon make a large clump.

The *Carludovica* grows so easily that there is no need to propagate the suckers in a nursery, but as the mother plant is divided the small plantlets can be set out direct in the field.

In dividing a large plant, about ¾ of the blades should be cut off to reduce evaporation of water in the young plants until they have established an independent root system, and with the aid of a bolo or sharp spade the clump should be divided so that each part has from one to 3 "hearts," depending upon their size. The plants should be set out at the same depth at which they formerly grew and the soil packed firm around them. If they are planted too deep they establish themselves with difficulty. The work should be performed during the rainy season to avoid the expense of watering.

As previously stated, the *Carludovica* does the best in the shade. No experiments with shade trees have been made, but it is probable that the various shade trees used for coffee would also serve well for the *Carludovica,* including Ipil-ipil, *Leucaena glauca,* Dapdap, *Erythrina lithosperma,* and other related species, *Guango, Pithecolobium saman* and *Albizzia moluccana.* As a matter of fact, the ipil-ipil has been so used at the La Carlota Experiment Station and found very satisfactory. This plant should then be set out from 5 to 6 meters apart. The trees of the other species grow larger and should be spaced ultimately from 12 to 18 meters apart, temporary shade trees being set out between them at first to be gradually thinned out as the shade becomes too dense.

Until the *Carludovica* plants are large enough to effectually shade the ground and suppress the weeds, the field should be cultivated from time to time to keep down the native vegetation, especially cogon, for if the palms are crowded by the weeds they grow slowly, and the expense of bringing them into the cutting stage will be greater than if the land is clean cultivated.

An upright growing cover crop such as Cadios, *Cajanus indicus, Tephrosia* or *Crotalaria,* will be found useful in keeping the weeds in check while the Carludovica plants are young. Viney cover crops which have a tendency to climb, such as patani and Lyon beans, are not suitable, as they entail too much expense in keeping the vines off the palms.

If the plants have been properly cared for, leaves for hat making can be cut 18 months after planting, after which the field should be systematically cut over from time to time as the leaves become ready for harvesting.

The hat material is obtained from young leaves, and these should be cut before they are expanded leaving a stalk about 15 centimeters long, adhering to the blade. Then the woody veins in the leaf are removed with a sharp knife, and the leaf split into narrow strips, but still attached to the stalk, which serves as a convenient "handle."

The leaves are next plunged into boiling water for 10 to 15 minutes, after which they are spread in the sun to dry for 2 to 3 hours and are finally bleached. The leaves are then ready for the weaver.

With the climatic conditions so favorable for the *Carludovica* in a large part of the Archipelago, coupled with the undisputed skill of the Filipino as a hat maker, there is every reason why the weaving of Panama hats should become an important industry in the Philippines.

"THE CLIMATE AND WEATHER OF THE PHILIPPINES, 1903–1918"

This is the name of a publication prepared by Rev. José Coronas, S. J., Chief, Meteorological Division, Weather Bureau, Manila, just issued by the Philippine Census, 1918.

Since the issue in 1914 of "The Annual Amount and Distribution of Rainfall in the Philippines," this is the most valuable and instructive publication of the press on the climate of the Philippines. Of particular interest to the prospective investor in agricultural ventures are Chapters III, Rainfall; IV, Relative Humidity and Cloudiness; V, Winds; and VI, Typhoons; as having a bearing on the adaptability of the various regions in the Archipelago to the different tropical staple crops.

The Climate Map graphically illustrates the seasons and the rainfall in the Archipelago, and together with the maps showing the typhoon tracks and the charts and tables showing the rainfall gives a clear idea of the parts of the Archipelago where coconuts, abacá, sugar cane, coffee and other crops may be grown from a climatic point of view.

In view of the growing interest in the development of Mindanao, it is much to be regretted that so little data on the rainfall of that great island is available. Fortunately several new rainfall stations have been opened in the interior of Mindanao during the past three years, which in the course of time will furnish information as to the precipitation of that little known territory.

LEATHER FROM THE SEA.

We quote the following from the Agricultural News (Barbados):

> Efforts have been made from time to time to turn the hide of the porpoise and shark to economic account in the leather industry, but they have not been completely successful. Accepted principles of tanning do not suffice. Porpoise leather, for instance, is likely to be rendered spongy and vastly inferior in point of strength and durability for hard wear under varying conditions of weather and climate. On the other hand, the skin of the shark, as well as lacking in flexibility, is good for naught but limited use, for instance, as an abrasive medium in the jewelry trade.
>
> These deficiencies have now been overcome, and the leather produced from the aquatic animals above mentioned is said to be equal in every respect to that forthcoming from the usual sources.
>
> In the case of the shark, the separation of the outer hornlike nodule-scarred hide or shagreen from the inner skin constituted a problem. It is the latter which is the valuable part of the hide, and, when dressed, it is as flexible as the accepted leather hide, although in the process of splitting, none of the toughness, durability, or distinctive beautiful markings of the shark's skin is sacrificed. This has been affected by a chemical process.
>
> The utilization of the shark's skin constitutes the sheet anchor of these new activities, this monster being prolific around the American coast, especially in the tropical zones. Experience has proved that five sharks are caught to every porpoise, and accordingly it offers greater scope for manufacturing activity. Following the introduction of the product to the market, experts were dispatched to the various known shark-infested seas to survey the prospect and extent of raw material, as well as new zones in which the fishery might be established with every promise of success. These authorities have reported that there is very little likelihood of the shark-yielding waters being exhausted or even seriously depleted for many

years to come, notwithstanding the intensified character of the fishery. The waters washing the Australian continent alone are believed to be capable of supporting the industry, even when fully developed, for an indefinite period.

The fishery is conducted upon essentially scientific lines. Four stations have been established in the United States up to the present, two being in Florida waters. Each is adequately equipped with fishery tackle as well as reduction plants, since every ounce of the animals is turned to economic account.

It is the seine net which brings the biggest harvests, and the catch may readily vary from 1,000 to 10,000 big fishes, having suitable skins for tanning per day, according to the locality and the character of the prevailing conditions. Motor boats are employed for laying the nets, which, when a catch has been made, are hauled ashore. As the fish are landed they are dispatched and skinned, care being taken in the case of the shark to remove the dorsal fins for drying, since these find a ready market among the Chinese for edible purposes. The hide is stripped in one piece and with only four holes, is folded, salted, and then dispatched to the tannery. That the shark is a bounteous hide yielder may be gathered from the fact that the skin may vary in superficies from 10 to 40 square feet according to the size and weight of the fish. The giant devil fish gives a still larger hide, this often running up to 100 square feet.

It is not only the hide which yields leather. The softer tissues and stomach membrane when tanned yield an excellent substitute for *suède* leather. The dressing processes are somewhat involved, but upon their completion it is said to be impossible to distinguish the leather made from the hide of a fish from that wrought from the goat, ox, or horse. There is no possibility of identifying the leather by odour, inasmuch as a degreasing process is followed, which completely eliminates the distinctive aroma of the sea. The only means whereby the difference can be detected is by submitting the leather to the tensile testing machine or the microscope, to identify the fibrous construction.

While the recovery of the hide constitutes the primary task, the carcasses of the animals are turned to the utmost account, thus fulfilling the requirements of economical exploitation. The prime portions of the fish are stated to be savory, and shark steak is coming into increasing favor. The inedible portions are subjected to treatment to furnish chicken food or fertilizer. The demand for the last named is increasing, owing to its superiority to ordinary fish scrap in point of nitrogen content. This ranges from 15 to 18½ per cent, and commands from 33⅓ to 50 per cent more than ordinary fish scrap manure upon the market.

The liver of the shark yields an excellent oil worth 2s. a gallon, while the teeth fetch 3d. each from the jewellery trade for conversion into various articles of adornment and utility. The blood is recovered, since it yields an excellent waterproof glue in keen demand for the fabrication of the integral propellers of aeroplanes; while the gut is used for the manufacture of strings for musical instruments, fishing lines, tennis rackets and such like. In short, no part of these fish animals is wasted. In the case of the porpoise, the oil is especially valuable. One grade derived from the jaw is the premier lubricant for watches and other delicate mechanisms, and readily commands a market price of £1 per gallon. It is the scientific utilization of the various by-products of the animals which has rendered the foundation of the new leather industry so successful, and incidentally, it is the high price realized for these various other commodities which is enabling the shark leather to be placed upon the market at a severely competitive price. In fact, it is asserted that the cost of footwear made from shark's skins will be one-third to one-quarter of the prices at present prevailing.

The articles capable of being fashioned from fish-skin leather virtually comprise all those hitherto obtained from the hides of various animals. Different grades, qualities and classifications are obtained as a result of varying the tanning process, and adapting it to the special requirements of the product under treatment. The demand of the leather for all purposes has already exceeded the supply. One of the largest glove manufacturers in the country has secured the whole of the output of *suède* leather made from the softer tissues and stomach membranes for the production of this specialty.

But it is the boot trade which is advancing the heaviest demands, since the shortage of leather footwear has reached an acute stage in the United States. The inner hide or split of the shark's skin is as soft and pliable, and as durable, as the best calf and kid, although it is asserted, from the trials which have been made, to be possessed of superior wearing and lasting qualities, as well as affording complete protection against any and every weather. So far as the soles are concerned, an interesting development is to be recorded. In certain cases prolonged wear is paramount and it has been found that the shagreen is preeminently adapted to such service. It is extremely durable, as may be gathered from the fact that it is used as an abrasive or animal emery in the working and polishing of jewels and ivory. When used for boot-soling purposes the horny, steel-like nodule-covered surface is presented to the pavement, and the wear is so slow as to outlast the heavy hobnail boot.

The industry is as yet in its infancy, but already the output has attained a huge figure. At the time of writing it is 20,000 square feet of fish leather per month, and the whole of the producing facilities of the enterprise concerned has been secured by the trade for several months ahead. To meet the increasing demand, forty additional fishing-stations are being laid down and equipped. When completed they will be sufficient to furnish the tanneries from 15,000 to 20,000 skins from the shark, devil-fish, porpoise, blackfish, and others every twenty-four hours.

As may be noted in this REVIEW, Vol. XIII, pp. 41–54, shark fishing as a local industry for the recovery of shark fins for export is of considerable importance in the Sulu Archipelago, but no attempt has been made to utilize any other part of the fish. Sharks as well as porpoises are abundant here as in Philippine waters elsewhere, and if shark fisheries pay on the Florida coast they should be profitable in the Philippines.

NEW SOURCES OF RUBBER

Besides the guayule, rubber is now successfully obtained from another American desert shrub, the ocotillo,[1] and a company

[1] The ocotillo, *Fouquieria splendens*, is a thorny shrub about 3 meters tall, and is found in practically inexhaustible quantities in the arid Southwest of the United States.

has recently completed the erection of a mill capable of handling 100 tons of ocotillo a day. The entire plant is used and various other products are derived from it besides rubber. The shrubs are delivered at the mill for ₱12.00 per ton. Says the *India Rubber World* (New York):

One ton of ocotillo yields 306 pounds of charcoal, 206 pounds of tars, 130 gallons of pyroligneous liquor, and 173 pounds of gums. While the charcoal is said to be superior to willow or poplar charcoal for sugar making, powder compounding, or absorbing emanations from radio-active water; while the pyroligneous liquor is said to be rich in acetic and carbolic acids, as well as alcohol, a synthetic oil rivalling linseed, and other substances useful in the arts; while the tars contain a high percentage of creosote and have in the laboratories yielded 104 fractions, including most of the dyes, drugs and synthetic preparations hitherto imported from Germany; it is from the gums that there is extracted for lacquer a substance said to equal first-class crude rubber, identical with it chemically, and capable of perfect compounding and vulcanization. This rubber content is 5 per cent of the whole plant.

Not satisfied with its present achievements, the company is experimenting with extraction of rubber from the giant cactus, *Cereus giganteus*, from which it is predicted a yield of 10 to 12 per cent of rubber will readily be obtained. This plant grows abundantly in Arizona and New Mexico.

In a later issue of the same publication it is related that rubber has also been successfully extracted from both the wild and spineless cactus, which grows over extensive areas in the south west of the United States.

To quote:

Prickly-pear, or *Opuntia vulgaris*, grows extensively in many parts of Arizona, California, Nevada, and other tropical parts of the United States. It is somewhat similar in structure to the spineless cactus, but is covered with long, sharp needles. It bears an edible fruit of a purplish colour, also covered with spines. Like the spineless, it is very easily propagated, and attains a height of 7 or 9 feet. Unlike Ocotillo and many other gum-bearing plants, the rubber in these two varieties of cactus occurs as a latex and yields a sticky white liquid from the abraded surface if pressure be applied by the fingers. By special treatment of the latex and subsequent refining, an amber coloured gum resembling smoked sheet in colour and guayule in physical properties is obtained, although the gum, when thoroughly dried, is considerably less plastic than guayule. It is reported that the gum can be produced at a price to compete favourably with guayule and crude rubber.

Following is a summary of some of the experiments made with gum form the spineless cactus:

Sample 1

	Per cent.
Smoked sheet rubber	50
Cactus rubber	40
Compound (mineral ingredients)	10

This compound was mixed upon the mill in the usual manner and contained only the amount of sulphur usually required to vulcanize a stock having 90 per cent smoked sheet. It mixed easily on the rolls at a much lower temperature than that which would have been required for pure smoked sheet. The next day test strips were cured in the press, and were found to have high tensile strength and elasticity, showing that the gum vulcanizes perfectly in about the same length of time required for plantation rubber. Another portion was used to friction a sample of belting duck which was found upon examination to be thoroughly impregnated with the gum. A very tacky cement was made from the remaining portion by dissolving in benzol.

Sample 2

	Per cent.
Smoked sheet	20
Auto reclaim	20
Cactus rubber	20
Compound	40

In spite of the fact that this stock was mixed on a relatively cold mill, it retained a sticky surface after calendering, and showed no tendency to bloom in the raw state. It would seem from this that the use of the gum in repair stocks and specially in those containing large amounts of carbon black would be advantageous, due to the necessity of preserving a tacky surface indefinitely, and the lower temperature at which the stock could be milled would minimize the danger of burning when use is made of certain organic accelerators. Part of Sample 2 was used to skim-coat and cover the fabric mentioned above, which was then made into a piece of belting.

Sample 3

	Per cent.
Smoked sheet	10
Auto reclaim	20
Cactus rubber	17
Compound	53

It was the object of this mixture to estimate the value of the gum in a cheaper compound containing a larger percentage of minerals. No difficulty was encountered in milling, and the stock was made into various kinds of articles of comparatively good quality.

Sample 4

	Per cent.
Cactus rubber	10
Reclaimed	60
Compound	30

This was a regular heel compound in which 10 per cent smoked sheet would ordinarily have been used. The smoked sheet was replaced entirely with the cactus rubber without reducing the quality of the heels so far as could be determined. It is interesting to note that the reclaimed rubber used in this case would not stick to the rolls and could not be milled until about 2 pounds of the cactus rubber was added, when it immediately began to spread out evenly over the roll and continued to adhere thereto until the milling was completed. A number of rubber heels were made from this stock, all of which appeared to be of good quality.

It is the opinion of the writer, as well as of others who assisted in the experiments, that the gum is in every way equal to guayule and in some respects superior, among which may be mentioned the readiness with which it vulcanises and the extent to which it will actually replace crude rubber without an apparent reduction in the quality of the finished product. This would evidently place it in a class with crude rubber itself. For use in frictions where penetrating qualities are necessary the gum possesses this property to a marked degree.

The results of these experiments indicate that although there will always be a demand for the superior Para rubber, this no longer holds its strong position of the past, and it may be only a question of time when much of the worlds requirements of rubber will not be derived from the Hevea but eventually will be produced on the hot desert lands of America, Africa and Australia.

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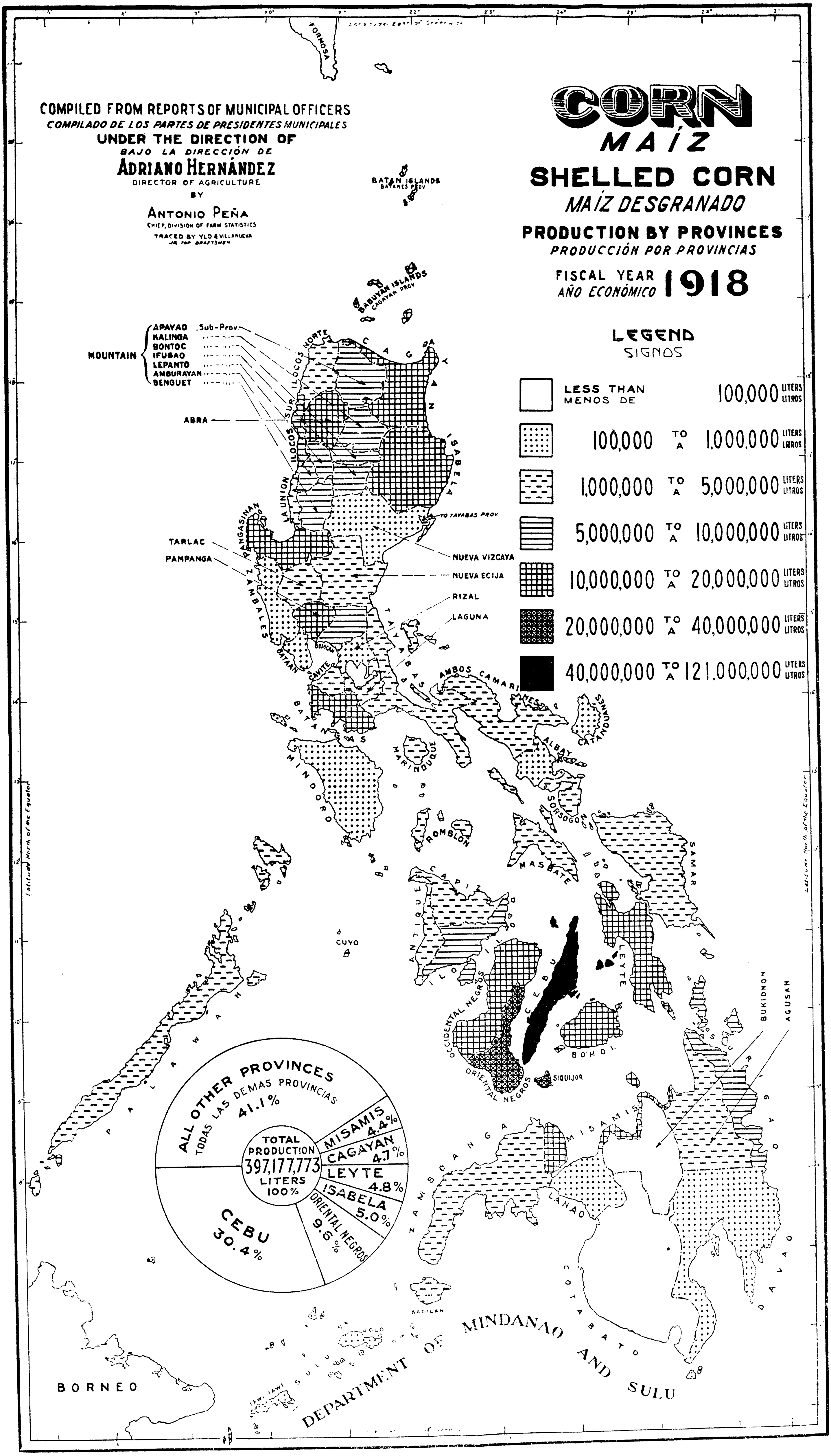
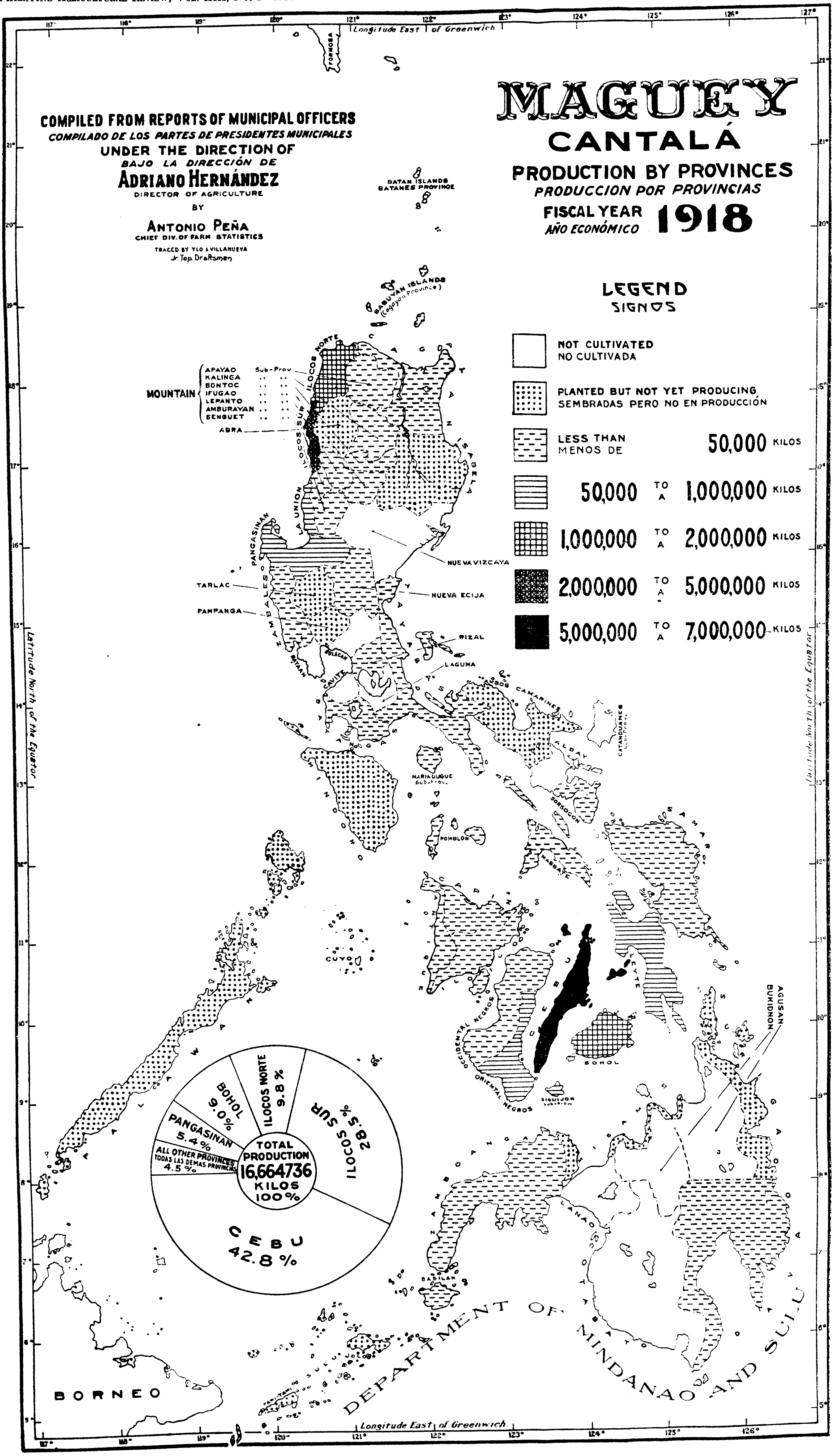
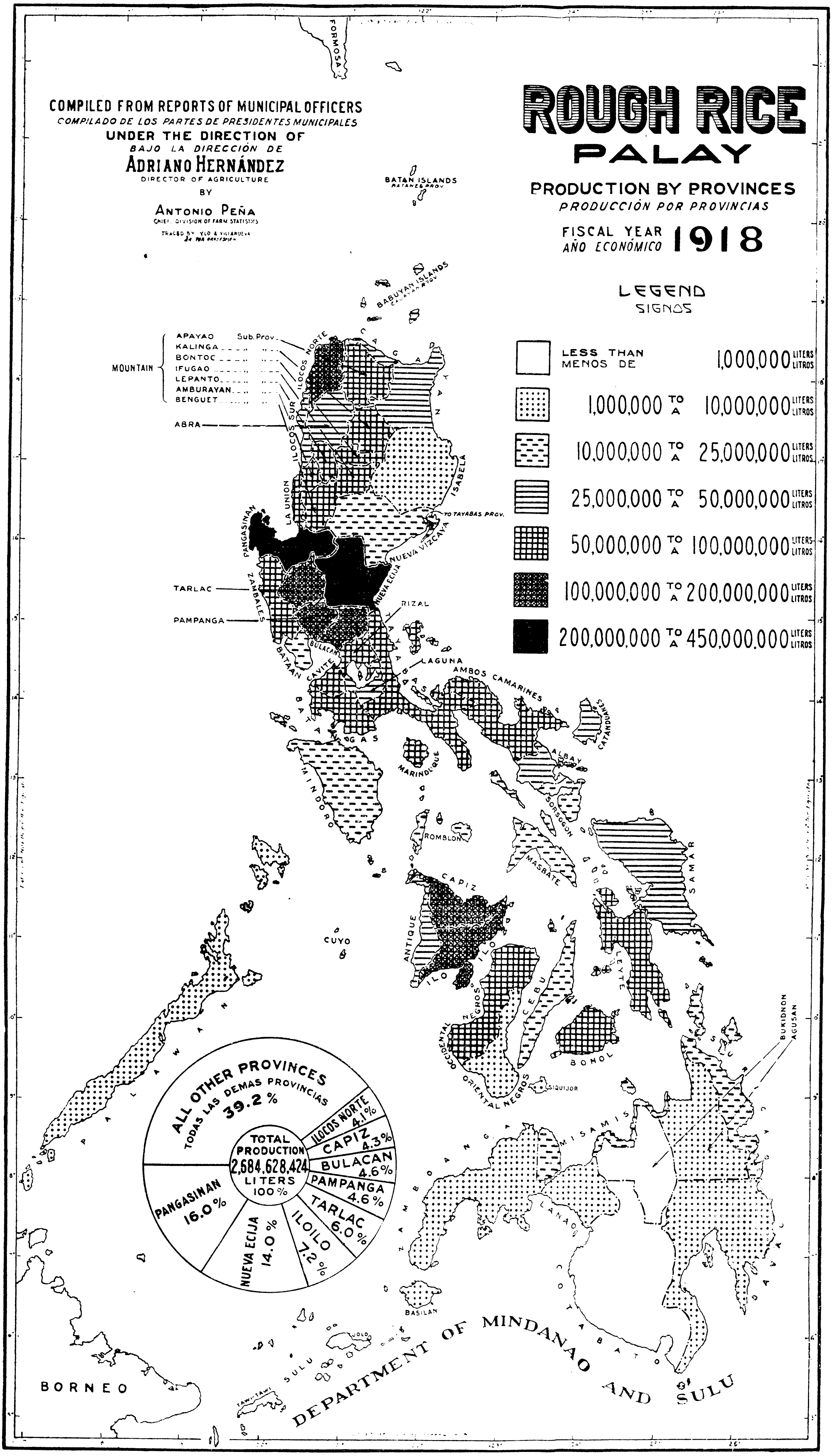


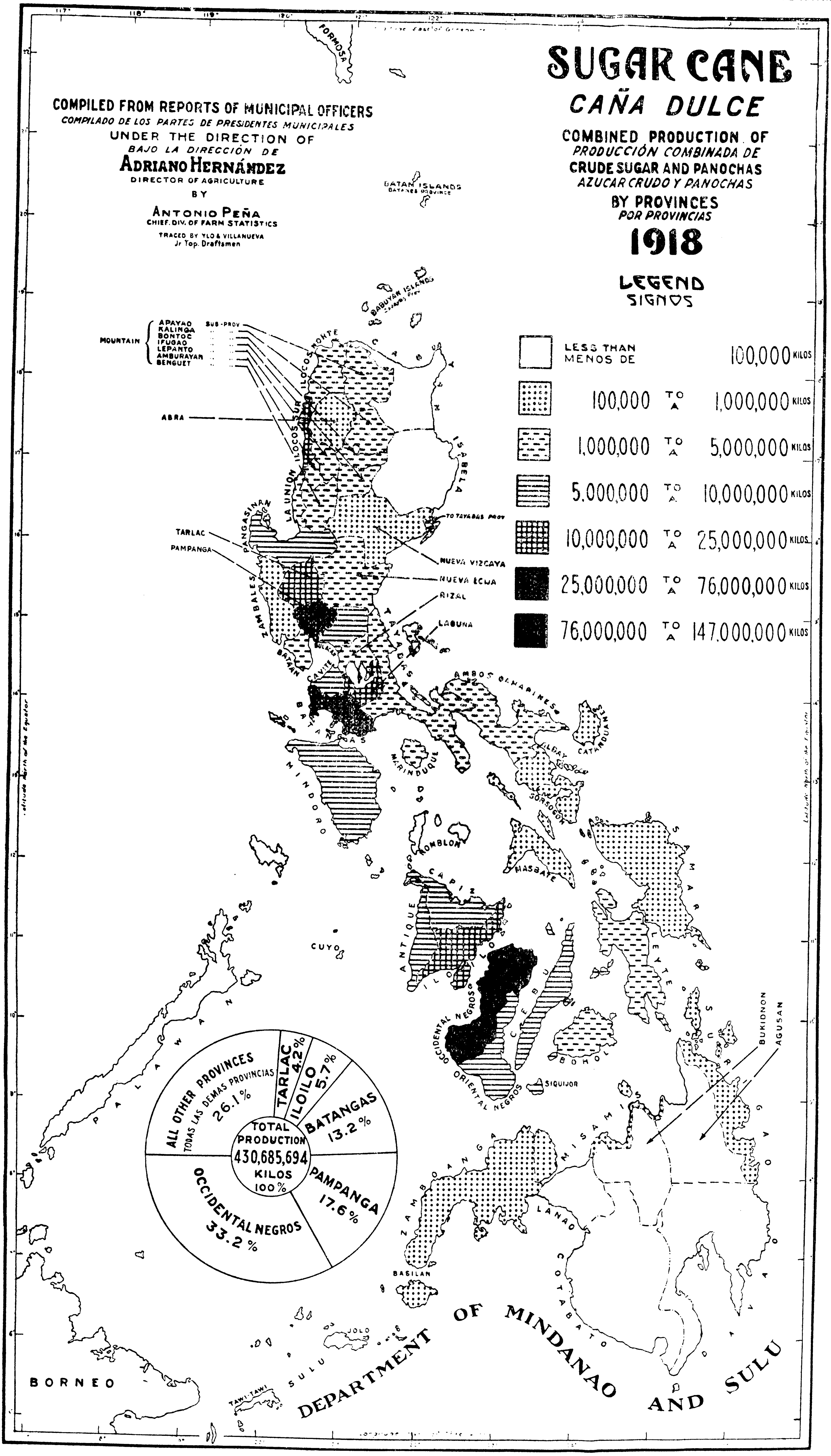
MAP SHOWING CORN PRODUCTION FOR THE YEAR 1918.



MAP SHOWING MAGUEY PRODUCTION FOR THE YEAR 1918.



MAP SHOWING RICE PRODUCTION FOR THE YEAR 1918.



MAP SHOWING SUGAR CANE PRODUCTION FOR THE YEAR 1918.

The Philippine Agricultural Review

VOL. XIII FOURTH QUARTER, 1920 No. 4

SPECIAL ARTICLE

A DESCRIPTIVE LIST OF MANGO VARIETIES IN INDIA

By P. J. WESTER

A QUARTERLY PUBLICATION

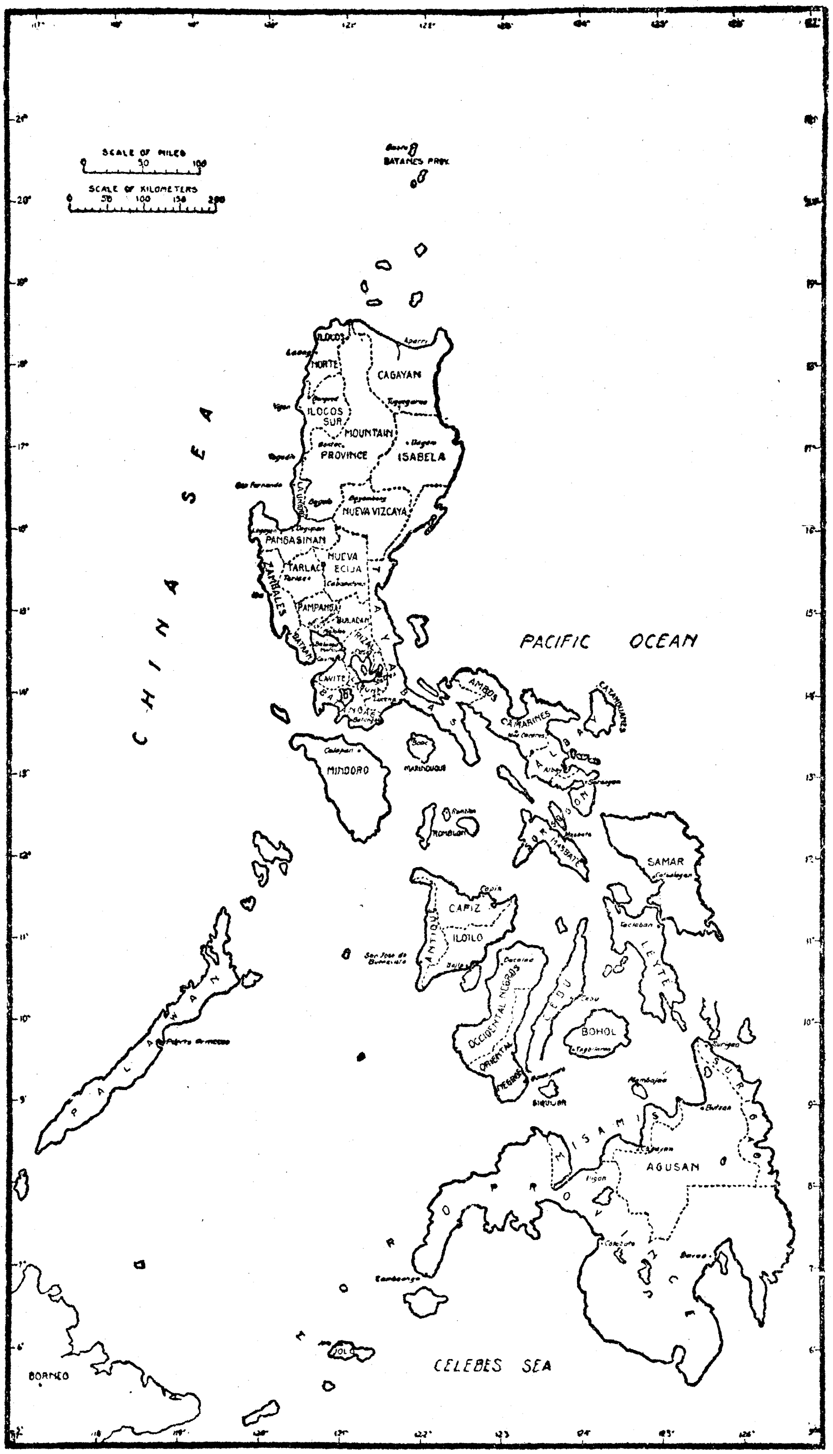
ISSUED IN ENGLISH BY THE BUREAU OF AGRICULTURE

The Government of the Philippine Islands
Department of Agriculture and Natural Resources

Subscription rates: ₱2 (Philippine currency) or $1 (U. S. currency) per annum in the Philippine Islands and the United States and territories.
$2 (U. S. currency) per annum in foreign countries.
Subscribers receive free copies of the Philippine Farmer, a monthly farm paper, or its Spanish edition, *El Agricultor Filipino*.

MANILA
BUREAU OF PRINTING
1920

(Entered at the Post Office at Manila as second-class matter)


SCALE OF MILES
0 50 100
SCALE OF KILOMETERS
0 50 100 150 200
BATANES PROV.
ILOCOS NORTE
CAGAYAN
ILOCOS SUR
MOUNTAIN PROVINCE
ISABELA
NUEVA VIZCAYA
PANGASINAN
TARLAC
NUEVA ECIJA
ZAMBALES
PAMPANGA
BULACAN
BATAAN
CAVITE
CHINA SEA
PACIFIC OCEAN
AMBOS CAMARINES
MINDORO
MARINDUQUE
ROMBLON
MASBATE
SAMAR
CAPIZ
ANTIQUE
ILOILO
LEYTE
OCCIDENTAL NEGROS
ORIENTAL NEGROS
CEBU
BOHOL
SIQUIJOR
PALAWAN
MISAMIS
SURIGAO
AGUSAN
MORO PROVINCE
JOLO
BORNEO
CELEBES SEA

PHILIPPINE ISLANDS

The total area is 114,400 square miles or about 1.6 times that of Missouri, twice the New England States, some 7,000 square miles less than the area of British Isles. The total population is 10,350,640 (about 90 inhabitants to every square mile).

STATISTICS ON THE PRINCIPAL CROPS FOR THE YEAR ENDED JUNE 30, 1919

[Compiled by Antonio Peña, Chief, Division of Farm Statistics.]

Crops	Area cultivated	Amount produced	Total value in the municipal markets
	Hectares		
Rice	1,381,339		
Rough rice		[a] 2,533,623,644	₱188,614,588
Coconuts (average of 200 trees per hectare)	373,251		
Ripe nuts as food		[b] 75,358,583	
Copra		[c] 349,384,855	
Coconut oil		[a] 5,142,213	
Tuba (a beverage)		[a] 100,315,522	
Total value of all coconut products			75,438,291
Sugar cane	200,199		
Crude sugar		[c] 379,127,229	
Panochas (small cakes)		[c] 32,145,430	
Basi (a beverage)		[a] 8,716,981	
Molasses		[a] 2,038,707	
Total value of all sugar cane products			74,462,819
Abacá (Manila hemp)	515,563	[c] 148,340,800	65,006,006
Corn	430,715		
Shelled corn		[c] 426,456,940	
Forage		[c] 16,078,688	
Total value of all corn products			37,591,423
Tobacco	73,859		
Tobacco leaf		[c] 56,497,748	17,585,449
Maguey	28,465		
Maguey (Cantala)		[c] 12,318,392	1,919,750
Cacao (estimated)	1,158	[c] 572,740	535,058
Coffee (estimated)	773	[c] 717,233	514,338
Total	3,005,322		461,667,717

[a] Liters. [b] Nuts. [c] Kilos.