GUAM AGRICULTURAL EXPERIMENT STATION
ISLAND OF GUAM
Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION

1930–31, 1931–32

Issued August 1933

UNITED STATES DEPARTMENT OF AGRICULTURE
OFFICE OF EXPERIMENT STATIONS

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GUAM AGRICULTURAL EXPERIMENT STATION, ISLAND OF GUAM

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

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REPORT OF THE GUAM AGRICULTURAL EXPERIMENT STATION, 1930–31, 1931–32 [1]

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REPORT OF THE DIRECTOR

By C. W. Edwards

SUMMARY OF RESULTS, 1909–32

The Guam Agricultural Experiment Station (fig. 1) was closed June 30, 1932, and its plant was transferred to the island government, to be used, with local support, as an agricultural school. The station was established in 1909. The act making appropriations for the United States Department of Agriculture for that year included an item of $5,000 for the establishment and maintenance of the station. Walter H. Evans had visited Guam in 1908 to study the agricultural conditions and determine the kind of work to be undertaken and to select a suitable site for the station. An area of 30 acres on the principal road between the towns of Piti and Agana was selected for the station because of its accessibility, and early in 1909 was cleared and fenced, and buildings were begun.

At the time of Dr. Evans' visit the island gave striking evidence of the unprogressive state of its agriculture. Many of the more important tropical fruits were not grown, and those that were produced were of inferior quality. Only unimproved native livestock was raised. The native people, Chamorros, had small ranches,

[1] Because of the closing of the station June 30, 1932, the work of the fiscal years 1930–31 and 1931–32 is incorporated in the one report, with a summary of results of work of the station since its establishment in 1909.

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often at considerable distance from the village where they had their homes. The methods of cultivating the land were primitive, nearly all the work being done by hand with a machete or a fosino

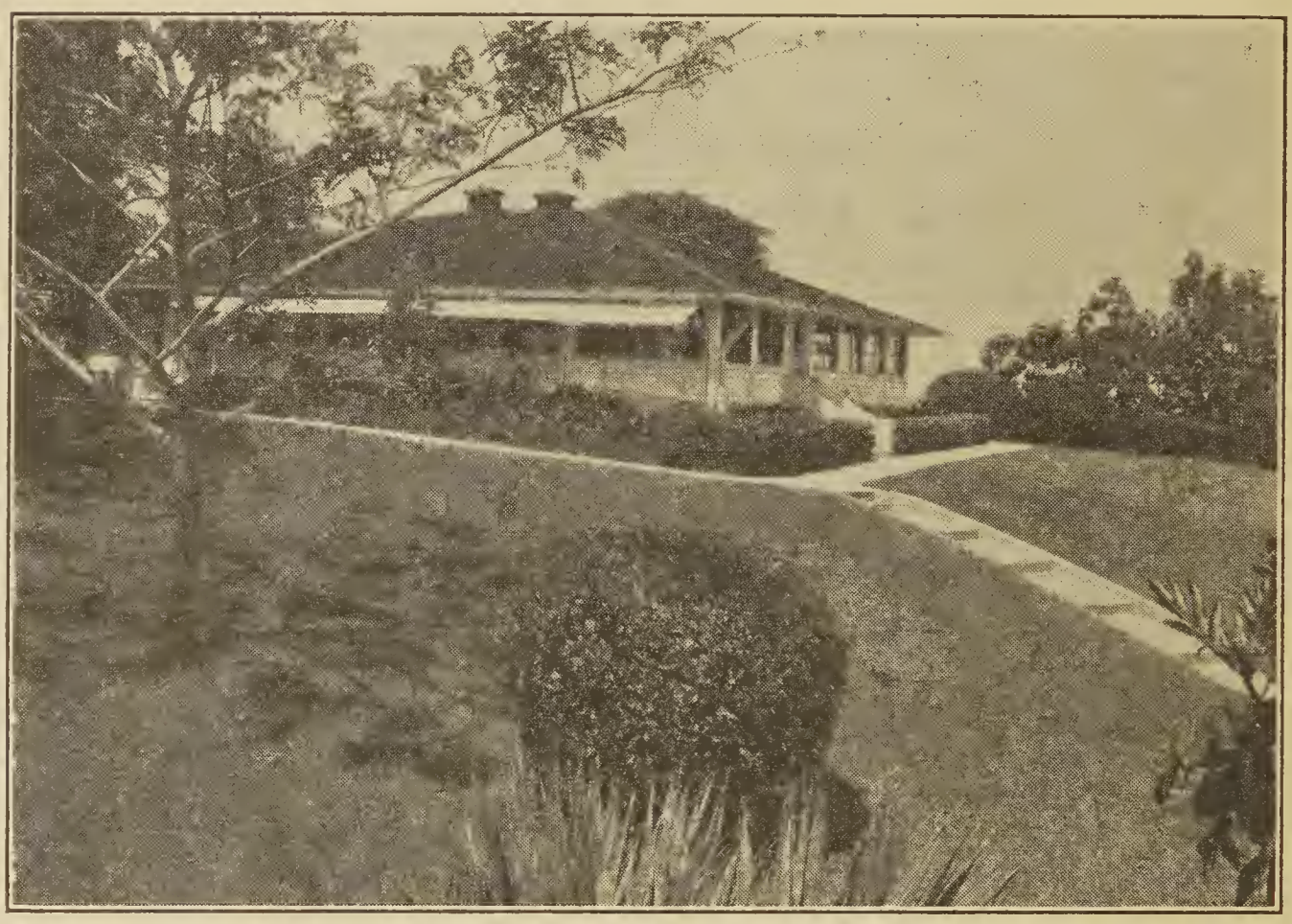

FIGURE 1.—Director's residence, Guam Agricultural Experiment Station.

FIGURE 2.—Adult demonstration work.

(a scuffle hoe set transversely on a long handle). Many of the coconut palm ranches were leased to Japanese traders, and there was a general tendency to abandon the farm and work by the day for the

Navy Department on various public improvements. This tendency was proving very detrimental to economic conditions and the general welfare.

FIGURE 3.—Poultry club work.

FIGURE 4.—Pig club work.

The station began at once to make the results of scientific investigations available for practical use through various simple forms of extension work. It helped the people by distributing seeds and

plants, introducing improved breeding stock, encouraging the farmers to visit and inspect the work of the station, and finally by visits by members of the station staff to the ranches in the various districts. However, it was difficult to convince the farmers of the value of methods differing radically from their own, and many of them did not become interested in improved methods of farming until an extension department of the station was established in 1919 to carry agricultural information and instruction directly to the people through constant personal contact with them in the field.

The extension activities were concerned chiefly with adult demonstrations (fig. 2), boys' and girls' club work (figs. 3 and 4), and school gardens. The boys' and girls' club work proved to be the most popular and effective. The children were eager to learn and were willing to put into practice the things they were taught. School gardens proved effective not only in teaching boys and girls better methods, but in serving as convincing demonstrations to older people and as an organized means of distributing seeds and plants that had been found to be adapted to local conditions. The results showed the essential need of extension work in the agricultural development of the island.

At the time of the establishment of the station the cattle of the island were small, of poor conformation, and greatly lacking in beef and milking qualities. The station introduced Ayrshire breeding stock for use in grading up the native stock. Some of the three-quarter breds and a majority of those carrying less Ayrshire blood compared favorably with the native cattle in adaptation to the environment. Other three-quarter breds and animals carrying more of the pure blood required better care. Through the use principally of suitable grade males Ayrshire grade cattle are now fairly well established throughout the island. For various reasons it was deemed inadvisable to recommend the general use of purebred bulls for this purpose. One Shorthorn bull calf was introduced by the station in 1931.

Since the conditions in Guam are such as to prohibit the general use of imported feeds, the station endeavored to find suitable rations composed, for the most part, of locally grown products. It also found methods of control of internal and external parasites of cattle and showed that the matai tati or "loin" disease affecting cattle pastured wholly on the savannas could be prevented by feeding the animals bone meal.

The station introduced purebred Morgan horses to test their adaptability and that of their progeny to tropical conditions, and to provide sires for upgrading the inferior native ponies. The Guam-grown Morgan progeny proved to be much better adapted to tropical conditions than did their introduced parents, and the crossbred progeny of the pure blood and grade Morgans showed marked improvement in size and conformation over the native ponies.

The station established an improved goat herd by crossing native stock with introduced Toggenburgs. The crossbreds were superior to the native in milk yield and in size. Suitable grade goats were disposed of for breeding.

The pigs on the island at the time of the American occupation were of poor conformation and slow growth, and were inferior in

size and in quality of bone. The station improved them by crossing them with purebred Berkshires and Duroc-Jerseys. As the breeding work progressed surplus animals were sold to local swine raisers for use in improving their stock. Few pure native pigs are now to

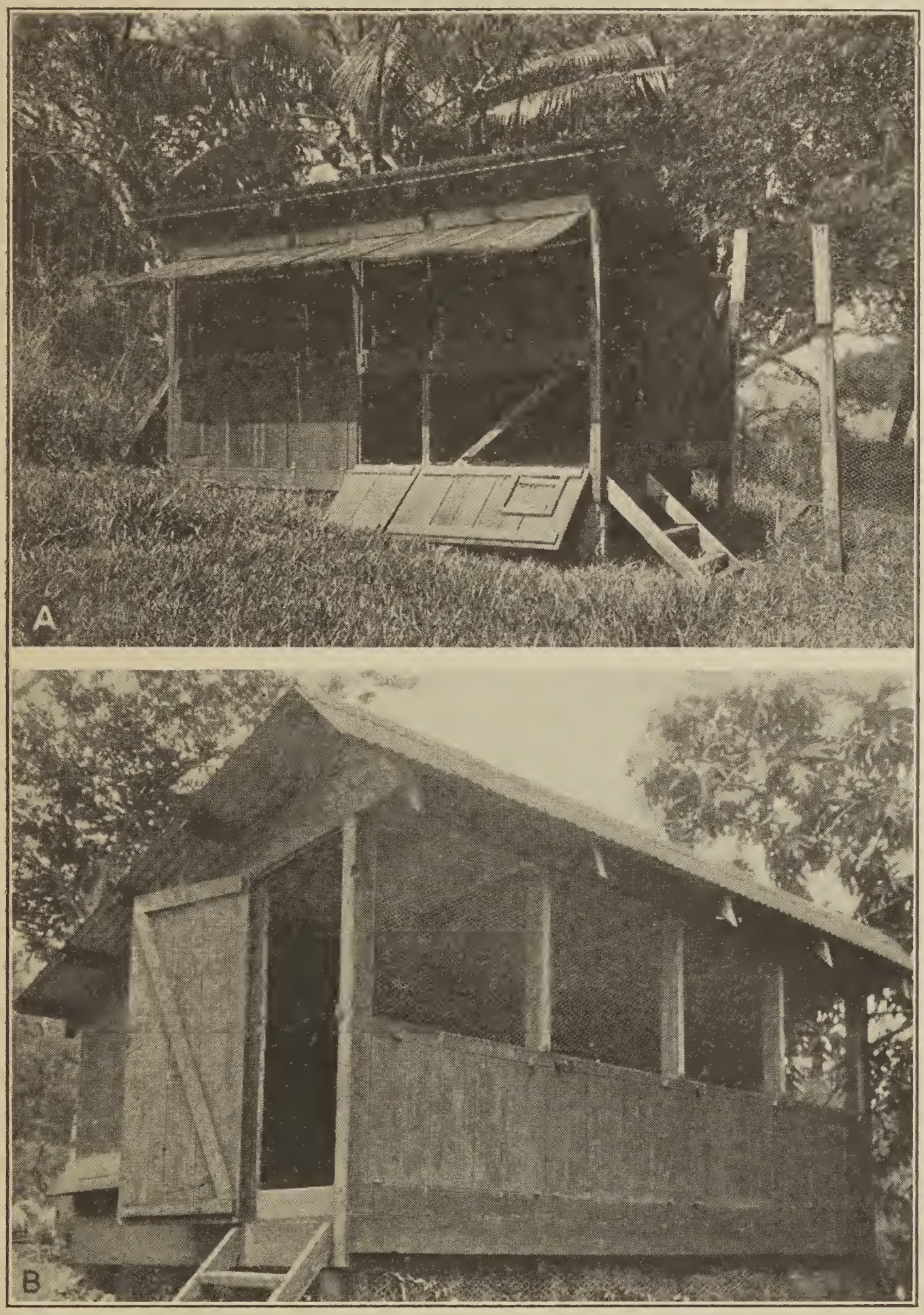

FIGURE 5.—Types of poultry houses designed by the station: A, Colony brooder house; B, laying house.

be found in Guam. The station also demonstrated the advantage of better methods of feeding, care, and management than were in common use.

Chickens are generally raised and are highly prized by the average Chamorro farmer. The station therefore gave particular attention to them. Because of insufficient facilities the work was necessarily confined to a study of comparative adaptability to local demands and conditions of a number of introduced purebreds and their various crosses with the native chickens, the designing of houses (fig. 5) suitable to local conditions, with some feeding, incubator, and brooding tests, and production for distribution of improved breeding stock for use in upgrading the chickens of the island. Under station management some of the native hens made good records in egg production, showing that the generally low productiveness of the native hen is largely due to lack of knowledge on the part of the local farmer concerning methods of feeding, care, and handling.

By crossing the Single Comb Rhode Island Red with native hens that had been improved by selective breeding through several generations, and in many respects resembled the Single Comb White Leghorns, and by crossings later with the Single Comb White Leghorns the station produced what is known as the "Guam" strain, which shows much improvement in type, color, and size of both eggs and fowl and a steady increase in egg-production capacity without any apparent decrease in vigor, over the original native parents. The strain has proved popular with the local chicken raisers, and the demand for breeding stock and for eggs for hatching has been greater than the station could supply. Simple methods of housing and maintaining the health of the flocks were also demonstrated by the station.

When the station was established the wild grasses and native plants were depended upon for feed even in the dry season, and none of the so-called "improved" pasture grasses and forage crops, except corn, was grown. The station showed that introduced grasses and forage crops could be raised to advantage and that they made it possible to carry more stock on a given area than could be done with the native grasses. Dallis grass (*Paspalum dilatatum*) and Para grass (*Panicum barbinode*) proved to be the most valuable of the introduced grasses. Japanese lawngrass (*Osterdamia japonica*) was shown to be better for lawn purposes than were those commonly grown.

Fiber plants, including henequen, maguey, and sisal, introduced by the station, make luxuriant growth, and give good yields.

Of the many varieties of sorghum tested kafir and durra have proved popular and are widely grown. Both the sweet and the nonsaccharine sorghum varieties were shown to have good drought-resistant properties and to be capable of supplying an abundance of forage and grain at a time when other forage crops are scarce.

Corn, the principal food crop of the Chamorro people, was introduced into Guam from Mexico during the early part of the Spanish regime. Many varieties were brought in from various parts of the world by the station, but none was found to be as well suited to local conditions as the common white corn, designated "Guam White", that has been grown and kept pure on the island since its introduction. The station demonstrated the advisability of carefully selecting seed, using improved cultural methods, growing the crop in rotation with other crops, and thinning the stalks in the hill to increase yield.

The station, in cooperation with the island government, rendered a distinct service following the destructive typhoon in July 1918, by commandeering and saving, for experimental purposes and for planting by farmers, all seed of the proper stage of maturity from such fields as had escaped destruction by the storm. The saving of this seed was considered to be one of the most important things the station did for the island as a whole, especially as it was done at a time when war conditions made transportation uncertain and seed and food were scarce.

Rice makes up a large part of the native dietary. The native methods of growing the crop were found to be essentially primitive, and the yields were far from satisfactory. The station tested rice from different sources and showed Philippine rice to be best suited to local conditions. Pronounced increases in yield throughout the rice-growing districts resulted from its distribution. The station showed the advantage of carefully selecting seed for planting, of plowing under the rice straw instead of burning it as had been the local custom, and of growing legumes between crop seasons.

Experiments with various kinds of root crops for feed and human consumption showed that such crops can be produced easily and are especially valuable when other food crops are not available, as, for example, after the occurrence of a typhoon. Sweetpotato varieties shown to be superior in quality and yield to the native kinds were introduced, and the edible canna was shown to be especially desirable in certain districts where taro could not be grown. A variety of yautia, introduced some years ago by the station, was found to be more acceptable to ranchers than taro, which had been commonly grown previously. Among other root crops tested and distributed in the hope of stimulating production of such crops were yams, taro, cassava, and arrowroot.

The station demonstrated that the heavy lowland clays of the island, which are poor in texture, and much of the upland clay loams, which are rather low in fertility and in moisture-holding capacity, may be improved by drainage, the turning under of green manure crops to furnish organic matter, and applications of ground cascajo (coral limestone) to correct acidity.

The yellowing of pineapple on the upland calcareous soils was shown by the station to be due to a deficiency of available iron in the soil, and it was shown that the trouble could be remedied by spraying the plants with a solution of iron sulphate. The station devised methods for asexually propagating mango, avocado, and citrus trees, and demonstrated that oranges and lemons could be stored for a considerable period between regular fruiting seasons. It also showed that under proper methods of picking, handling, grading, packing, and storing, various fruits and vegetables could be shipped in good condition to Manila and to Japanese and Chinese ports, thus opening a market for such products.

Until within recent years, a native orange, known as the "Cahit" (fig. 6), was abundantly produced on the island, but disease, particularly scaly bark, destroyed many of the trees. To remedy the situation, the station grew and distributed tangerine or naranghita seedlings, which are apparently highly resistant to the disease, and resistant sour-stock seedlings for budding with the Cahit. To replace

the lime and lemon trees which were succumbing to gummosis, the station distributed seedlings and rooted cuttings, and experimented in the production of resistant budded stock.

The quality and methods of culture of mangoes, avocados, and bananas were improved by the work of the station, as were the production of the coconut, which is about the only money crop, and of copra, the dried kernel of the nut, which is the only export of any size.

When the station began experiments with vegetables in 1909, very few garden vegetables were grown by the natives, but now many of the vegetables raised in the States are successfully grown.

To conserve and improve the valuable timberlands, which were rapidly becoming depleted, the station made experiments to deter-

FIGURE 6.—The Cahit orange.

mine the possibility of growing certain economic trees on the otherwise wasted savanna lands, and distributed seeds of the various hardwoods, principally teak, mahogany, and narra, to test their adaptability to the existing conditions. The teak made surprisingly good growth on most of the tillable lands. Narra appeared to be suited to planting on the heavy clay lowlands where drainage is fairly good, and on some of the soils in the northern part of the island. Mahogany did fairly well on river-bottom land.

An outstanding achievement of the station was the introduction and establishment of a tachinid fly to control the sugarcane borer, and of natural enemies to control the transparent coconut scale, which threatened the copra industry. Parasites which rapidly subdued the cottony cushion scale were also introduced by the station and parasites of the house fly were established around the station buildings and well distributed over the island. An intensive and successful campaign was waged against coconut bud rot.

A general quarantine law restricting the importation of plants and providing for the fumigation of such plants as were allowed to enter was established, largely as a result of the station's efforts. Members of the station staff inspected on board ship all plant material and animals intended for entry into Guam.

PROGRESS OF WORK, 1930–31, 1931–32

From June 10, 1930, to January 16, 1931, the director was absent from the station on a visit to the United States. During the trip he secured for the station various supplies, seeds, and plant material, and, through the Bureau of Animal Husbandry of the United States Department of Agriculture, livestock including 1 Shorthorn and 2 Ayrshire bull calves, 1 boar and 2 gilts of the Duroc-Jersey breed, 2 cockerels and 10 pullets of the Single Comb Rhode Island Red breed, and 2 cockerels and 9 pullets of the Single Comb White Leghorn breed.

The work in agronomy and horticulture included principally the growing of legumes and forage grasses, cultural tests with root crops, vegetables, fiber plants, and lawngrasses, the vegetative propagation of mangoes, avocados, and citrus, care of the station orchard, disease-control studies, the distribution of seeds and plant-propagating material, and studies of the suitability of certain economic plants for use in reforesting denuded areas.

In December 1930, the entomologist went to Kobe, Japan, whence, in cooperation with the Bureau of Entomology of the United States Department of Agriculture, he successfully introduced into Guam three species of parasites that attack the European corn borer in Japan and in China. From February to July 1931 the entomologist was on leave of absence in the United States.

The adult demonstration work and the boys' and girls' club work received approximately an equal amount of attention, although the latter continued to be the most popular feature of extension. Agencies generously cooperating with the extension division included the department of public instruction, the island forester, the island government extension agent, and the district commissioners.

HORSES

Renewed interest was shown by the people of the island in the work of the station in upgrading the native ponies, and a large number of privately owned mares were bred to the station purebred Morgan sire.

CATTLE

FEEDING TEST

The results of a feeding test with grade cows, begun several years ago, indicated that in general a local ration of corn and coconut meal is satisfactory for cows of average milk production when they are pastured on Dallis grass or on Para grass. A ration made up of imported corn, oats, cottonseed meal, and wheat bran proved to be more satisfactory than the local ration for cows giving the higher milk yields.

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MATAI TATI DISEASE

Further studies of the matai tati disease affecting cattle and carabao pasturing wholly on the savanna uplands showed that this trouble in cattle may be corrected and even prevented by feeding them bone meal. Affected adult carabao, on the other hand, cannot be so quickly cured because they reluctantly eat the meal even when it is prepared in combination with salt or with grain. Carabao calves can be trained to eat the bone mixture.

CONTROL OF INTERNAL PARASITES

Carbon tetrachloride in coconut oil proved to be a highly efficacious treatment for fourth-stomach worms (*Haemonchus contortus*) in cattle, and also apparently reduced infestation with the liver fluke (*Fasciola hepatica*) under the conditions prevailing in the test.

CONTROL OF CATTLE TICKS

Because of the locally prevalent cattle tick, identified by various authorities as *Boophilus australis*, *B. margaropus annulatus*, *B. annulatus*, and *Margaropus caudatus*, the station further demonstrated the value of spraying affected cattle with an arsenical solution. Increasing numbers of farmers treated their cattle according to station instructions, and two installed modern dipping vats on their ranches. With one exception, the calves introduced by the station, and some brought in by a local livestock raiser, were successfully immunized against the tick-fever organism.

SHELTER VERSUS OPEN RANGE

Five grade cows, kept on pasture from June 1 to January 15 during the rainy season, gave decidedly decreased yields of milk as compared with their previous performance during the same months under shelter, and showed the ill effects of exposure to chilling night rains.

SWINE

To demonstrate the inadvisability of feeding restricted rations especially to young pigs—a practice common among the native farmers—16 grade pigs about 4 months old were fed daily for a period of 86 days half a ration made up of equal parts by weight of corn and coconut meal, 2 parts of cooked breadfruit, and 6 percent of tankage. The lot was fed in addition fresh Para grass daily and was confined to a small run. The pigs made an average daily gain of only 0.38 pound per head. In previous tests the gains made by pigs of similar age and breeding, on the same full ration, was at least double the gains obtained in this test.

Five female grade pigs about 4 months old were ranged on Para grass and fed for a period of 61 days a ration composed of equal parts of coconut meal and fresh cassava with about 5 percent of

tankage. The lot made an average daily gain of 0.79 pound per head. The cost of the feed, exclusive of pasturage, per pound of gain was 3 cents.

Five Duroc-Jersey pigs about 8 months old were fed daily for a period of 60 days a ration made up of equal parts by weight of coconut meal and cooked breadfruit. The lot was fed in addition fresh Para grass daily and made an average daily gain of 0.5 pound per head. The cost of the feed, exclusive of pasturage, per pound of gain was 3.9 cents.

Six weanling pigs on a full ration composed of equal parts by weight of fresh cassava and coconut meal, with about 5 percent of tankage, produced substantially greater gains than did another lot of six weanling pigs fed a ration made up of 2 parts by weight of cassava, 1 part of coconut meal, and 5 percent of tankage.

REPORT OF THE ASSISTANT IN POULTRY HUSBANDRY

By F. B. Leon Guerrero

The development of a new variety (Single Comb Rhode Island Red × white natives × Single Comb White Leghorns), locally called the "Guam" variety, progressed satisfactorily under the limited funds and facilities of the station.

Occasional isolated cases of disease were brought to the attention of the station. Of the internal parasites affecting poultry, the tapeworm, the common intestinal roundworm, the stomach worm, and the caecum worm were the most prevalent, and therefore the most important.

During the year ended June 1931, 802 dozen eggs for hatching and 50 surplus cockerels and pullets were distributed.

REPORT OF THE ASSISTANT IN AGRONOMY AND HORTICULTURE

By Joaquin Guerrero

FORAGE GRASSES

The results of tests of Dallis grass (*Paspalum dilatatum*), Vasey grass, (*P. urvillei*), Rhodes grass (*Chloris gayana*), Para grass (*Panicum barbinode*), Jaragua grass (*Andropogon rufus*), molasses grass (*Melinis minutiflora*), guinea grass (*Panicum maximum*), *Pennisetum setosum*, Guatemala grass (*Tripsacum laxum*), Japanese cane (*Saccharum chinense*), and Napier grass (*Pennisetum purpureum*), carried on cooperatively at the Barrigada farm since 1928, have indicated their comparative suitability to this and similar localities. Napier grass gave the highest yield of forage. The Japanese cane died after it was cut the second time and gave the lowest yield of forage. Table 1 records the results of the tests.

TABLE 1.—*Record of acre yield of 11 coarse forages in adaptability tests which were begun at the Barrigada farm in September 1928 and completed in October 1930*

Date of cutting	*Paspalum dilatatum*	Vasey grass	Rhodes grass	Para grass	Jaragua grass	Molasses grass
1929	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Jan. 21	10,500	9,600	8,400	36,700	2,200	11,000
May 21	----------	8,900	7,500	17,700	2,500	13,200
Sept. 20	31,300	12,600	7,100	29,100	7,800	15,900
Dec. 12	14,400	7,500	4,500	34,200	5,700	6,200
1930						
Mar. 22	6,900	3,000	2,500	6.200	1,800	4,400
May 26	----------	----------	----------	----------	----------	----------
Oct. 14	20,300	14,300	2,800	32,200	23,200	12,500
Average	16,680	9,317	5,467	26,017	7,200	10,533

Date of cutting	Guinea grass	*Pennisetum setosum*	Guatemala grass	Japanese cane	Napier grass
1929	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Jan. 21	14,200	3,500	4,700	2,900	25,400
May 21	20,300	11,500	8,800	3,600	65,500
Sept. 20	27,900	33,500	31,000	----------	85,100
Dec. 12	20,400	19,300	22,600	----------	82,300
1930					
Mar. 22	9,200	6,900	11,700	----------	48,800
May 26	4,700	3,900	4,700	----------	15,400
Oct. 14	22,500	30,600	44,900	----------	71,700
Average	17,028	15,600	18,343	3,250	56,314

Para grass, cut for the first time 3 months after date of planting, produced in three cuttings at the average rate of 10,250 pounds of green forage per acre on a 1¼-acre plat on which Napier grass had previously been grown, mungo beans had been plowed under, and a heavy top-dressing of ground cascajo had been applied.

LAWNGRASSES

Lawngrasses under test at the Barrigada farm included centipede grass (*Eremochloa ophiuroides*), carpet grass (*Axonopus compressus*), and Japanese lawngrass (*Osterdamia japoniça*), the two latter of which made fine growth.

In tests of four methods of planting Japanese lawngrass, centipede grass, and Bermuda grass, begun in 1920, on a clay loam hillside area, a good sod was established within a short time when the root sets were divided and planted in drills 4 inches apart each way, but the method was the most expensive of those tried. Growth was unsatisfactory when the chopped sets were mixed with soil, thoroughly wetted and broadcast and the area was lightly covered with dry soil and rolled. Growth was very slow when the root sets were chopped and scattered in drills and lightly covered with soil. Sodding, as was to be expected, proved to be the quickest method for establishing a lawn.

Of lawngrasses planted in 1929, Bermuda grass was crowded out by Japanese lawngrass and by centipede grass grown in alternate rows with the former. In tests made in 1931–32 the Japanese lawn-

grass produced the most compact sod of the three varieties and was better able to resist encroaching weed growth. Centipede grass ranked second in these respects.

FIBER PLANTS

In a planting of maguey and henequen, made November 20, 1930, in continuation of a test to determine the range of adaptability of fiber plants to local conditions, the best growth was made on black savanna soil, followed by that on red soil, white adobe rock soil, and black adobe rock soil, in the order named. If these fiber plants continue to grow satisfactorily, another means of utilizing the otherwise waste savanna lands will have been found.

LEGUMES

COWPEA VARIETY TEST

The station continued to test many varieties of cowpeas to determine those best suited to local conditions. The average acre yields of seed for the period 1928–31 were as follows: Progressive White, 534 pounds; Conch, 994 pounds; S.P.I. no. 46373, 604 pounds; S.P.I. no. 64017, 918 pounds; S.P.I. no. 46175, 410 pounds; Hawaiian hybrid, 513 pounds; White Queen, 454 pounds; Buff, 563 pounds; New Era, 318 pounds; Potomac, 88 pounds; Asparagus, 275 pounds; Groit, 338 pounds; Guam hybrid, 875 pounds; Black, 400 pounds; Red Ripper, 521 pounds; Arlington, 483 pounds; Iron, 250 pounds; Virginia Blackeye, 644 pounds; Taylor, 486 pounds; and Large Blackeye, 350 pounds. These varieties made good cover and green-manure crops. The seed was used as a food for human consumption and as a feed for livestock.

Varieties of cowpeas planted March 4, 1932, and harvested May 5, gave the following average acre yields of seeds: Shahan, 450 pounds; Columbia, 325 pounds; Brabham, 575 pounds; California Blackeye, 381 pounds; Large Blackeye, 425 pounds; Conch, 231 pounds; Groit, 900 pounds; Cream Crowder, 200 pounds; Victor, 238 pounds; Progressive White, 856 pounds; and Arlington, 1,206 pounds.

ROOT CROPS

SWEETPOTATOES

From the seed material of six varieties of sweetpotatoes (*Ipomoea batatas*), received during the fiscal year 1930–31 from the United States Department of Agriculture, several thousand cuttings were obtained for distribution to local farmers.

Sweetpotatoes planted June 10, 1930, and harvested December 16, gave the following acre-basis yields: Hawaiian no. 1, 4,200 pounds; Hawaiian no. 2, 8,100 pounds; Hawaiian no. 3, 3,000 pounds; Hawaiian no. 4, 3,400 pounds; Hawaiian no. 5, 6,900 pounds; Yellow Jersey, 1,900 pounds; Nancy Hall, 6,300 pounds; Patas Nganga, 5,900 pounds; Puerto Rico, 3,900 pounds; and Yap, 5,100 pounds.

Sweetpotatoes planted November 16, 1931, and harvested April 14, 1932, gave the following acre-basis yields: Mameyita, 3,100 pounds;

Triumph, 2,800 pounds; Puerto Rico, 4,200 pounds; Nancy Hall, 5,000 pounds; Southern Queen, 3,600 pounds; Yellow Jersey, 3,200 pounds; Hawaiian variety, 2,900 pounds; Yap, 3,000 pounds; Patas Nganga, 2,600 pounds; and Amarillo, 1,500 pounds.

YAMS

During the fiscal year 1930–31 the yam (*Dioscorea* spp.) variety test, begun in 1925, was completed. In every instance during the test period 1925–31 the trellised plats outyielded the untrellised, and the increased yields amply compensated for the extra labor involved in making the trellises. The acre-basis yields for 1931 were as follows: *D. latifolia*, trellised, 11,808 pounds; untrellised, 4,059 pounds; *D. alata*, trellised, 14,760 pounds; untrellised, 4,551 pounds; Dagon Agaga, trellised, 14,391 pounds; untrellised, 3,198 pounds; Dagon Apaca, trellised, 8,856 pounds; untrellised, 2,583 pounds; Dagon Jaya, trellised, 6,150 pounds; untrellised, 2,460 pounds; Dagon Nika, trellised, 9,225 pounds; untrellised, 4,674 pounds; Dagon Gado (smooth), trellised, 5,904 pounds; untrellised, 2,214 pounds; and Dagon Sumay, trellised, 10,578 pounds; untrellised, 4,551 pounds.

TARO, DASHEEN, AND YAUTIA

Five varieties of taro, six varieties of Japanese Dasheen (*Colocasia* spp.), and one variety of yautia (*Xanthosoma* sp.) were planted August 4, 1930, to secure additional information on yield. The crops were harvested March 20, 1931. The acre-basis yields were as follows: Of the taros, Visaya gave 925 pounds; Apaca, 475 pounds; and Agrigan, 3,200 pounds; the yautia variety gave 4,000 pounds; and of the dasheens, Japanese no. 1 gave 5,000 pounds; Japanese no. 2, 4,000 pounds; Japanese no. 3, 2,200 pounds; Japanese no. 4, 2,400 pounds; Japanese no. 5, 3,400 pounds; and Japanese no. 6, 3,200 pounds.

Taro, dasheen, and yautia were planted April 16, 1931, and harvested April 29, 1932. The acre-basis yields were as follows: Of the taros, Visaya, 700 pounds; Pacencia, 1,050 pounds; Manila, 1,100 pounds; Apaca, 759 pounds; and Agrigan, 2,150 pounds; of the yautia variety, 2,600 pounds; and of the dasheens, Japanese no. 1, 2,400 pounds; Japanese no. 2, 2,000 pounds; Japanese no. 3, 2,250 pounds; Japanese no. 4, 3,075 pounds; Japanese no. 5, 2,075 pounds; and Japanese no. 6, 1,050 pounds.

SOIL IMPROVEMENT

Tests of barnyard manure and ground cascajo, and green manure (velvetbeans and pigeonpeas) were made with corn on heavy lowland clay soil of poor fertility. The corn was planted January 6, 1931, and harvested May 18. The pigeonpeas and the velvetbeans were not harvested. The two plats receiving barnyard manure in combination with ground cascajo made higher yields than did the untreated (check) plats.

FRUIT INVESTIGATIONS

LEMASA TREE

A lemasa tree (*Artocarpus champeden*), planted June 14, 1923, came into bearing for the first time November 20, 1930, yielding 10 edible fruits weighing 69 pounds.

CITRUS

Some of the introduced citrus trees that were planted in 1918 fruited in 1931. One tree of Mediterranean sweet orange yielded 11 fruits weighing a little over 5 pounds. One tree of the Marsh Seedless variety of pomelo yielded 446 fruits weighing over 454 pounds. The fruits were of fine flavor and were golden yellow when mature.

Further studies for the control of scaly bark (psorosis) and gummosis of citrus showed that apparently treatment is most beneficial if given during the initial stages of the troubles. The most successful treatment was that of thoroughly scraping, with a knife, infected parts of the tree, disinfecting the wounds preferably with bichloride of mercury (1:500 in a 25 percent aqueous solution of ethyl alcohol), and applying a weak solution of carbolineum. If infestation reappeared, the wounds were again scraped and coated with a paste made by mixing either calcium carbide residue or lime with the carbolineum.

TRIAL SHIPMENTS OF FRUIT

Because of a general decline in the price of copra, the station encouraged the development and the improvement of various kinds of fruits both for local use and for exportation. Trial shipments of avocados were made to the Philippines and to other parts of the Orient to learn the most efficient methods of handling and packing the fruit. Avocados that were carefully handled and packed and stored at a temperature of about 40° F. reached Manila and Japanese and Chinese ports in good condition. With the assistance of the station, private growers made a few trial shipments of different kinds of fruits. The results were encouraging.

MANGOES AND AVOCADOS

The station spent considerable time in propagating for local distribution suitable varieties of avocados and mangoes. Various methods of budding and grafting were tested. In the grafting experiments with mangoes the Saipan variety (*Mangifera odorata*) was used as the stock, and the Carabao variety (*M. indica*) and some introduced kinds of known quality were used as the scion. Of the several methods tried, the side-graft method, together with the practice of leaving the crown or top intact, was successful in 89.2 percent of the cases when the union was paraffined in the usual manner, covered with sphagnum moss kept moist, and wrapped with corrugated cardboard. Only 57.9 percent of these unions were successful when not protected with moss and cardboard.

In tests in which the tops of the stocks were removed at once following the grafting operation 86.2 percent of the grafts were successful when the union was paraffined and covered with moss and with cardboard, and in 76.03 percent of the cases when the moss and the cardboard were omitted. In cleft grafting 60 percent of the unions were successful when they were paraffined, covered with moist sphagnum moss, and wrapped with cardboard, whereas with the omission of the cardboard and the moss only 9 percent were successful. The method of whip grafting on stocks from which the top had been removed was 70.3 percent successful when the unions were paraffined.

FIGURE 7.—Forest seedling nursery at Yigo.

BANANAS, PLANTAINS, AND PINEAPPLES

Of the banana varieties under test during the year, Manila gave the highest yield of fruit, followed by Ice Cream. Of the plantains tested, Pahong gave the highest yield.

Old pineapple plants, suckers, sectioned stems, crowns, and slips were tested to determine their comparative value as propagating material. All the plants made satisfactory growth during the year.

FORESTRY

To determine the adaptability and suitability of certain economic trees, the station has from time to time introduced various species of hardwood. Bamboo plants (*Bambusa balcooa*), set out along the

river bank in 1924, had reached a height of 40 feet in 1932. Plants of *Dendrocalamus strictus* and *Bambusa polymorpha*, set out in 1929, had attained a height of 10 to 15 feet in 1932. Tests of the adaptability of various economic trees to the island were continued.

The trees from seedlings set out in October 1928 on a typical red clay upland area of the savannas were measured in June 1932. The average height of each kind was as follows: Algaroba (*Prosopis chilensis*), 4.93 feet; talisay (*Terminalia catappa*), 5.8 feet; baguiliunbang (*Aleurites trisperma*), 6.95 feet; cashew or casoy (*Anacardium occidentale*), 3.66 feet; gago (*Casuarina equisetifolia*), 6.7 feet; pili-nut (*Canarium ovatum*), 10 feet; mahogany (*Swietenia mahagoni*), 12 feet; and lebbek (*Albizzia lebbeck*), 15 feet.

Beginning September 1, 1931, the work of the island forester and of the island government extension agent was placed under the immediate supervision of the director of the station. They assisted, among other things, with the forestry, plant-distribution, and plant-collection work of the station. Forestry nurseries were established in the districts of Yigo (fig. 7), Dededo, Barrigada, Yona, Inarajan, Merizo, and Agat. The forest work on the Pinenglo reservation was increased by plantings of seedlings of mahogany, teak, albizzia, *Enterolobium cyclocarpum*, and raintree.

GARDEN-VEGETABLE DEMONSTRATIONS

ADAPTABILITY OF VEGETABLES

Many trials with vegetables were made to determine their suitability to local conditions. Vegetables giving the best results were the California Wonder variety of pepper, the Red St. Valery variety of carrot, a beet named Improved Blood Turnip, and the Grano variety of onion (fig. 8) from the New Mexico Agricultural Experiment Station. This variety of onion gave an acre-rate yield of 19,063 pounds despite the unfavorable weather conditions prevailing at the time the crop was growing. Some of the bulbs averaged 8 ounces.

VARIETY TESTS

In connection with the selective breeding of tomatoes six varieties were planted February 11, 1932. The yield of all plats was much reduced by *Sclerotium rolfsii*. The acre-rate yields were as follows: Marglobe, 195 pounds; Cristobal, 2,543 pounds; a variety from the Baleric Islands, 694 pounds; a variety from Argentina, 124 pounds; Louisiana Pink, 101 pounds; and Louisiana Red, 135 pounds.

The work with cabbage was largely a continuation of that previously done. The acre-rate yields were as follows: Sure Crop, 3,825 heads, 2,072 pounds; Allhead Early, 6,938 heads, 4,219 pounds; Early Jersey Wakefield, 9,375 heads, 7,523 pounds; Charleston Wakefield, 10,687 heads, 7,606 pounds; Succession, 4,125 heads, 1,875 pounds; Copenhagen Market, 8,250 heads, 4,547 pounds; Long Island Wake-

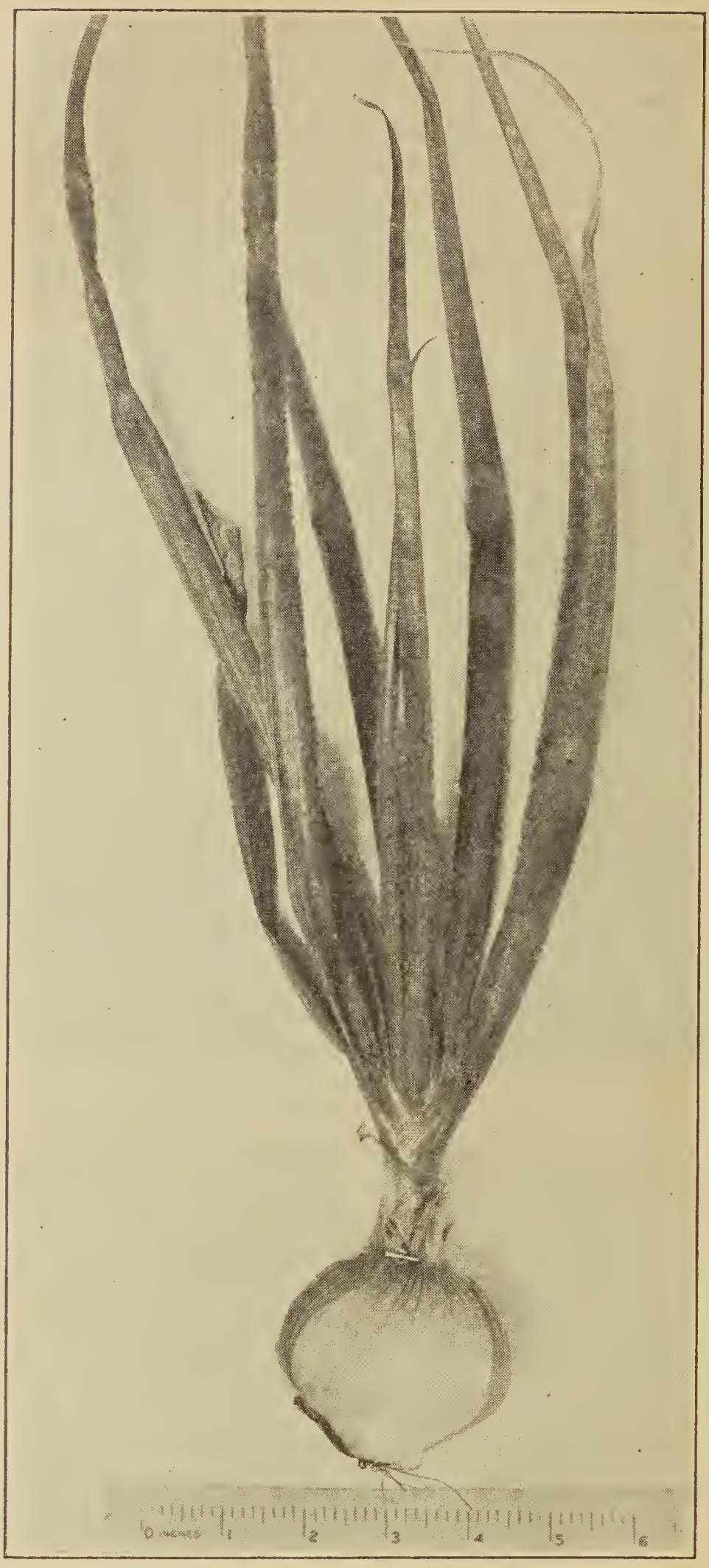

FIGURE 8.—Grano variety of onion.

field, 9,375 heads, 6,797 pounds; Golden Acre, 6,375 heads, 1,055 pounds; Genuine Surehead, 3,000 heads, 1,547 pounds; Early Blood Red Erfurt, 1,500 heads, 563 pounds; and All Seasons, 4,125 heads, 2,430 pounds.

Beginning in January 1932 4 bush and 4 pole varieties of lima beans, and 12 bush and 5 pole varieties of string beans were under test. Harvesting began in February and continued throughout the rest of the fiscal year. The acre-rate yields were as follows:

	Pounds
Bush lima varieties:	
Jackson Wonder	1,797.13
Fordhook	592.25
Burpee Improved	319.37
Henderson	1,049.37
Pole lima varieties:	
Yopp	5,338.13
Small White	7,254.37
Large White	3,640.87
Florida Butter	4,571.62
Bush string varieties:	
Bountiful	2,591.50
Excelsior Refugee	666.13
Improved Round Refugee	647.87
Red Valentine	839.50
Black Valentine	976.37
Stringless Green Pod	1,259.25
Giant Stringless Green Pod	1,104.13
Tennessee Green Pod	1,049.37
Sure Crop Stringless Wax	547.50
Wardwell Kidney Wax	538.37
Rust Proof Golden Wax	638.75
Prolific Black Wax	410.62
Pole string varieties:	
New McCaslan	1,204.59
Genuine Cornfield	3,604.37
White Cornfield	3,704.75
Kentucky Wonder	3,120.75
Kentucky Wonder Wax	2,044.00
Early Wonder Prolific, a dry pea bean similar to navy	1,085.87

Tests were begun in 1930–31 to develop a variety of eggplant combining the hardiness and flavor of the native variety with the attractive purple color and the high yielding qualities of the imported eggplant. The New York Improved was crossed with the local variety. In June 1931 the acre-basis yields were as follows: Native, 7,962 pounds; New York Improved, 17,213 pounds; hybrid no. 1, 15,325 pounds; hybrid no. 2, 16,913 pounds; hybrid no. 3, 16,000 pounds; hybrid no. 4, 15,100 pounds; hybrid no. 5, 6,900 pounds; hybrid no. 6, 12,525 pounds; and hybrid no. 7, 11,750 pounds. In June 1932 the second crop of hybrids had the following acre-basis yields: Hybrid no. 1, 15,132 pounds; hybrid no. 2, 12,203 pounds; hybrid no. 3, 14,460 pounds; hybrid no. 4, 17,303 pounds; and hybrid no. 5, 19,128 pounds. The fruit of each crop exhibited a wide range of variation in color, shape, and size. One plant of the 1932 crop bore fruit having the desired color, size, and flavor.

SEED AND PLANT DISTRIBUTION

The distribution of seeds and plants during the fiscal years 1930–31 and 1931–32 is shown in table 2.

TABLE 2.—*Seeds and plants distributed, 1930–31 and 1931–32*

Name	Form	1930–31	1931–32	Name	Form	1930–31	1931–32
		Number	*Number*			*Number*	*Number*
Mango	Seedlings	200	185	Ornamentals (rooted)	Cuttings	3,415	----
Avocado	do	46	97	Breadfruit	do	----	8
Papaya	do	654	247	Sweetpotato	do	----	16,850
Garden	do	15,787	2,040	Grape	do	----	138
Citrus	do	----	150	Sugarcane	do	----	45
Forest	do	----	1,267	Avocado	Seeds	----	200
Raintree	do	----	750				
Santol	do	----	4				*Ounces*
Mabolo	do	----	5	Cover crops	do	----	7
Date palm	do	----	28				
Lanzon	do	----	1			*Packets*	*Packets*
Marcottaged citrus	do	----	37	Vegetables	do	265	109
Mangoes (grafted)	Plants	210	201	Ornamentals	do	----	7
Avocados (grafted)	do	21	103				
Citrus (grafter)	do	----	15			*Sacks*	*Sacks*
Lanzon (grafted)	do	----	1	Lawngrass	do	38	----
Citrus	do	309	----	Forage crops	do	58	----
Miscellaneous	do	284	----	Pasture grasses	do	----	315
Fiber	do	40	----				
Lemasa	do	----	102			*Number*	*Number*
Macadamia	do	----	10	Forest trees	----	260	----
Fig	do	----	3	Pili-nut trees	----	----	6
Bamboo	do	----	23	Taro	Suckers	----	65
Ornamentals	do	----	9,042	Banana	do	----	138
Citrus	Cuttings	----	355	Pineapple	do	----	10
Root crops	do	5,800	----				

REPORT OF THE ENTOMOLOGIST

By S. R. VANDENBERG

EUROPEAN CORN-BORER PARASITES

Further trials were made to learn the effect of cold storage on the keeping quality of the eggs of the European corn-borer parasite *Exeristes roborator*. The eggs were placed in storage July 10, 1931, and tested after periods of 5, 10, and 15 days in storage. Table 3 gives the results of the test.

TABLE 3.—*Record of effect on hatchability of storing 60 eggs of the European corn-borer parasite Exeristes roborator at temperatures ranging between 32° and 35° F.*

Period eggs were in storage	Eggs removed	Condition in which found	Remarks
Days	*Number*		
5	20	Not hatched	16 hatched the day following their removal. The others failed to hatch.
10	20	do	17 hatched the day following their removal. The others failed to hatch.
15	20	do	15 hatched the day following their removal. The others failed to hatch.

From the above and previous tests it is concluded (1) that a temperature almost at the freezing point is required to prevent the

parasitic eggs from hatching, and (2) that low temperature, provided it does not range below the freezing point, has no appreciably harmful effect on hatchability. Under normal temperatures and insectary breeding 80 percent of the eggs were viable.

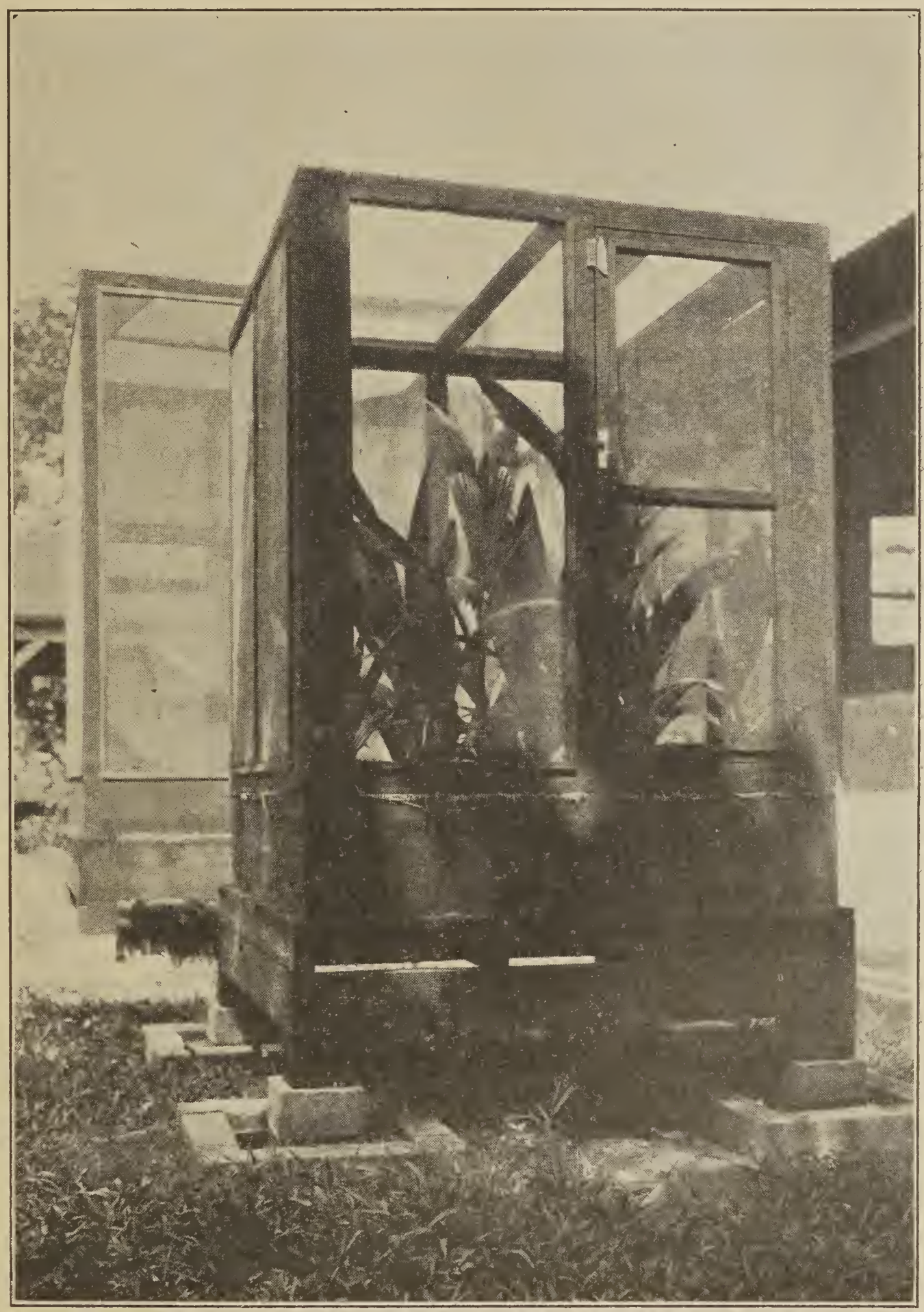

FIGURE 9.—Cages used in breeding *Ceromasia lepida,* a tachinid parasite of the European corn borer.

The breeding of *Exeristes roborator* for distribution was continued in the hope of eventually establishing it on the island.

The entomologist made a trip to Japan in December 1930 to secure for Guam a supply of *Ceromasia lepida* (*Masicera senilis*)—

a tachinid parasite of the European corn borer. Through the cooperation of a representative of the Bureau of Entomology of the United States Department of Agriculture he collected 12,000 corn-borer larvae in Japan. During the return trip these were stored at temperatures ranging between 38° and 45° F. From them, 1,071 adults and 394 pupae of *C. lepida*, 141 adults of *Cremastus hymeniae*, and 25 adults of *Eulimneria* species were recovered. From 50 pupae of *Eulimneria* sp. also included in the shipment, 40 adults emerged. Part of the *C. hymeniae* and nearly all the *Eulimneria* species were used in an unsuccessful attempt to breed them in the insectary. The rest of the *C. hymeniae* and some of the *Eulimneria* sp. were liberated in a cornfield harboring an exceptionally heavy infestation of the corn borer. Storing the 394 pupae of *C. lepida* delayed emergence for about 15 days. From January 7, 1931, to February 15, 1931, 982 of the resulting progenies were liberated in the field.

From July 1931 to December 1931, eight generations (2,675 progenies) of *C. lepida* were reared in a large cage, and seven generations (2,585 progenies) were reared in a small cage (fig. 9). In addition, 1,920 parasits were collected in the field. From the total of 7,180 adults or pupae, either reared in the cages or taken from the field, 4,819 adults were distributed in small lots in infested cornfields in 50 localities. Some of the liberated parasites or their fieldborn progenies reached practically all the corn grown on the island. In many instances migrations of one half to three fourths of a mile were definitely ascertained, and in 1 or 2 others migrations of 1½ to 2 miles occurred probably as the result of help by native farmers. From January 1932 to June 1932 it was definitely ascertained that, in the lowland coastal districts, the parasite survived the period between corn-growing seasons, July to December, which is the wet season. It appears to be a very efficient parasite under these conditions, approaching the danger point of self-extermination in the most favorable locations. It is doubtful whether the parasite on the uplands survived the period December to June, which is the dry season, when little corn is grown.

HOUSE-FLY AND STABLE-FLY PARASITES

The collection and distribution of *Spalangia* sp., an introduced parasite of the house fly and stable fly, were continued. These parasites are well established around the station barns, paddocks, and manure pits and can be readily collected at any time for distribution. During the years 1930–31 and 1931–32, 26,500 *Spalangia* sp. were distributed over the island.

REPORT OF THE ASSISTANT IN EXTENSION

By A. I. Cruz

ADULT DEMONSTRATION WORK

Adult demonstration work was carried on as in previous years in cooperation with the island government extension agent and with the district commissioners, who, by coming in contact with the older

ranchers through monthly field meetings and demonstrations, gradually succeeded in persuading many of them not only to attend the meetings and demonstrations but also to put into practice the improved methods recommended by the station. The district commissioners were appointed leaders in their respective districts, acted in the capacity of interpreters in clarifying such points as were not readily grasped by the farmers, and as agricultural agents by carrying the lessons taught in each demonstration to farmers living in remote places. Demonstrations were given with vegetables, fruits, and root crops in nearly every district, with gratifying results.

The people were taught how to select and maintain for breeding the best cattle of both the dairy and the beef type. Demonstrations with pigs taught the importance of controlling disease, using correct methods of management, and of improving the herd. The station proved that loss from hog cholera and from pneumonia can be greatly reduced by giving the pigs proper care under sanitary conditions and by the use of the requisite serum. Demonstrations were given of methods of feeding and raising chickens, with special emphasis on cleanliness, housing, and the care of sick fowls. Helpful suggestions were given on culling and marketing the flock.

BOYS' AND GIRLS' CLUB WORK

Boys' and girls' agricultural club work was conducted in close cooperation with the schools of the island in all the outlying districts and in two of the Agana school districts. The club year was divided into two seasons, corresponding with the two general crop seasons, and, likewise, with the two school semesters, which ended, respectively, October and March 31.

The club activities supervised included those dealing with corn, beans, horticulture, gardening, pigs, poultry, rice, copra, and root crops.

Members of the corn club who followed instructions in improved methods of seed selection and culture produced increased yields of good corn. Members of the bean club were supplied by the station with the seed of four varieties of beans and were given instructions in seed-bed preparation, planting, and cultivation, and in seed selection and storing.

Members of the horticultural club were instructed in proper methods of budding and grafting avocado, mango, and citrus trees, and of treating trees affected with gummosis and with scaly bark. Members of the garden club were shown how to plant, cultivate, harvest, and market vegetables, how to store the seed, and the need of growing vegetables in great variety to make the island self-supporting (fig. 10). Pig-club members made good progress in their methods of caring for the animals, and nearly all provided sanitary quarters and proper feeds for them (fig. 3). Many of the members raised high-grade pigs and some purchased from the United States pure-bred stock.

Members of the poultry club raised good-sized flocks of chickens and some ducks and turkeys, all of improved stock (fig. 2). They were given instructions on the selection and care of eggs for hatching and on proper methods of feeding and caring for the flock.

Rice-club activities were carried on among young farmers in Piti, Asan, Merizo, Sumay, and Inarajan. Members of the rice club were instructed in modern methods of raising the crop.

Members of the copra club who closely followed instructions on proper methods of caring for the coconut tree, of gathering the nuts, and of making, drying, and storing copra, produced copra of superior quality as compared with that made in Guam during earlier years. Racks were being used in place of mats to dry the copra, and sheds for storing it were erected in many places.

FIGURE 10.—Garden club member.

Members of the root-crop club were encouraged to grow the more important root crops for home consumption and for use as emergency crops.

BOYS' AND GIRLS' CLUB FAIRS

In March 1931, a series of club fairs were held in the 16 district clubs in conjunction with the school-closing exercises. The first fair was held at Piti in March and the last at Agana 22 days later. Most of the clubs made a creditable showing.

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