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**THE CACAO INDUSTRY
OF ECUADOR**

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By

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THE CACAO INDUSTRY OF ECUADOR

SUMMARY

This report is based on a survey of the cacao industry of Ecuador made by the Estación Experimental Agrícola del Ecuador while searching for cacao trees superior in yield, performance, and resistance to destructive shoot and fruit diseases. Although approximately 400 haciendas were visited, sufficiently complete data were obtained from 288 haciendas, which have a combined area in cacao of approximately 113,000 acres, or about 35 percent of the estimated total area now in cacao in Ecuador, excluding abandoned and semiabandoned plantations.

The principal growing areas are located in the Coastal Region in the Provinces of Los Rios, Guayas, Manabi, and El Oro. From here come the following local types: Arriba, Balao and Naranjal, Bahía de Caraquez, and Machala. A small quantity of cacao is also produced in the Province of Esmeraldas. Arriba makes up about 58 percent of cacao exportations, Machala about 18 percent, and the other types make up the remainder in about equal amounts.

Although no legal provisions exist for official classification and grading of Ecuadorean cacao, several commercial and export grades, based on quality, region of origin, and season of harvest, are recognized. Among the most important of these are Superior Red Summer Arriba, the highest grade in the export trade, Cosecha Navidad or Christmas Harvest, and Cacao Epoca.

The first grade is harvested from February to August, the second from December through February, and the third grade is harvested during any month of the year. Cacao destined for the European market is usually graded more carefully as to size and shape of beans, and a premium of several dollars per hundred pounds is paid for these choice grades.

Climatic and soil conditions are well suited to the cultivation of cacao in the principal growing regions, and substantial expansion of the industry is possible.

Several varieties and species of cacao grow in Ecuador, but only *Theobroma cacao* L., represented by cacao nacional and several introduced types, collectively called locally cacao venezuela - both red and yellow pod-color types - are planted commercially. Cacao nacional is the more abundant and judged to produce the highest quality beans. The white-seeded cacao grown in Esmeraldas is said to have excellent commercial possibility.

Cacao nacional produces one crop, which is harvested principally from February to May, whereas cacao venezuela produces two. The main crop of cacao venezuela is harvested from July to October, and a light one is harvested during April and May.

The average production of dry cacao is about 82 pounds per acre, or about 0.29 pound per tree. There are on an average about 280 trees per acre.

The areas yielding the most dry beans per acre lie in the vicinity of Chone, Manabi, and Vinces, Los Rios, where the average production on the best haciendas approaches 250 pounds per acre.

Cultivation practices consist of weeding the plantation once or twice each year. Pruning, spraying, and the use of fertilizers are not generally practiced. Trucks and tractors were reported on only 6 percent of the haciendas studied, and such agricultural machinery as plows, discs, and harrows is used on correspondingly few. The machete is still the standard implement.

Fermentation in tanks or boxes is not practiced in preparing the beans for market. Instead, they are spread on floors where they dry slowly and ferment.

The most important diseases are witches'-broom, caused by *Marasmius perniciosus*, and Monilia pod rot, caused by *Monilia royeri*. These two diseases have contributed greatly to the 65-percent reduction in average annual production during the two decades ending in 1947. On old plantations, the decrease was probably as great as 80 percent. Witches'-broom appears to be the more serious disease, destroying not only the fruits but also the foliage and flowers.

Among the various types of cacao venezuela, there are some that are more resistant to disease than cacao nacional. The red-pod types are usually more susceptible than the yellow.

The incidence of witches'-broom disease decreases and yield increases from the Province of Los Rios in the north to the Province of El Oro in the south, due probably to rainfall and sunlight.

A total of 339 superior trees from all provinces were selected for study because of their disease resistance and high-yielding ability.

Insects and animal pests, especially cacao beetles, various butterfly larvae, thrips, and squirrels cause damage to the crop, particularly in plantations adjacent to abandoned or semiabandoned cacao.

Management in most haciendas comes from the resident foreman, with infrequent visits and guidance from the nonresident owner.

There is usually insufficient working capital utilized on the haciendas to permit efficient production. Labor shortages and hand methods also seriously handicap proper operation of many haciendas. Resident labor provides most of the workers on large haciendas, while small haciendas depend more upon nonresident and migratory help. Improvement in diet, sanitation, living conditions, and education facilities are needed in all cacao zones.

Low prices and abnormally low production prompted growers to increase the cultivation of more profitable cash crops, such as rice, corn, and bananas. Diversification in agriculture is practiced on a few of the haciendas only, and most of them have little livestock.

Growers emphasized the need for the maintenance of favorable prices and the establishment of agricultural credit facilities for long periods of time at reasonable rates of interest. Growers also desire technical service to develop and make available superior planting materials and cultivation practices.

INTRODUCTION

Although the cultivation of cacao in Ecuador long antedates the Spanish conquest, it was not until the eighteenth century that the industry reached international importance and Ecuador became the world's leading source of excellent quality cacao beans. This position was held for nearly two centuries. During this period, the area under the cultivation of cacao was greatly expanded and exports increased from about 1,500 short tons in 1740 to approximately 49,600 tons in 1916. Since then the production has decreased to an average of about 16,500 short tons, or about 65 percent, and Ecuador has dropped to approximately fifth in rank among exporting nations.

Among the principal reasons for the decrease in production were (1) the increasing incidence of pests and diseases, (2) the nonreplacement of inefficient trees, (3) the increasing age of cacao trees, (4) the decreasing soil fertility, and (5) the low prices, which reduced the attention given by the grower to cacao cultivation.

With the establishment of the Tropical Agricultural Station at Hacienda Pichilingue, near the town of Quevedo, Los Rios, by the Ministerio de Economía del Ecuador in cooperation with the Office of Foreign Agricultural Relations, United States Department of Agriculture, a cacao improvement program was organized and commenced. Because of the importance of superior stock to this program, a search was made in all major producing regions for high yielding, disease resistant trees. At the same time, a study was made of existing conditions in the industry and factors contributing to its decline.

Data on approximately 113,000 acres, or about 35 percent of the estimated area now in actual production, were gathered for the study on 288 haciendas. These haciendas are distributed as follows: 188 in the Arriba Region, 24 in the Balao Region, 36 in the Bahía Region, and 40 in the Machala Region. These regions are indicated in figure 2.

AREA AND GEOGRAPHIC SETTING OF SURVEY

The Republic of Ecuador, roughly triangular in shape, straddles the Equator on the northwest coast of South America between Peru and Colombia, as is shown on figure 1. It is about 435 miles in its longest dimension, north to south, by 406 miles, at its widest point, east to west, with total surface area of approximately 116,000 square miles.¹



FIGURE 1.--More than 18,500 short tons of cacao beans valued at \$1,441,000 were exported in 1947, of this amount the United States imported about two-thirds.

¹ DIRECCION NACIONAL DE ESTADISTICA. ECUADOR EN CIFRAS, 1938 a 1942. Quito, Ecuador. 1944.

$$18500 \times 21000 = 370000000 \div 1441000 = \text{only } .04 \text{ US per lb.}$$

?

The population is estimated at three million inhabitants of which approximately one million live in the Littoral, or Coastal, Region.

The Andes Mountains, traversing the country from north to south, divide the Republic into three distinct geographical regions. They are the Littoral, or Coastal, Region, which extends from the Pacific Ocean to the western foothills of the Andes, the Sierra, or Inter-Andean, Plateau, and the Oriente, or Amazonian, which is east of the Andes. Of these, only the Littoral is important in the cultivation of cacao, although less than 3 percent of the area is planted to this crop. Therefore, this study is concerned with that region since it is here that cacao production has reached commercial importance.

The Littoral, comprising from north to south the Provinces of Esmeraldas, Manabi, Los Rios, Guayas, and El Oro, has a surface area of about 27,000 square miles. With the exception of a few disconnected scattered ranges of low hills near the coast, the region is low, relatively flat, and well drained for the most part. The most important river is the Guayas, with two large tributaries, Babahoyo and Vinces, whose drainage basin embraces most of the Province of Los Rios, the

principal producing region. Other important rivers of the Littoral are the Chone, Esmeraldas, Jubones, Balao, Gala, and Naranjal.

CLIMATE AND SOILS

Climatic conditions in the Littoral, although differing markedly in rainfall, temperature, humidity in the various sections, are modified by the Humboldt Current. In the belt where cacao is grown, conditions are rather uniform, with high relative humidity, abundant rainfall during approximately six consecutive months of the year, and warm with fairly even temperature through the year.² Gentle winds from the

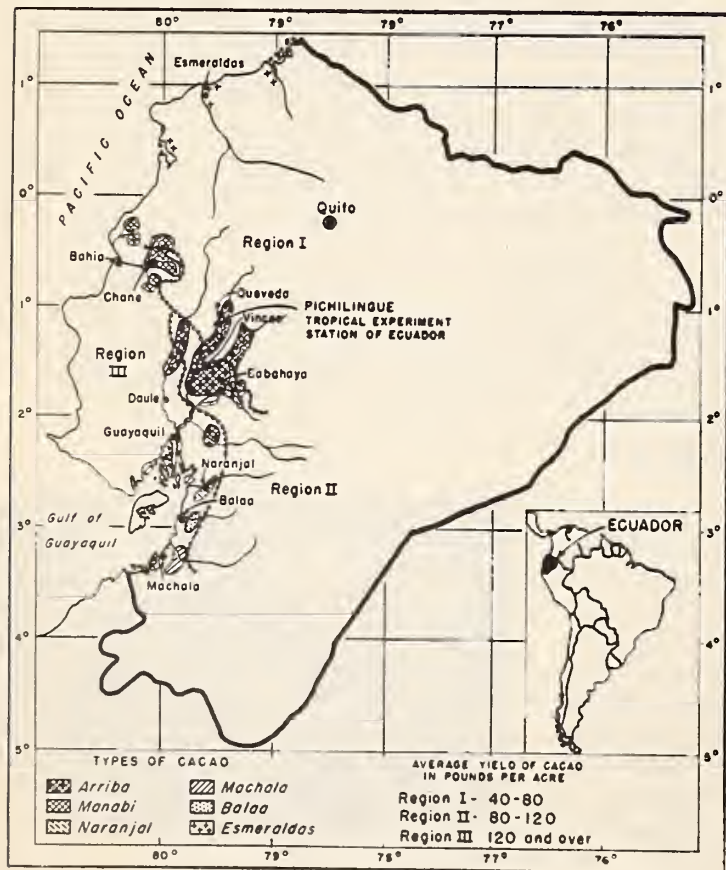


FIGURE 2.--Ecuador and its cacao-producing regions, showing the average yield in cut per acre.

² SERVICIO METEOROLOGICO DEL ECUADOR. BOLETIN METEOROLOGICO No. 2. Quito, Ecuador. 1945.

south or southwest prevail during the dry season and from the north during the wet season.

Rainfall

Marked changes in precipitation rate occur during the year, resulting in definite wet and dry seasons. Usually the rainy season begins in December or January and ends in May. The average rainfall in the cacao-producing regions varies between about 60 and 100 inches. More than 80 percent of the annual rainfall occurs from January to April, with the heaviest precipitation, 20 to 30 inches, occurring in February. Much of the rain comes as heavy showers late in the afternoon or night. The regions of heaviest rainfall lie in the northern portion of the Littoral and near the western slope of the Andes.

Cloudy or overcast weather occurs most of the time during the dry season, while during the wet season there is more sunshine.

Temperature

In general, a uniform monthly mean temperature of about 76° F. prevails throughout the year in the cacao-growing zones. During the rainy season, particularly in the month of April, temperatures often exceed 90° F. The lowest temperatures occur in the dry season, July through September. During these months, night temperatures may drop as low as 60° F.

Relative Humidity

The relative humidity for the year averages approximately 87 percent, with the lowest average occurring during the rainy season and the highest during the dry season. The long periods of overcast and early-morning light misty rains during the dry months tend to prevent excessive evaporation and to keep the relative humidity high.

Soils

The soils of the cacao-producing regions are usually fertile, deep, and moist. For the most part, they have good drainage and are slightly acidic. The lime content is usually adequate, whereas phosphorous is often low in clayey soils.

These soils, according to Miller,³ former Soils Technologist, United States Department of Agriculture, assigned to the Estación Experimental Agrícola del Ecuador, are largely alluvial in origin as is shown in the following tabulation.

³ MILLER, EILIF V. ECUADOREAN SOILS AND SOME OF THEIR FERTILITY PROPERTIES. 1948. Unpublished thesis. Cornell University, Ithaca, New York.

<i>Cacao-producing region</i>	<i>Soil parent material</i>	<i>Major soil group</i>
Arriba (Vinces northward)	Recent volcanic ash and recent alluvial.	Brown loams and gray noncalciic soils.
Arriba (Vinces southward)	Recent alluvial....	Alluvial delta soils in the gray noncalciic zone.
Balao.....	Alluvial.....	Predominately gray noncalciic with coastal strip of alluvial delta soils.
Machala.....	Predominately recent coastal plain sediments; some metamorphic rocks.	Gray noncalciic soil; some alluvial delta soils.
Bahía.....	Tertiary sedimentary rocks.	Gray noncalciic soils.

In the upper Arriba Region the soils are brown loams that developed from wind-blown volcanic ash. The topsoil varies from 20 to 40 inches and rests on a heavy reddish clay subsoil. The organic content decreases from 8 percent in the upper 6-inch layer to an average of 3 percent in the 12- to 40-inch layer. Rapid chemical soil tests for plant nutrient elements made at the Tropical Agricultural Station in Pichilingue⁴ showed that the most important occurred in the following amounts:

<i>Pounds per acre</i>	<i>Pounds per acre</i>
Phosphorous 11	Potassium 430
Nitrogen (No. 3) ... 20	Manganese 25
Calcium 4,700	Iron 2
Magnesium 650	Aluminium 80

$$\text{Ratio } \frac{\text{extractable calcium}}{\text{extractable magnesium}} = 7.2$$

In the lower Arriba Region the dominate soil is derived from alluvium. An exposure along the bank of the Vinces River near the town of Vinces showed that the recent alluvial soil is approximately 2 feet deep and consisted of light-brown sandy loam. The subsoil is a heavy dark-gray clay. These soils are among the best for growing cacao.

⁴ Quantities dissolved by a single extraction with Morgan's Universal Extracting Solution (sodium acetate .72N buffered with acetic acid to pH 4.8).

The dominant soil in the Balao Region is a gray alluvial soil, called gray noncalic soil by Miller because of its color and low lime accumulation. It has a thin topsoil layer, about 6 inches in depth, composed of dark silty organic loam. The subsoil consists of a mottled bluish-gray clay about 12 inches thick, which grades into a yellowish-brown clay loam. This heavy soil has poor drainage.

Gray soils, similar to those of the Balao Region, occur also in the Bahía and Machala Regions. They differ, however, in that they are not entirely alluvium in origin.

CACAO-GROWING REGIONS

The production of cacao is confined principally to an interior strip lying near the foothills of the Andes in the Provinces of Esmeraldas, Manabi, Los Rios, Guayas, and El Oro, as shown in figure 2.

In the discussion of the survey results, each principal growing region is referred to by the local commercial name of cacao produced therein. That is, the growing regions of Los Rios and Guayas in the Guayas River Basin are designated as the Arriba Region, Manabi by Bahía Region, the remainder of the Provinces of Guayas, including cacao from near the town of Naranjal unless indicated separately, by Balao Region, and the Province of El Oro by Machala Region.

It is estimated that the total area now under active cacao cultivation approximates 321,000 acres with about 65,000,000 trees. Comparing the estimates of 1947 with those of 1916, the year of maximum production, they represent a decrease of about 20 percent in area harvested and 35 percent in number of trees. The actual area still planted in cacao has not decreased more than 10 percent. Approximately 58 percent of the production comes from the Guayas River Basin in the Province of Los Rios and consists largely of beans of cacao nacional.

Of the total arable land in the Littoral, estimated at about 924,000 acres, approximately 5.4 percent is being used agriculturally⁵ as shown in figure 3. An insignificant amount of cacao is being produced in the Oriente, or Amazonian, Region, and production may not be expected to increase until the Region is more densely settled and systems of transportation are developed.

PLANTATIONS

Cacao is grown on haciendas, largely under the plantation system, in which practically all of the plantings have been made by individuals known as sembradores or finqueros, under a contract with the landowner. These contracts provide for the establishment of cacao trees according to agreed planting specifications and for the purchase of the trees at a certain price and age, usually between 5 and 8 years old. All harvest prior to purchase belongs to the sembrador. The price paid to him ranges from 4 to 11 cents per plant.

⁵ DIRECCION NACIONAL DE ESTADISTICA. ECUADOR EN CIFRAS, 1938 a 1942. Quito, Ecuador. 1944.

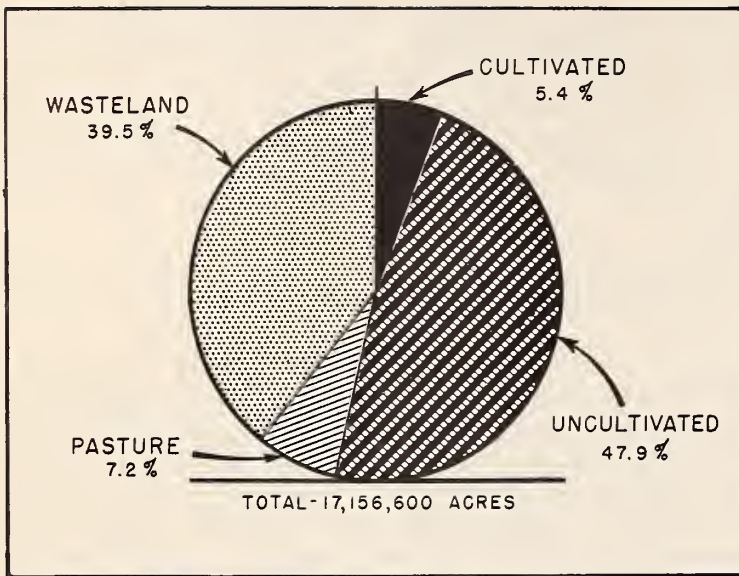


FIGURE 3.--Land-class distribution, Coastal Region, 1943.

The size of the haciendas varies widely among the regions, but in general the smallest ones are in the Bahía Region and the largest in the Balao Region, as shown in table 1. The average area of the haciendas in the two regions are 611 and 20,083 acres, respectively, as shown in table 2. Approximately one-fourth of the haciendas studied comprise about 250 acres or less, while two-thirds have less than 1,250 acres. In the Balao Region, few haciendas have less than

1,000 acres, while several have upwards of 62,000 acres and more than 1½ million trees. An average of approximately 10 percent of the total area of the haciendas are planted to cacao, with a range from 13.6 percent in the Arriba Region to 6.4 percent in the Balao Region, as indicated in table 2.

A reverse ratio exists between the size of the hacienda and the percentage of total area planted to cacao (figure 4). Haciendas with an area of about 125 acres or less have as much as 29 percent of the total area in cacao, while all the other area classes have between 3 and 10 percent.

Concerning the cacao plantings, it was found that two-thirds of the haciendas visited have less than 1,250 acres in cacao, as shown in figure 5 and table 1. The smallest individual plantings are located in the Bahía Region, and the largest are in the Balao Region, with areas of 56 and 1,275 acres, respectively (table 2).

With few exceptions, cacao plantings are located along the rivers. Although they

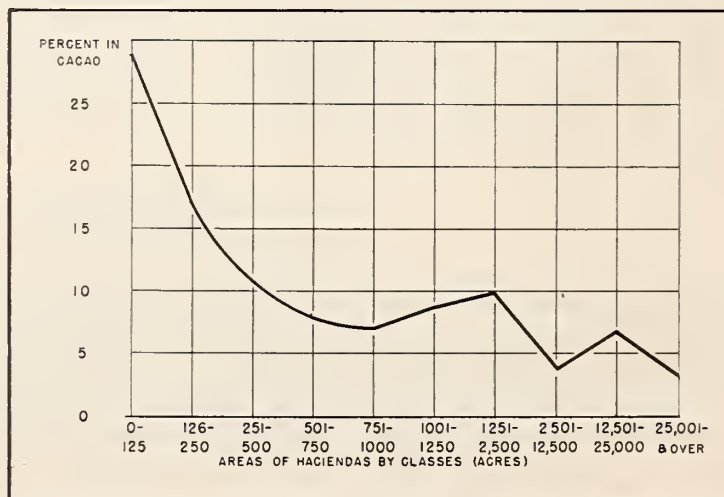


FIGURE 4.--Proportion of total area of haciendas in cacao, by area classes.

TABLE 1. - Class distribution of haciendas and cacao plantings

REGION	0-125 acres		126-250 acres		251-500 acres		501-750 acres	
	NUMBER OF HACIENDAS	NUMBER OF CACAO PLANTINGS	NUMBER OF HACIENDAS	NUMBER OF CACAO PLANTINGS	NUMBER OF HACIENDAS	NUMBER OF CACAO PLANTINGS	NUMBER OF HACIENDAS	NUMBER OF CACAO PLANTINGS
Arriba....	17	72	20	51	37	25	25	23
Balao....	0	3	0	0	0	2	0	4
Bahía....	9	32	8	4	7	0	6	0
Machala....	3	22	10	10	11	8	3	0
Total....	29	129	38	65	55	35	34	27
	751-1,000 acres		1,001-1,250 acres		1,251-2,500 acres		2,501-12,500 acres	
Arriba....	14	7	15	2	24	7	27	1
Balao....	0	2	3	1	6	9	8	3
Bahía....	0	0	0	0	4	0	2	0
Machala....	4	0	2	0	3	0	3	0
Total....	18	9	20	3	37	16	40	4
	12,501-25,000 acres		25,001 acres and over		Total acres			
Arriba....	5	0	4	0	188	188		
Balao....	2	0	5	0	24	24		
Bahía....	0	0	0	0	36	36		
Machala....	1	0	0	0	40	40		
Total....	8	0	9	0	288	288		

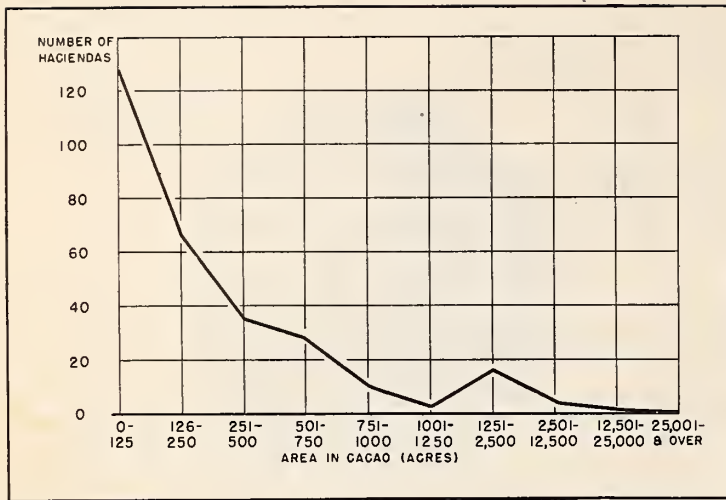


FIGURE 5.--Numerical distribution of haciendas by actual area in cacao.

may be many miles long, they seldom exceed 1 mile in width. Most of the plantings occur between an elevation of 15 to 75 feet above sea level.

In 1942, cacao, including abandoned and semiabandoned plantings, was grown on about 53 percent of the cultivated lands of the Coastal Region, while coffee, rice, and bananas occupied about 17, 11, and 7 percent, respectively. Data for recent years, ending in 1948, are not available. Estimates,

however, indicate a decrease in percentage of cultivated lands in coffee and cacao of about 6 and 10 percent, respectively, and an increase of about 7 and 10 percent in bananas and rice, respectively. The remainder of the cultivated lands, as shown in figure 6, was planted to cotton, sugarcane, citrus, and miscellaneous crops.

Complete abandonment of the plantations is more common in extremely humid zones with an absence of a pronounced dry season, but partial or semiabandonment is high throughout all regions, being estimated at approximately 50 percent for the country as a whole. In general, areas with small haciendas have a lower percentage of abandonment. Among the principal factors responsible for complete or semiabandonment are lack of capital for proper maintenance and the prevalence of diseases.

TYPES AND CHARACTERISTICS OF CACAO GROWN

Theobroma cacao, the only species of cacao grown commercially in the world, is traditionally classified into two broad groups: Criollo, white or pale vio-

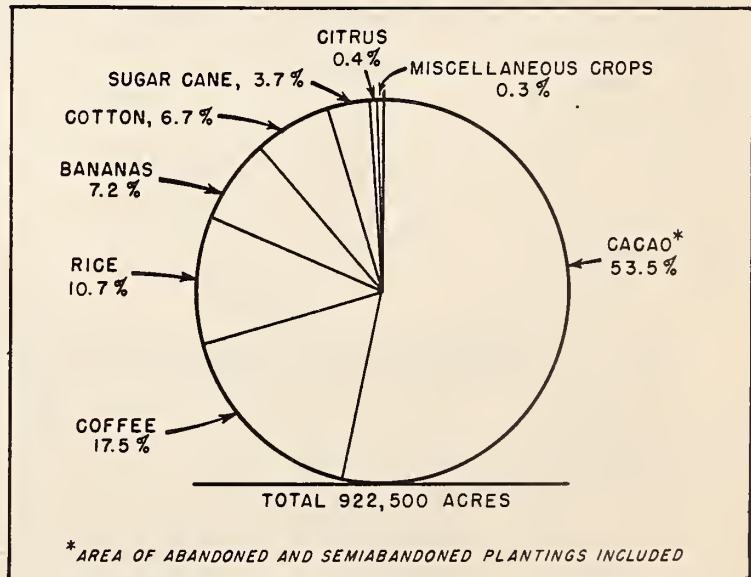


FIGURE 6.--Estimated crop distribution, Coastal Region, 1943.



FIGURE 7.--Semiabandoned cacao plantations are common in the Littoral. The leaning tree is cacao nacional.

let-seeded forms, and Forastero, purple-seeded forms. The Criollos occur in Central America and northern South America, while the Forasteros are found principally in the Amazon River Valley. Recently, Cheesman⁶ subdivided the Forasteros into two groups, separating the pure noncriollo populations from the hybrid populations of recent origin resulting from crosses between Criollos and Forasteros. These two groups are called Amazonian Forasteros and Trinitarios, respectively. All these groups are reported in Ecuador, but only Forasteros and Trinitarios have commercial importance.

Amazonian Forasteros

In Ecuador, this group is represented by cacao nacional, which possibly is indigenous to the Littoral. Cacao nacional is a tall, slender tree, 30 to 40 feet high, with a narrow usually one-sided crown. The trunk is generally free of low branches. Old trees are often bent over and in many cases nearly prostrate.

TABLE 2. - Number of trees, production, area of haciendas, and cacao planting by regions

REGION	NO. OF HDAS. VISITED	TOTAL ACREAGES		AVERAGE ACREAGES		AREA OF HDAS. IN CACAO	ESTIMATED NUMBER OF TREES			TREE RATIO NAC. VEN.	PRODUCTION			TREES PER ACRE
		HDAS.	CACAO	TOTAL HDAS.	CACAO		NAC.	VEN.	TOTAL		AVERAGE		TOTAL	
											ACRE	TREE		
		1,000 acres	1,000 acres	Acres	Acres	Percent	1,000	1,000	1,000	Ratio	Lbs.	Lbs.	1,000 lbs.	
Arriba	188	541	73.6	2,878	391	13.6	15,208	3,534	18,742	4.3	64	.25	4,698	255
Balao	24	482	30.6	20,083	1,275	6.4	7,181	2,781	9,962	2.6	105.	.32	3,212	326
Bahia	36	22	2.0	611	56	11.4	602	70	672	8.6	127.	.38	254	336
Machala	40	59	6.9	1,475	172	11.7	1,027	1,222	2,249	.8	154.	.47	1,060	325
Total	288	1,104	113.1	3,833	393	10.3	24,018	7,607	31,625	3.2	82.	.29	9,224	280

⁶ CHEESMAN, E. E. NOTES ON THE NOMENCLATURE, CLASSIFICATION AND POSSIBLE RELATIONSHIP OF CACAO POPULATIONS. Tropical Agriculture 21(8): 144-159. 1944.

The matured fruit is orange yellow in exterior color and because of its melonlike shape is called amelonado. Its walls are smooth, with 10 shallow furrows. Sometimes the fruits are warty and slightly constricted at the base. Eight to ten fruits, depending on the season, are required to produce a pound of dry cacao beans. The average number of beans per fruit is about 35.

Most of Ecuador's cacao is cacao nacional as is shown in table 2. The approximate numerical relationship of cacao nacional to cacao venezuela in all Regions is 3 to 1, with a range from about 1 to 1 in the Machala Region to 8 to 1 in the Bahía Region. The widest ratio, 70 cacao nacional trees to 1 cacao venezuela, occurs in the upper northeastern part of the Arriba Region. Approximately 59 percent of the total number of cacao nacional and venezuela trees are on haciendas in the Arriba Region.

Trinitarios

The Trinitarios of Ecuador comprise several foreign introductions known collectively as cacao venezuela. The first were made about 1890. Most of the introductions were from Venezuela and Trinidad, but a few came from Mexico and Guatemala. They were introduced because of earliness, heavy productivity, and wide adaptability to different soil types. The trees are erect, 15 to 25 feet high when mature, and usually have a more balanced crown than cacao nacional. Being a hybrid group, these foreign introductions produce a continuous series of fruit shapes, which are not always easily distinguished. The more important shapes are:

Angoleta - Fruit broad near stalk, apical end pointed, fruit wall warty and ridges deep.

Cundeamor - Fruit constricted (bottlenecked) near stalk end, apical and somewhat pointed, wall warty and ridges deep.

Amelonado - Fruit often slightly constricted at basal end, apical end, wall



FIGURE 8.--Cacao nacional produces an "amelonado" type of fruit, which occur principally on the trunk of the tree. Note the development of vertical branches of the old leaning trunk.



FIGURE 9.--A plant of cacao venezuela amarillo developed from a rooted cutting.

nezuela, and Central America. The interior color of the plump seeds is white rather than purple, as in the Forasteros. Some of the matured fruits are criollo-like, resembling angoleta, while others having a bottleneck resemble the cundeamor. This cacao type occurs sparingly in the Province of Pichincha near Santo Domingo de los Colorados and in the Province of Esmeraldas. It is said to occur also in the upper part of the Province of Los Rios.

A few introduced criollo trees were observed during the study.

Other Species

Other species occurring in the forest of the Littoral of Ecuador are Cacao Blanco, or Muricumbe

may be smooth and ridges shallow.

Calabacillo - Fruit small, round, smooth.

The most common pod shapes are amelonado and calabacillo. At maturity the pods may be either red or yellow. The types producing yellow matured pods are called cacao venezuela amarillo and those with red matured pods are called cacao venezuela morado.

Approximately 12 to 15 pods, each of an average of about 35 seeds, are required to produce 1 pound of dry cacao. The beans are considered inferior in quality to those of cacao nacional and in normal times do not command as high a price. Exporters say that this cacao is more susceptible to insect damage during storage than cacao nacional.

Criollo

In the Province of Esmeraldas, there occur scattered plantings of cacao whose growth habit resembles the criollo cacaos of Colombia, Venezuela, and Central America. The interior color of the plump seeds is white rather than purple, as in the Forasteros. Some of the matured fruits are criollo-like, resembling angoleta, while others having a bot-

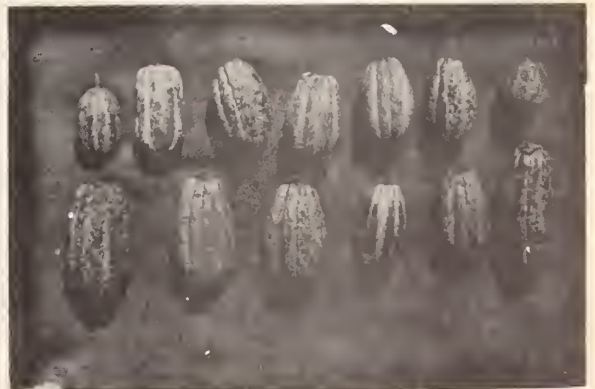


FIGURE 10.--The introduced types of cacao produced a wide variety of pod forms. The small, round fruit, called calabacillo, contains low-quality beans, while the larger ones, amelonado types, contain quality beans.

(*Theobroma bicolor*), and Cacao del Monte (*Herrania balaoensis*), but they have little or no commercial value.

YIELDS

Records for individual trees, unfortunately, are kept by haciendas in only a few instances. The highest yield per tree reported during this study was approximately 500 pods per year. These pods, however, were produced by a venezuela type called Pajarito (Calabacillo) and it would probably take 40 or more to make 1 pound of dry cacao. The annual average rates reported by many haciendas during the good years of production before the appearance of diseases were from 1 to 4 pounds of dry cacao beans per tree. This rate is now between one-fourth and one-third pound, with an average production of approximately 82 pounds per acre. The highest average yields, approaching 250 pounds per acre, were reported by haciendas in vicinity of Vinces, Los Rios, and Chone, Manabi. The lowest yield reported by a grower was 0.04 pound per tree. In the Arriba Region, there are two well-defined zones of production. The relative production rate for each Region is given in figure 2.

Cacao venezuela is reported to commence bearing when between 2½ and 4 years old and to reach maximum production between the ages of 8 to 10 years. Disease-free trees produce annually an average of about 50 pods per tree. Cacao nacional comes into bearing several years later and does not reach maximum production until after 15 years. Its annual production is less than that of cacao venezuela during its best years of production. The rate of production of venezuela declines when the trees are between 12 and 15 years old but continues many years for cacao nacional. Near the town of Baba, Los Rios, a planting of cacao nacional, with roots estimated to be 200 years old, was reported to be in production, with a yield still above average. The red-pod type of cacao venezuela is said to produce heavier than the yellow, but its life of productivity is shorter. Several cacao nacional trees were observed whose annual yield was said to have exceeded 160 pods.

The usual range in age of the trees observed in all regions is from 10 to 80 years, with the majority of the venezuela trees between 10 to 25 years old and the nacional trees usually more than 40. The most extensive planting of young cacao venezuela trees was observed in the Machala Region. Only a few plantings of young cacao nacional were observed.

CULTIVATION

Few cultural changes have been made in growing cacao during the past years. The machete still is the most commonly used implement.

Nursery

A few hacendados reported making new plantations as well as replacing old trees. Replacements or replanting of vacancies were not always made with the same variety predominating in the plantation resulting

in mixed planting of cacao nacional and cacao venezuela. The traditional method of establishing cacao consisted in planting the seed directly in the field, sowing from two to four seeds in holes usually made with a machete. When the seeds germinated the seedlings were not always thinned to one vigorous plant. Owing to this practice, old cacao trees, particularly cacao nacional, appear to have several trunks.

Care was taken, however, to select seeds from apparently the best pods, which in the case of cacao venezuela were from trees 3 and 10 years old, either of the yellow type or from cacao nacional-venezuela hybrids. Tree age was not an important factor in seed selection of cacao nacional. An effort was made, it was said, to secure pods from the branches rather than the trunks.

On a few haciendas it was a practice to establish nurseries generally under old cacao trees. This was usually done at the beginning of the rainy season; then 1 year later, the best plants were transplanted to the field.

Planting Distance

Planting distance varies considerably among haciendas. A majority of the trees observed were planted at a distance of approximately 8 by



FIGURE 11.--Selected cacao seedlings ready for planting. The propagating bins in the background are used for rooting cuttings.



FIGURE 12.--Cacao plants developed from rooted terminal portion of a branch (left) and from a chupon or sucker (right).

8 feet. On some haciendas the growers have thinned their stands in accordance with soil type, shade, and climate of the area. The range in spacing observed was from about 6 to 20 feet. Usually cacao nacional is more closely spaced than cacao venezuela. Several growers reported using a spacing of different widths in an attempt to control diseases.

The average number of trees per acre for all regions was found to be 280, with a range from 255 in the Arriba Region to 336 in the Bahía Region. On individual haciendas the number varied from 125 to 500 trees per acre. Many of the planters are recommending a spacing of approximately 13 by 13 feet for nacional. On rich soils the spacing of these two varieties may be increased by several feet.

Weeding, Pruning, and Fertilizing

Weeding of the plantations consists of cutting the weeds with machetes and windrowing the debris between the rows of cacao trees. Suckers, epiphytes, and diseased pods and shoots, which are within easy reach of the worker, also may be removed at this time. An effort is made to finish weeding before the brief showers begin -- often early in October -- because this is said to influence the flowering period.

In general, 47 percent of the plantations visited were cleaned once each year, just before harvest, while 42 percent of them were weeded twice each year, December through February and June through August, especially when there were prospects of a good harvest. Only the better producing stands, however, were weeded twice. Rarely are the plantations weeded three or more times annually.

Pruning was reported by a few growers as a common practice prior to the disease epidemics. It was effected on thin branches with cacao harvesting knives and on large branches or suckers with the machete. Rarely were pruning saws used. Pruning was discontinued because the financial returns received from the cacao crop did not justify the work. Now that the prices are favorable, however, growers are again giving attention to it. Occasionally the shade trees in the cacao groves were pruned or thinned.

A few hacendados also sprayed their trees in an effort to control disease but discontinued it because effective control was not realized.

The use of fertilizers and green manures is rarely if ever practiced on cacao plantations.

SHADE

In Ecuador, high shade is considered necessary for mature cacao trees. Both native and introduced trees are commonly used to provide this shade. The favorite introduced trees for years were palo prieto (*Erythrina glauca*) and perhaps other species of *Erythrina*, despite its brittleness and susceptibility to certain diseases of cacao and citrus. As yet no suitable substitute has been found to replace this leguminous tree. Several native and introduced guavas (*Inga* sp.) are also commonly used. In forested areas, timber trees, such as fernan sanchez (*Triplaris guayaquilensis*), laurel (*Cordia alliodora*), roble (*Tabebuia pentaphylla*), and cedro (*Ocotea* sp.), may provide shade, although they probably were left for their timber value. Frequently the best timber trees were removed at the time of clearing, leaving only the less desirable ones. Following the good market for balsa wood during the recent war, balsa (*Ochroma lagopus*) was also permitted to grow in the cacao plantations. Other species that have been used are: Marañón (*Anacardium excelsum*), majagua (*Poulsenia armata*), pechiche (*Vitex gigantea*), saman (*Samanea saman*), and guachapeli' (*Pseudosamanea guachapele*). Although several kinds of matapalos (*Ficus* spp.) provide shade in old cacao plantations, they never were planted but appeared as epiphytes on other shade trees. Fruit trees are also occasionally used. In the Balao Region, cana fistula (*Cassia fistula*) was tried but was found to be unsatisfactory.

A spacing of the permanent trees between 50 and 80 feet is said to provide medium shade, while a spacing less than about 40 feet is considered dense.

Approximately 74 percent of the hacendados reported that they were using a medium shade, while 6 percent were using dense shade. The rest of them reported that shade conditions were not uniform throughout the cacao plantations.

Approximately two-thirds of the growers stated that they had never made an effort to control the shade of their cacao plantations.

Temporary shade is usually provided where the land is completely cleared. The most commonly used species is plantain (*Musa paradisiaca*). Cassava, rice, corn, and other food plants are planted as cash crops and not necessarily as temporary shade. Temporary shade is usually established about 9 months before planting cacao. Provision for permanent shade is frequently made at the same time but may be delayed until the third year.

DRAINAGE

The problems of drainage are receiving less attention now than formerly. In certain sections, particularly in the southern portion of the Arriba Region, the rivers periodically inundate the land, and the roots of the trees may be in water-logged soil for several months during the rainy season.

IRRIGATION

Several small plantings of cacao under irrigation were observed near Portoviejo in the Bahía Region. The trees were about 2 years old, well developed and free from disease.

DISEASES AND PESTS

The two most important fungal diseases reported are witches'-broom (*Marasmius perniciosus*) and Monilia pod rot (*Monilia rozeri*).

Other diseases reported are, Sphaeronema pod rot (*Sphaeronema* sp.), Phytophthora pod rot (*Phytophthora palmivora*), anthracnose (*Colletotrichum* sp.), and die-back (*Diplodia theobromae* Norvell). Several unidentified root diseases occur but are apparently of minor importance.



Witches'-broom

This disease was reported in Ecuador in 1921 in the Balao Region and by 1926 was observed in all producing areas. The first report of

FIGURE 13.--A typical succulent green witches'-broom.

witches'-broom came from Surinam, but it is probably indigenous to the Amazon Valley. How it got to Ecuador is not known.

The disease manifests itself in three forms: Hypertrophied vegetative shoots, commonly called witches'-brooms or simply brooms; hypertrophied flower cushions, commonly called starbrooms; and malformed fruits. As yet, an alternate host has not been reported.

The months of heaviest infection are February, March, and April, but a few green brooms may be found throughout the year. Observations indicate that the disease appears first on the outside terminal shoots; later the infection moves inside the crown as the season progresses, producing starbrooms and small undeveloped indurated fruits. This condition is more commonly observed in cacao venezuela, particularly the red-pod type, than in cacao nacional. It is generally reported, however, that once the fruit of cacao nacional has reached a length of several inches its chances of this type of manifestation of witches'-broom disease decrease. One grower explained that this apparent increase in resistance was due to the development of the cuticle on the fruit.

The survey indicates a decrease in disease intensity from approximately 48 percent in the upper Arriba Region in the north to approximately 20 percent in the Machala Region in the south. Locally the severity of witches'-broom disease varies from 15 to 90 percent. No relationship appears to exist between disease intensity and areas of haciendas. Significant among the factors reported to be responsible for this wide differential are rainfall, cacao type, age of trees, shade conditions, altitude, and maintenance of trees.

Regarding disease susceptibility of the two principal cacao populations, cacao nacional trees appear to be more resistant and uniform in reactions to the disease; cacao venezuela, being more genetically unstable, segregates into a wide range of types with different degrees of susceptibility. These offer a greater possibility for obtaining resistance than do the more normal nacional population. This is evidenced by there being a few lightly infected trees in the midst of a stand of heavily infected ones. The incidence of witches'-broom on cacao nacional was estimated at 30 percent and on cacao venezuela at 35 percent. These estimates were based on an average percentage of total shoots infected.

Observations indicate that isolated trees often escape the disease. As cacao venezuela produces more growth flushes each year, it has a greater opportunity to become infected since the fungus enters the growing point.

Some of the red-pod types of venezuela seem to be very susceptible to shoot infection. In



FIGURE 14.--Diseased immature fruits of cacao infected by witches'-broom.



FIGURE 15.--Interior branch of a cacao tree of the red-pod type of Venezuela, showing diseased flower cushions and indurated fruits caused by witches'-broom. Infected flowers, called starbrooms, may remain attached even after they are dead.

Region, the seeds came from the upper Arriba Region near the town of Ventanas. Frequently these selections, called refractories, are actually not immune but appear to be escape and sooner or later become infected. One notable example was the wide distribution, principally in the Arriba Region, of seeds from supposedly resistant selections made by several haciendas shortly after the appearance of witches'-broom. Observations of thousands of these trees during this study indicate that they possessed little if any resistance to witches'-broom.

A relationship between age and reaction to witches'-broom was also reported for the different varieties. Young cacao nacional plants appear to be more susceptible to the disease than young cacao venezuela, but the reverse was reported for adult trees of the two varieties.

Monilia Pod Rot

This disease was first observed about

the Machala Region, for example, an average of approximately 40 percent of the shoots of the red type were infected, as compared with only about 15 percent of the yellow type.

In general the lower quality types, calabacillo, appear to possess more resistance than the higher quality. One in particular called Blanco Calabacillo, because of its whiteness in fruit color, was reported to be relatively resistant to witches'-broom. Although this type was observed in the Balao



FIGURE 16.--Seedlings of cacao nacional. Plants at left are infected with witches'-broom disease.

1914 in the upper Arriba Region near the town of Quevedo, and in 1933 it was identified as *Monilia roreri* by Ciferri and Parodi.⁷ Before its identity was established, it was called Quevedo disease and watery disease. Pod losses throughout all growing regions are high, with the heaviest being reported from haciendas in the more humid parts of Arriba and Machala Regions. The average loss for all Regions was estimated at 40 percent. There appears to be no relationship between incidence of *Monilia* pod rot and total area of the plantation. One of the areas of least infection occurs in the Arriba Region along the Puebloviejo and Caracol Rivers.

The principal season of infection is from March to May in the Arriba Region and from March to July in the Machala Region. During these months, fruit losses, particularly of cacao venezuela, may reach 98 percent some years. December is the month of least infection.

It is not known exactly when infection occurs during the development of the fruit. One grower who is a close observer thought that it occurred after the pods were about a month old. Gradually the disease spreads internally throughout the fruit and changes the pulp and seeds into a watery mass.

The introduced varieties appear to possess less tolerance to *Monilia* pod rot than cacao nacional. The yellow-pod types of cacao venezuela are believed to be more resistant to *Monilia* than the red-pod types. Humid weather or damp environments seem to favor heavier infection.

No effort is being made by hacendados to control *Monilia* pod rot. Heavily infected pods are left on the trees and lightly infected ones are harvested. Several growers attempted unsuccessfully to control *Monilia* pod rot for several years by collecting all diseased pods at regular intervals and burying them in pits with lime. Only one grower reported making selections

of cacao trees that appeared to be resistant, but later he abandoned the project.

Other Diseases

Of the other diseases reported, *Sphaeronema* pod rot is the most important. In the more humid regions, certain growers reported upwards of 30 percent damage. This disease becomes evident



FIGURE 17.--*Monilia* pod rot is one of the most serious fruit diseases of cacao.

⁷ CIFERRI, R. E. PARODI, E. DESCRIZIONE DEL CHE CAUSA LA "MONILIASI" DEL CACAO. *Phytopathologische Zeitschrift*. 6: 539-542. 1933.



FIGURE 18.--Cross-section of diseased fruits. Left, *Monilia* pod rot, showing the seeds enveloped in a watery tissue. Note the droplet of excess liquid below the fruit. Right, *Sphaeronema* pod rot.

on matured pods as a dark spot, and, as the fungus develops, the content of the fruit is converted into a hard dry brown ball from which it is difficult to extract the seeds. If the fruits are allowed to remain on the tree when ripe, the losses from *Sphaeronema* pod rot increase. Off-season fruits are frequently attacked by this disease. *Sphaeronema* also causes a bark rot, gaining entrance through insect damages and cuts, particularly those made by machetes; hence, the common name,—"machete disease."

Epiphytes, such as aroids, ferns, mosses, and many kinds of climbers, are common on neglected trees, particularly in the humid regions. These plants do little serious damage in well-kept plantations where they are controlled. Among the parasitic plants occurring on cacao, bird vine or mistletoe (*Loranthaceae*), is the most important. When fully developed, it produces a dying-back effect of the branches.

Insect Pests

Insects cause damage each year, chiefly through destroying the foliage and twigs by eating the leaf blades or boring into the twigs or stems. Unshaded trees seem to be more affected. Of the various kinds of insect pests that attack cacao, lepidopterous larvae are the most destructive. Bark beetles, leaf-cutting ants, leaf hoppers, and thrips also cause damage, which may facilitate the entry of diseases. One of the worst pests is a long-horned beetle called cacao beetle (*Steirastoma depressum*). The larvae of this species tunnel into the young branches, and the adults feed on the bark, causing serious local injury and occasionally complete ringing of the branch.

In the Machala Region a chinch bug (*Monalonian atratum* and *M. dissimulatum*) occasionally is a serious cacao pest, attacking fruits of all sizes.

Animal Pests

Among the animal pests of cacao, squirrels (*Sciurus* sp.) are the most destructive. In some old plantings it is estimated that they destroy



FIGURE 19.--Squirrels often destroy a large number of fruits.

peckers, cause some direct damage by picking holes in the pods. Birds are also responsible for the dissemination of seeds of many epiphytes occurring on cacao trees.

40 percent of the pods. The usual control measure, practiced with some degree of success, consists of offering a bounty of several cents for the tail of each dead squirrel.

Other pests such as rats and the kinkajou (*Potos* sp.), also destroy a large number of pods annually. These arboreal animals, as well as squirrels, breed in abandoned or partially abandoned plantations.

Birds, particularly parrots and wood-

CACAO SELECTIONS

During the survey more than 500 trees were located for study. From this group, 339 were finally selected and, by means of budding and rooting of cuttings, were established at the Tropical Agricultural Station. These selections are the basis of the cacao-improvement program.

Of these selections, 265 were made in the Arriba Region, 36 in the Balao, 20 in the Bahía, and 18 in the Machala Region. These trees were chosen for one or more of the following characteristics: High yield and resistance or tolerance to *Monilia*-pod rot and witches'-broom. For each selection, reference data relating to tree description, production, and location on hacienda were obtained.

HARVESTING AND MARKET PREPARATION

There are two well-defined harvest seasons for cacao, February-May and July-November. Cacao national produces one crop each year, which is harvested principally from February to May. Cacao venezuela, however, produces two, with the

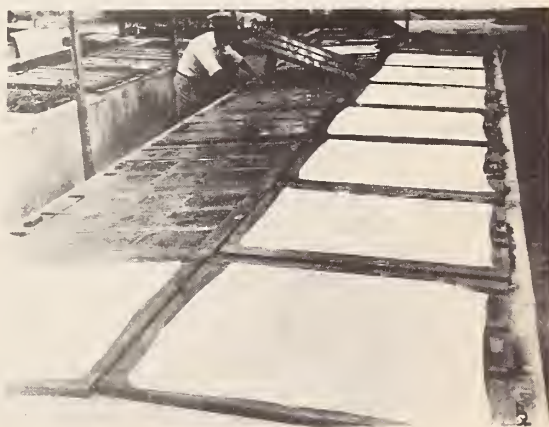


FIGURE 20.--Special propagating bins are used for rooting cuttings of cacao.



FIGURE 21.--Cacao cuttings require from 30 to 45 days to develop a root system. To stimulate faster root development the cuttings are treated with a root inducing chemical.

main harvest in August and September and a light one during April and May. The variations in harvesting seasons in the several regions are indicated by figure 22, which shows the monthly proportion of each type of cacao entered on the Guayaquil market. Such fluctuations are due primarily to the climate and the predominate types of cacao grown in the various regions.

Approximately 58 percent of the total exports of cacao are produced in the Arriba Region. Machala is now second with about 18 percent, and Balao, Bahía, and Naranjal each contribute a total of about 8 percent, as shown in figure 22.

In 1916, peak year of production, the proportion of the exports contributed by Arriba, Balao, Machala, and Bahía were 68, 20, 7, and 6 percent, respectively. Balao has sustained the

heaviest loss in production, while Machala has made the greatest gain.

Harvesting

The method of harvesting cacao is relatively simple. A cacao picker cuts the pods from the trees with a flat, triangular-shaped knife attached to the tip of a long bamboo pole, so that the cutting edge, about 2 inches long, is uppermost and perpendicular to the axis of the handle. A boy retrieves the felled pods. These pods are then taken to a designated place where women or children crack them and remove the beans. The beans are then transported in canvas bags by mule or burro to the drying platform.

Fermentation

In Ecuador, cacao beans are never fermented in tanks or boxes. When the beans are brought in from the field, they are covered and left in small heaps for one or more days to permit fermentation and to allow the mucilage to liquify and drain off. Then the beans are ready for drying on the platforms.

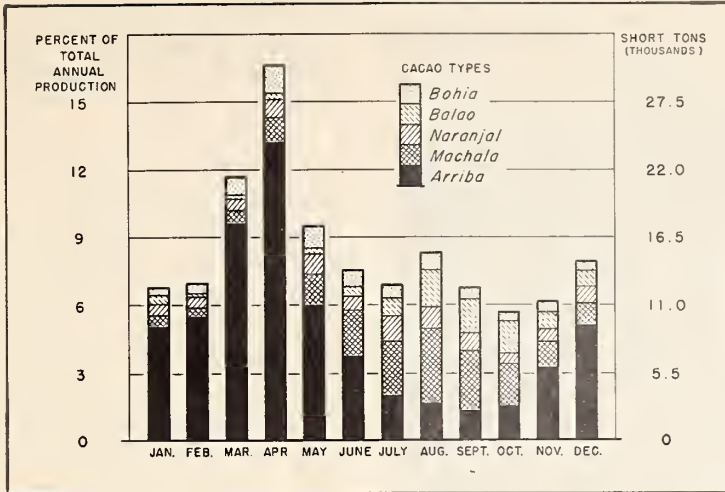


FIGURE 22.--Monthly proportion and amount of each cacao type entered annually on the Guayaquil market, 1941-47.

Exporting firms report that, of the several grades, Superior grades, Superior Red Summer Arriba is best prepared, with approximately 75 to 85 percent of the beans well cured or fermented (table 3). About 20 percent of the beans have regular fermentation, and from 6 to 9 percent have little or none. Less than 1 percent of the beans are moldy, weevily, slaty, flat, or broken. Cosecha Navidad, or

Christmas Harvest, is second best in preparation, having from 40 to 65 percent of the beans well fermented, about 20 percent of them with average fermentation, and about 14 percent with little fermentation. The percentage of bad beans, however, is less than 1. Cacao Epoca has a lower percentage of well-fermented beans and a higher percentage with regular fermentation. The proportion of bad beans may reach 5 percent.

Drying

Drying consists in spreading the beans out on platforms in the sun each day for a period of about a week. To insure even drying, the beans are continually turned over. Diseased and bad beans are hand-separated from the good. A few growers clean and polish the beans when they become moldy by heaping them in small piles, adding a small amount of water, and then stirring them rapidly.

Bagging

When dry, the beans are weighed into bags holding 150 to 175 pounds. Owing to the



FIGURE 23.--Cacao beans drying in the sun. Workers turn the beans over with their feet to insure uniform drying.



prevailing humid atmosphere and the danger of the beans absorbing moisture and spoiling, growers as a rule do not store the bags long before shipping them to Guayaquil. If the exporter is obliged to redry and rebag the beans owing to excessive moisture content, the grower is penalized a certain percentage of the weight of the cacao. For the privilege of using the streets of Guayaquil as drying platforms, the exporter pays the city a rental of approximately one-tenth of a cent per day per square meter.

FIGURE 24.--After the cacao beans are dried, they are sacked, weighed, and made ready for shipment to market.

tenth of a cent per day per square meter.

Marketing

When marketed, both cleaned and uncleaned cacao beans are frequently mixed together. Approximately 80 percent of the beans are sold by planters directly to exporters. In several instances, however, companies

TABLE 3. - Analysis of the interior characters of commercial grades of cacao 1942-47

COMMERCIAL GRADES	FERMENTATION				DAMAGED BEANS			RESIDUES
	GOOD	REGULAR		LITTLE OR NONE	EXCESSIVE MOISTURE, INTERIOR WHITE	DISEASE, INTERIOR YELLOW	INSECT	CRUSHED FLAT OR EMPTY
	RED-BROWN OR BROWN	GRAYISH-BROWN	VIOLET OR BLUE CHEESY OR SLATY	VIOLET OR BLUE CHEESY OR SLATY				
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Selected Superior Red Summer Arriba. . .	84.43	1.39	7.63	6.20	0.22	0.00	0.00	0.13
Superior Red Summer Arriba.	76.85	4.53	8.76	8.65	.49	.11	.01	.60
Cosecha Navidad or Christmas Harvest. . .	65.40	10.32	10.14	13.66	.16	.16	.00	.16
Cacao Epoca	55.70	18.33	11.58	11.04	1.54	.36	.16	1.29
Seasons	54.10	24.10	9.90	7.40	2.20	.90	.70	.70
Machala Corriente . . .	46.90	22.00	12.80	14.22	2.44	.33	.16	1.15
Segunda	52.47	17.96	6.40	10.40	7.87	.67	1.00	3.23

who control a number of haciendas arrange for the sale and export of their product themselves. Several exporting firms have representatives in New York and other important marketing centers.

Transportation

Most roads in Ecuador are of dirt and passable only during the dry season. As the principal harvest of Arriba cacao is carried on during the rainy season, growers in the Guayas Valley must ship their cacao to

TABLE 4. - Average expenses involved in shipping cacao from an hacienda in Ecuador to the United States

	<i>United States cents per hundredweight</i>
A. EXPENSES OF GROWER:	
1. Transportation charges from hacienda to port of embarkation:	
(a) Arriba Region:	
Babahoyo-Guayaquil (about 50 miles).....	31.7
Quevedo-Guayaquil (about 171 miles)	34.1
(b) Machala Region:	
To Guayaquil (about 86 miles).....	45.5
(c) Bahía Region:	
Chone-Guayaquil (about 260 miles)	36.3
(d) Balao Region:	
Balao-Guayaquil	18.4
2. Handling charges at port of embarkation, Guayaquil:	
(a) Pier tax	2.5
(b) Portage	2.5
(c) Service of exporters in weighing, sacking, etc.	6.7
(d) Municipal tax:	
Tax collected for cacao originating or passing through municipality:	
(1) Guayaquil	0.6
(2) Vinces	4.3
(3) Quevedo	4.3
(4) Baba	2.5
(5) Pueblo Viejo	4.3
(6) Urdaneta	4.3
(7) Balzar	1.8
(e) Revenue stamps	1.8
(f) Miscellaneous expenses:	
(1) Penalty deducted by exporter for excessive moisture, dirtiness, etc.	30.0 or more
(2) Sales commission ¹	60.0
(3) Agricultural Association of the Provinces of Manabí	7.0
B. EXPENSES OF EXPORTER (GUAYAQUIL):	
1. Cleaning, drying, classifying, sacking, etc.:	
(a) Washing	7.3
(b) Sun-drying	2.5
(c) Classification	2.5
(d) Piling of beans for sacking	0.6
(e) Cost of empty sacks	36.8

See footnote on page 28.

TABLE 4. - Average expenses involved in shipping cacao from an hacienda in Ecuador to the United States - continued

	<i>United States cents per hundredweight</i>
B. EXPENSES OF EXPORTERS (Guayaquil): Continued	
1. Cleaning, drying, classifying, sacking, etc.: Continued	
(f) Sacking	3.0
(g) Handling of sacks	2.5
(h) Twine for sewing sack	0.6
(i) Sewing sack	0.6
(j) Marking sack	0.6
2. Municipal tax for use of street space for drying cacao, about 1 cent per 11 square feet	
3. Municipal pier tax	1.2
4. Pier handling charges	4.3
5. Loading charges on lighter	3.4
6. Port charges collected by National Government ¹	6.8
7. Export taxes:	
(a) Antituberculosis Society	0.3
(b) Ecuadorean Cultural Institute	2.3
(c) National Government	1.5
8. Charges of the Central Bank of Ecuador¹	
(a) Commission	0.1
(b) Bank tax	0.6
9. Ocean Freight:	
(a) Guayaquil to New York	115.0
(b) Guayaquil to New Orleans	115.0
(c) Guayaquil to San Francisco	101.2

¹ Calculated at U. S. \$30.00 per 100 pounds - average price in 1947.

market by river launches. Small coastwide boats also are frequently used to ship cacao from the Provinces of Manabi and El Oro to Guayaquil.

The cost of shipping cacao in the river launches has not been fixed and is quite elastic, depending on competition and the level of the river. The average charge for shipping cacao to Guayaquil from the several producing regions is given in table 4. These figures also include railroad charges where involved.

In the Bahía Region and to a lesser extent in the Machala Region, railroads are used for transporting cacao to the ports of embarkation for shipment to Guayaquil.

DIRECTION OF MOVEMENT OF CACAO

Europe has long been the principal market for Ecuadorean cacao, with Germany, Holland, and France being the largest buyers. During World Wars I and II this market was closed, and the United States purchased about 80 percent of the cacao exported. The direction of movement of cacao and value in dollars for the years 1916-47 are given in table 5.

Guayaquil is the principal port from which cacao is exported. A small amount of cacao is shipped directly to Peru from the Machala Region and to Colombia from Esmeraldas and Bahía.

CACAO-PRODUCTION STATISTICS

Production, based on export records, shows wide annual fluctuations. The trend nevertheless was upward, reaching a peak of approximately 50,000 short tons in 1916; then production declined to about 12,000 short tons in 1933, as shown in figure 25 and table 6.

The average annual production for each region during the years 1941 to 1947 as indicated by Guayaquil export records are:

	Volume (Short tons)	Value (Dollars)	Percent
Arriba.....	10,664.04	2,945,177.28	57.50
Balao.....	1,451.34	404,641.75	7.90
Machala.....	3,440.99	947,578.77	18.50
Bahía.....	1,409.68	389,275.61	7.60
Naranjal.....	1,578.11	435,374.03	8.50
Total	18,544.16	5,122,047.44	100.00

CONSUMPTION

Little cacao is prepared or consumed locally. Usually the best grades are exported. In 1938 the national consumption was estimated at 1.1 percent of production increasing to 15.2 in 1939 but decreasing to 5.3 in 1942.⁸ Estimates for later years are not available.

PRODUCTION COSTS

Data concerning the cost of producing 100 pounds of dry cacao are difficult to obtain and not too reliable. In general, the cost varies from about \$3.70 to \$8.15, with the higher costs being reported from Balao and Arriba Regions.

This wide range is the result of many factors, which include area of the hacienda, number of employees, wages, productive rate of trees, distance of cacao trees to drying platforms, days required for drying cacao, and cost of weeding.

⁸ DIRECCION NACIONAL DE ESTADISTICA. ECUADOR EN CIFRAS, 1938 a 1942. Quito, Ecuador. 1944.

TABLE 5. - Percentage distribution of Ecuadorean cacao exports to principal countries and value in dollars, 1946-47 CONTINUED

COUNTRY	1916		1917		1918	
	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE
	Percent	\$1,000	Percent	\$1,000	Percent	\$1,000
United States ..	49	5,457	82	7,019	91	7,169
England	28	3,063	(1)	34	4	377
France	11	1,481	11	1,131	--	--
Holland	6	766	--	--	--	--
Spain	4	532	5	469	3	266
Italy	--	--	1	56	--	--
Chile	--	--	--	--	1	56
Colombia	--	--	--	--	1	44
Other Countries	2	309	1	70	0	46
Total	100	11,608	100	8,779	100	7,958

See footnote at end of table.

TABLE 5. - Percentage distribution of Ecuadorean cacao exports to principal countries and value in dollars, 1916-47 CONTINUED

COUNTRY	1919		1920		1921	
	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE
	<i>Percent</i>	<i>\$1,000</i>	<i>Percent</i>	<i>\$1,000</i>	<i>Percent</i>	<i>\$1,000</i>
United States ..	42	6,364	65	9,287	37	2,135
England	17	2,038	16	2,766	-	-
France	29	3,456	2	296	7	452
Holland	-	-	6	926	7	444
Spain	5	598	-	-	5	377
Germany	-	-	5	508	35	2,203
Panama	4	582	-	-	-	-
Other Countries	3	678	6	104	9	597
Total	100	13,716	100	13,887	100	6,208
	1922		1923		1924	
United States ..	47	3,349	56	2,215	40	2,468
England	3	238	4	161	5	306
France	7	515	4	172	6	360
Holland	14	1,067	9	352	18	1,113
Germany	16	1,150	12	451	21	1,281
Other Countries	13	916	15	618	10	709
Total	100	7,235	100	3,969	100	6,237
	1925		1926		1927	
United States ..	47	3,791	49	2,418	36	2,505
England	5	369	-	-	-	-
France	9	665	13	716	17	1,370
Holland	11	886	11	559	14	1,080
Spain	-	-	5	245	6	470
Germany	16	1,247	11	573	17	1,282
Other Countries	12	1,020	11	603	10	774
Total	100	7,978	100	5,114	100	7,481
	1928		1929		1930	
United States ..	39	2,228	44	592	34	1,589
England	-	-	-	-	4	187
France	12	768	9	370	11	491
Holland	10	634	12	485	14	662
Spain	6	325	4	164	4	168
Germany	19	1,145	18	749	21	975
Italy	-	-	-	-	3	128
Other Countries	14	808	13	602	-	-
Belgium	-	-	-	-	2	85
Denmark	-	-	-	-	3	128
Austria	-	-	-	-	2	113
Sweden	-	-	-	-	2	109
Total	100	5,908	100	2,962	100	4,635
	1931		1932		1933	
United States ..	34	786	34	658	41	584
Holland	15	368	8	171	10	142
England	3	81	8	173	4	61
Spain	4	82	3	157	3	39

TABLE 5. - Percentage distribution of Ecuadorean cacao exports to principal countries and value in dollars, 1918-47 CONTINUED

COUNTRY	1931		1932		1933	
	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE
	Percent	\$1,000	Percent	\$1,000	Percent	\$1,000
France	8	181	9	191	9	142
Germany.....	20	559	20	391	14	206
Italy	3	79	3	73	6	92
Belgium	5	111	3	69	5	67
Denmark	2	92	4	87	5	61
Austria	3	83	5	102	2	58
Sweden	3	65	3	66	1	15
Total	100	2,487	100	2,138	100	1,467
	1934		1935		1936	
United States ..	16	1,297	39	904	30	904
England	6	166	7	171	4	105
France	9	245	3	92	7	240
Holland	15	394	5	153	8	227
Spain	3	86	1	42	(1)	33
Germany.....	25	627	33	737	35	1,081
Italy	5	131	2	58	2	52
Belgium	4	91	4	108	6	192
Denmark	2	59	2	46	2	79
Austria	14	67	3	67	"	109
Sweden	1	20	1	25	2	50
Total	100	3,183	100	2,403	100	3,072
	1937		1938		1939	
United States ..	27	107	22	612	46	1,134
England	1	58	2	53	5	125
France	3	134	2	53	3	84
Holland.....	4	286	5	157	9	227
Germany	52	2,478	56	1,627	16	349
Italy	2	82	2	53	3	81
Belgium.....	3	111	2	87	9	250
Denmark.....	1	53	2	78	4	111
Austria.....	5	243	-	-	-	-
Sweden	1	26	1	41	2	66
Norway	(1)	2	(1)	6	(1)	5
Switzerland	1	7	-	-	(1)	2
Peru	-	-	(1)	6	(1)	3
Chile	-	-	1	14	(1)	6
Argentina.....	-	-	1	16	(1)	8
Uruguay	-	-	(1)	4	(1)	3
Bolivia	-	-	1	12	(1)	4
Czechoslovakia .	-	-	2	62	(1)	8
Finland	-	-	(1)	2	(1)	1
Poland	-	-	1	25	(1)	10
Yugoslavia	-	-	(1)	1	(1)	5
Australia	-	-	(1)	8	1	22
Palestine	-	-	-	-	(1)	4
Panama	-	-	-	-	(1)	1
New Zealand	-	-	-	-	(1)	10
Total	100	3,587	100	2,916	100	2,519
	1940		1941		1942	
United States ..	86	1,552	96	2,185	78	2,080
England	3	79	1	3	(1)	4
France	(1)	4	-	-	-	-
Holland	(1)	5	-	-	-	-
Germany	(1)	4	-	-	-	-
Italy	4	109	-	-	-	-
Belgium	2	50	-	-	-	-
Sweden	1	28	-	-	-	-
Norway	(1)	3	-	-	-	-

See footnote at end of table.

TABLE 5. - Percentage distribution of Ecuadorean cacao exports to principal countries and value in dollars, 1916-47 CONTINUED

COUNTRY	1940		1941		1942	
	AMOUNT	VALUE	AMOUNT	VALUE	AMOUNT	VALUE
	Percent	\$1,000	Percent	\$1,000	Percent	\$1,000
Switzerland.....	1	6	1	19	-	-
Mexico	-	-	-	-	7	18
Peru	(1)	(2)	(1)	4	4	99
Colombia	-	-	-	-	7	227
Chile	(1)	3	1	34	2	65
Argentina	1	11	1	17	1	22
Uruguay	(1)	3	(1)	5	(1)	3
Bolivia	(1)	1	(1)	25	1	28
Australia	1	19	-	-	-	-
Panama	(1)	4	-	-	-	-
Total	100	1,881	100	2,292	100	2,546
	1943		1944		1945	
United States.....	85	324	84	2,478	68	2,647
Denmark	-	-	-	-	(1)	2
Norway	-	-	-	-	(1)	(2)
Switzerland	2	86	3	88	2	92
Mexico	3	108	-	-	2	67
Colombia.....	3	112	4	128	19	815
Peru	5	168	3	60	3	99
Chile	1	26	2	155	2	87
Argentina	1	26	1	15	1	35
Uruguay	(1)	6	(1)	8	(1)	7
Bolivia	(1)	18	1	21	1	20
Panama	-	-	-	-	(1)	7
Guatemala	-	-	1	38	-	-
France	-	-	-	-	(1)	(2)
Total	100	874	100	2,990	100	3,969
	1946		1947			
United States	47	2,663	74	1,019		
Holland	8	404	2	39		
Italy	1	60	2	38		
Belgium	2	129	8	106		
Denmark	2	129	(1)	(2)		
Sweden	4	224	1	7		
Norway	2	112	-	-		
Switzerland	5	265	(1)	2		
Mexico	3	119	-	-		
Colombia	22	1,191	10	150		
Peru	2	63	(1)	2		
Chile	1	105	1	13		
Argentina	(1)	26	1	13		
Uruguay	(1)	6	-	-		
Bolivia	1	19	(1)	6		
Finland	-	-	(1)	8		
Australia	-	-	(1)	(2)		
Costa Rica	(1)	1	-	-		
China	(1)	17	-	-		
Cuba	-	-	(1)	10		
Egypt	-	-	(1)	8		
Puerto Rico	-	-	(1)	(2)		
Palestine	(1)	18	(1)	20		
Total	100	5,550	100	1,441		

¹ Less than 0.5 percent.

² Less than \$1,000.

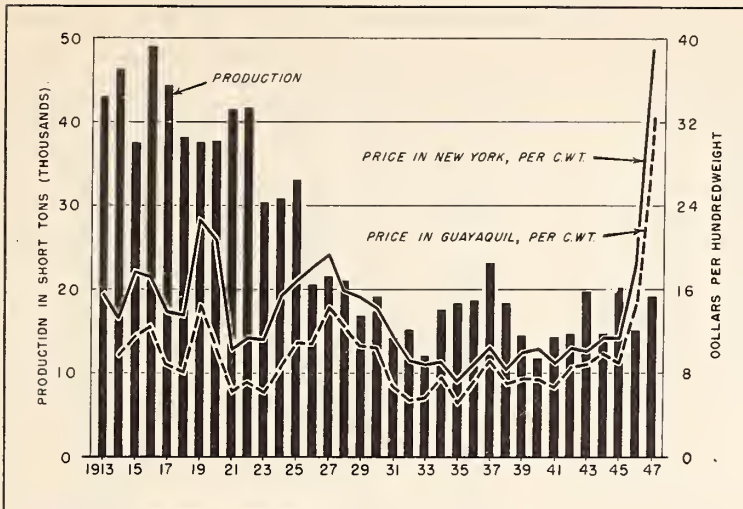


FIGURE 25.--Annual production and average annual market price of cacao "Superior Arriba" in New York and Guayaquil, 1913-47.

never been established by law. Yet, three commercial superior grades are offered for sale by exporters. They are: (1) Superior Red Summer Arriba, (2) Cosecha Navidad, or Christmas Harvest, and (3) Cacao Época, cacao corriente, or seasons arriba. Each of these grades may be separated into American and European qualities on the basis of the size and shape of the beans. The American market will accept a mixture of plump and flat beans, while the European market prefers plump ones of uniform size and will pay a bonus of from \$2.50 to \$3.00 per hundredweight.

Even though sets of grades for cacao have not been officially devised, cacao exporters have developed classification methods over a period of many years that enable them to maintain their quality standards within a margin of about 5 percent from one shipment to another or from one year to another.

One export company of Guayaquil, in standardizing its commercial grades, estimated that during a period of 28 years, approximately 90,000 bags of cacao were samples. Summaries of exterior and interior characteristics of cacao as well as bean measurements obtained in this important study are given in tables 3, 8, and 9, respectively.

Each cacao grade exported from the country has its own characteristics, which are based largely on adequacy of curing, region of origin, quality, time of year harvested, climatical conditions of the producing region, and the kind of cacao tree producing it. Certain regions, being more favorable than others for the culti-

An itemized list of expenses involved in producing 100 pounds of dry cacao in the Arriba Region on an hacienda with a calculated production rate of 100 pounds per acre and a daily wage scale of 76 cents for men and 67 cents for women and children is given in table 7.

CLASSIFICATION AND GRADING

Provision for classifying and grading Ecuadorian cacao has



FIGURE 26.--Dried cacao beans of the commercial grade, Superior Red Summer Arriba.

TABLE 6. - Cacao exports from the port of Guayaquil, Ecuador, 1840-1947

YEARS	AMOUNT	YEARS	AMOUNT	YEARS	AMOUNT
	<i>Short tons</i>		<i>Short tons</i>		<i>Short tons</i>
1840	7,133	1876	11,049	1912	36,446
1841	5,706	1877	10,266	1913	42,954
1842	3,354	1878	5,165	1914	46,106
1843	7,732	1879	15,767	1915	37,337
1844	4,287	1880	16,940	1916	49,002
1845	4,864	1881	11,062	1917	44,402
1846	5,606	1882	10,189	1918	38,014
1847	6,037	1883	7,503	1919	37,523
1848	10,504	1884	8,847	1920	37,723
1849	7,118	1885	12,037	1921	41,352
1850	5,534	1886	19,318	1922	41,639
1851	4,784	1887	16,711	1923	30,326
1852	6,983	1888	13,850	1924	30,863
1853	6,622	1889	12,325	1925	33,090
1854	5,496	1890	18,127	1926	20,471
1855	7,545	1891	10,539	1927	21,458
1856	6,637	1892	16,744	1928	20,975
1857	7,383	1893	20,257	1929	16,753
1858	9,910	1894	19,565	1930	19,096
1859	6,809	1895	18,056	1931	14,159
1860	8,381	1896	12,164	1932	15,065
1861	9,339	1897	16,565	1933	11,961
1862	8,013	1898	21,120	1934	17,546
1863	8,200	1899	25,972	1935	18,380
1864	5,725	1900	19,179	1936	18,624
1865	7,134	1901	24,447	1937	22,500
1866	11,253	1902	23,374	1938	18,374
1867	9,863	1903	22,801	1939	14,468
1868	5,617	1904	29,694	1940	11,663
1869	8,675	1905	20,161	1941	14,397
1870	12,156	1906	23,014	1942	14,738
1871	8,621	1907	19,919	1943	19,695
1872	9,362	1908	31,597	1944	14,726
1873	12,298	1909	31,033	1945	20,119
1874	12,374	1910	37,638	1946	15,127
1875	8,176	1911	40,321	1947	19,143

vation of this crop, produce a higher quality of cacao that is more highly esteemed by the cacao manufacturer.

The first grade of cacao, Superior Red Summer Arriba, consists almost exclusively of beans of cacao nacional from the Arriba Region in the vicinities of Vinces, Pueblo Viejo, Baba, Catarama, Quevedo, and Balzar, where the oldest plantations of cacao nacional exist. This grade is usually separated by exporters into two commercial subgrades: Selected Red Summer Arriba and Superior Red Summer Arriba. The beans of the former are larger, heavier, and have less wall tissue than the latter. In fact, the beans are larger than those of all three export grades, as is seen in table 9. As already indicated, the Arriba Region is the most important producing area in Ecuador as far as quantity and quality are concerned.

The second grade, Cosecha Navidad, generally limited in amount, also contains beans of cacao nacional. It is harvested usually from December through January, but the season may extend into February.

A third grade, Cacao Época, contains cacao harvested throughout the year primarily in regions other than those producing the first or second grades. This grade exhibits a wide variation in shape, size, and inte-

rior as well as exterior color of the beans and consists mostly of cacao venezuela.

In addition to the above three grades, there may be others, such as Machala Superior, Machala Corriente, Bahía de Caráquez, and Segunda. The inferior grade, Segunda, may be consumed locally or exported to countries with no rigid entrance requirements.

Before cacao may be exported, the law requires that the lot be inspected by the Office of Control of Exportation as provided in article 6 of Executive Decree No. 1285, October 31, 1941. This inspection consists of checking the weights of bags and determining whether the lots meet the conditions specified by the exporter in the transaction. The Department of Sanidad Vegetal may also inspect the lots of cacao, but this is not necessary.

PRICE

The f.o.b. Guayaquil market price of the several grades of Ecuadorean cacao is determined largely by the New York spot price and is several cents lower than the New York quotation, as shown in figure 25. The price received by the grower for his cacao, however, may be lower owing to penalties imposed by the buyers because of dirtiness, excessive dampness, defectiveness, lack of quality, or improper preparation.

Cacao is subjected also to a number of national, provincial, and municipal taxes, a part of which the grower absorbs. A list of the principal expenses and taxes incurred by the producer and exporter are given in table 4.

Middlemen buy small lots of cacao at prices considerably below market price, then mix and sell them to the exporters. This cacao is

TABLE 7. - *Estimated cost of weeding and harvesting an acre of cacao on plantations, assuming an average production of 100 pounds per acre*

	Dollars
WEEDING:	
Twice per year (9 workers).....	3.55
HARVESTING:	
Two pickers.....	1.14
Two assistants.....	1.00
TRANSPORTATION OF FRESH CACAO TO DRYING PLATFORM:	
One boy (including rental of mule).....	.39
DRYING OF CACAO (including cleaning and sorting):	
One attendant (6 days required for 1,000 pounds).....	.48
WAREHOUSE EXPENSES: (10 workers required to handle 10,000 pounds)	
Weighing, sacking, marking, and shipping.....	.06
Sacks and string for 100 pounds.....	.39
Miscellaneous expenses (tools, etc.).....	.07
Total expenses.....	\$ 7.08
NOTE: Wages calculated as follows:	
Men at.....	\$0.76 per day
Women and children at.....	.67 per day

TABLE 8.- Analysis of the external characters of commercial grades of cacao
1928-41

COMMERCIAL GRADES	HARVEST SEASON	NORMAL BEANS, COLOR			BAD OR DAMAGED BEANS							
		LIGHT	MEDIUM	DARK	GERMINATED	LIGHT WEIGHT, WHITE	LIGHT WEIGHT, WHITE	BEANS UNITED IN BALLS OF 3-5	BROKEN	CRUSHED	FLAT AND EMPTY	TOTAL
		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Selected Superior Red Summer Arriba	March-July	45.25	40.90	13.20	0.00	0.00	0.00	0.00	0.52	0.07	0.06	100.00
Superior Red Summer Arriba.....	Feb.-August	31.09	50.45	17.01	.06	.15	.00	.06	.59	.33	.27	100.00
Cosecha Navidad or Christmas Harvest	Dec.-Feb.	24.16	52.28	22.92	.00	.00	.00	.00	.48	.08	.08	100.00
Cacao Época.....	Jan.-Dec.	26.44	51.68	18.65	.46	.70	.13	.02	.63	.65	.64	100.00
Seasons	Jan.-Dec.	17.50	61.00	18.60	.50	.20	.10	.00	.70	.40	.30	100.00
Machala Corriente	Jan.-Dec.	24.25	54.07	17.37	.60	1.80	.07	.20	.50	.70	.44	100.00
Segunda	Jan.-Dec.	13.57	45.00	23.03	3.70	7.63	1.47	.60	1.77	1.90	1.33	100.00

then cleaned by the exporter and the good quality beans are taken and added to the superior grades, while the others, including defective beans, are sold as Segundo grade. Defective cacao includes moldy, flat, slaty, and germinated beans.

Frequently, producers in the Province of Manabi will accept a lower price for their cacao to compensate for the expenses and troubles that would be incurred in making shipment to Guayaquil.

Since the replacement of Arriba by Accra, and African cacao, as the indicator of the statistic position of cacao in 1918, the price of Arriba on the world market has been at a disadvantage. The availability of large quantities of ordinary grades of cacao on the world market has forced Ecuadorean planters in the past to sell at prices frequently not remunerative. The mixing of the beans from the two varieties as well as the deterioration of quality through hybridization of cacao nacional with low quality introduced types is said also to be a factor partly responsible for depressing the price of Arriba.

Beginning in 1927 and continuing into 1935, the general trend in price was downward as is shown by figure 25. In table 10, the average monthly price of cacao beans for selected years is also given. The recovery in prices during the later years, due to improvement in the world economic situation, has continued to the present time. Wartime ceiling prices established by the United States Government in 1943, however, acted as a check on price advances. With the removal of ceiling prices late in 1946, the price of cacao skyrocketed and has remained high. The minimum price paid per hundredweight for superior Arriba f.o.b. Guayaquil in 1947 by one Guayaquil exporter was \$25.90 and the maximum was \$46.90 per hundredweight.

The differential between the price of cacao in New York and Guayaquil has decreased by about three cents during the past three decades as

TABLE 9. - *Weight and volume statistics of cacao beans of several commercial grades*

COMMERCIAL GRADES	DRY BEANS	AVERAGE WEIGHT OF 100 BEANS	AVERAGE WEIGHT OF WALL OF 100 BEANS	AVERAGE VOLUME
	<i>No. per pound</i>	<i>Ounces</i>	<i>Percent</i>	<i>Cubic inches</i>
Selected Superior				
Red Summer Arriba	329	4.9	9.5	8.9
Superior Red Summer Arriba	351	4.6	10.4	8.3
Cosecha Navidad or Christmas Harvest	329	4.8	10.3	8.8
Cacao Epoca	371	4.5	11.9	7.8
Seasons	371	4.3	12.9	7.8
Machala Corriente	376	4.3	13.1	7.7
Segunda	377	4.3	13.5	7.6
Average	358	4.5	11.6	8.1

TABLE 10. - Average monthly market price of cacao in Guayaquil per hundredweight for selected years

MONTHS	1915	1920	1925	1930	1935	1940	1945	1946	1947
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
January	10.70	13.83	12.26	11.08	5.32	8.52	8.51	9.48	28.81
February ...	11.60	16.66	12.52	10.89	5.71	7.11	8.81	9.62	31.62
March	11.60	16.66	9.49	10.89	5.33	7.68	8.59	10.05	30.66
April	11.60	16.66	10.43	11.08	5.12	8.20	9.07	11.48	28.66
May	12.09	15.40	9.49	11.48	4.50	10.32	9.37	12.22	23.70
June	12.50	15.83	12.03	10.49	4.53	10.57	8.88	15.18	27.03
July	12.50	15.83	11.58	10.69	4.23	9.29	8.88	15.55	26.66
August	12.50	15.83	11.80	9.10	4.03	6.78	8.88	15.92	27.03
September ..	12.50	9.16	12.26	7.72	3.94	6.92	8.66	17.40	30.37
October	13.58	10.00	12.26	8.31	4.53	5.64	9.18	19.11	36.66
November ..	14.83	7.08	9.49	7.32	4.63	5.06	9.25	22.39	34.81
December ...	14.41	6.66	11.58	7.12	4.82	4.74	9.40	25.33	34.07
Average ..	12.53	13.47	11.27	9.68	4.73	7.57	8.95	15.30	30.00

is shown by figure 25. During periods of high prices the differential is wide but during periods of low prices it is narrow.

HACIENDA OPERATIONS

Management

The job of managing the hacienda is frequently delegated to an administrator who may have a clerk and several foremen as assistants. The administrator may receive little supervision from the owner or delegate of the owner in the case of large haciendas and is responsible for the organization and operations of the hacienda. Generally, the percentage of owner absenteeism is low on small plantations and high on large ones, particularly those in the more humid areas.

The percentage of owner absenteeism on the haciendas studied in the Arriba, Balao, Bahía, and Machala Regions was 65, 81, 89, and 60 percent, respectively.

Records of the haciendas in many instances do not enable the administrator to determine which sections of the hacienda are paying, which crop, if several are grown, to eliminate, and whether the animal industry is yielding satisfactory returns.

In general, it was observed that the more prosperous haciendas were those receiving adequate owner supervision and keeping close business records.

Labor

Most of the haciendas, particularly the larger ones, maintain adequate resident laborers. Small haciendas, especially those near towns, depend more upon nonresident and migratory labor. The labor shortage, which has existed in most regions, resulted from the migration of the workers to industrial regions where the wage scale was higher. Labor availability on the haciendas visited is given in table 11.

In general, the number of resident workers and available workers increases with the size of the hacienda, ranging from approximately 2 each on small haciendas to an average of 49 on the largest ones.

The largest number of resident families per hacienda was reported from the Balao Region and the smallest from the Bahía Region. In the Balao Region it is generally necessary for workers to live on the hacienda while in the Bahía Region they may live in town.

The wage scale is rather low on some haciendas, and it is sometimes difficult for the administrators and workers to maintain a good standard of living.

Daily wages for men differ considerably both within and between regions, as is shown below for the year 1944.

Region	One Meal		Without Meal	
	Range (Cents)	Average (Cents)	Range (Cents)	Average (Cents)
Arriba.....	29-76	44	19-96	52
Balao.....	33-52	43	45-63	52
Machala.....	37-56	46	59-82	74
Bahía.....	26-37	32	45	45

The average daily wage of women and children is between 22 to 36 cents.

It is common on many haciendas to let work out on contract, which specifies the amount to be paid and the work expected. The contractor then makes arrangements with his men concerning their wages and meals.

TABLE 11.--Regional distribution of crops, animals, and workers, average per hacienda

	ARRIBA REGION	BAHIA REGION	BALAO REGION	MACHALA REGION	AVERAGE
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
CROPS:					
Rice.....	91	7	292	2	82
Bananas.....	22	12	452	20	57
Pastures.....	30	218	610	166	289
ANIMALS:	<i>(Number)</i>	<i>(Number)</i>	<i>(Number)</i>	<i>(Number)</i>	<i>(Number)</i>
Horses.....	9	3	11	2	7
Mares.....	2	1	65	1	2
Mules.....	11	2	42	4	11
Burros.....	0	1	0	1	1
Bulls.....	7	0	72	1	5
Cows.....	84	53	66	1	66
WORKERS:					
Resident families.....	23	1	69	3	21
Resident workers.....	17	2	61	1	16
Nonresident workers....	3	1	29	1	4
Available workers.....	10	7	31	23	13

HEALTH, SANITATION, AND RECREATION

The living conditions of the workers in the cacao-growing regions are not always the best. Medical men report that a large number of the people are suffering from malaria and intestinal parasites. Tuberculosis is also prevalent. These diseases not only reduce the effectiveness of the workers but make their work attendance irregular. A few haciendas maintain first-aid service for their employees and if necessary will arrange for medical services in a neighboring town.

Nutrition is also poor. The usual diet is high in carbohydrates and lacking in proteins, minerals, and protective vitamins. It consists largely of white rice, plantains, a little fish or meat, potatoes, and cassava. Cabbage is about the only leafy vegetable eaten when available. Fruits, such as oranges, mangos, avocados, and papayas, are eaten when available. The effect of this unbalanced diet is reflected in the stunted growth of the children and in the loss of teeth. Infant mortality is reported to be high, up to 50 percent.

Sanitation measures are woefully lacking. The water supply and toilet facilities often are unprotected, favoring the spread of diseases.

Few recreation facilities are available on the haciendas, and only the larger ones have provided schools for the children.

EQUIPMENT ON THE PLANTATION

Buildings

There is usually one principal building on the hacienda, which may be a combination of living quarters above for the administrator and a warehouse and office below. In addition, there are usually a number of small unscreened bamboo houses for the laborers and their families.

On a few of the better managed plantations, the buildings are in good condition, and the administrator's house may be equipped with electricity and running water.

Drying Platform

The drying platform for cacao beans is generally on the ground and constructed of bamboo. It consists of a slightly convex bamboo-board floor laid on a thin layer of sand. Various types of roofs are employed to protect the beans from rain and dew. Among these are curved pieces of corrugated sheet metal and triangular-shaped roofs thatched with leaves of *bijao* (*Calathea insignis*) or Panama

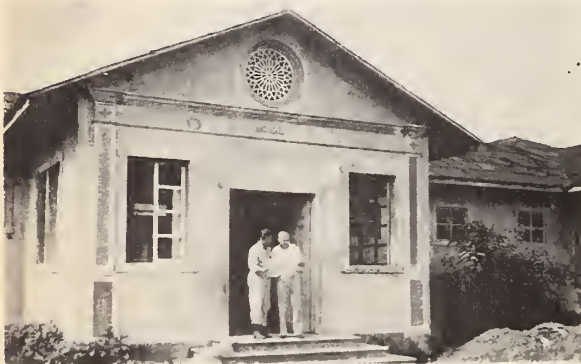


FIGURE 27.--Community hospital at the Tropical Agricultural Station.



FIGURE 28.--Primary school at hacienda Pichilingue.

hatpalm (*Carludovica palmata*). Wooden shingles are occasionally used. Drying trays are not common. A few haciendas have movable drying platforms on wheels, which can be run under shelters when necessary.

Machinery

Few haciendas reported such equipment as tractors, plows, harrows, discs, and cultivators. In all the regions a total of 21 trucks was noted, representing 18 haciendas, or approximately 6 percent of the total number studied. Fourteen tractors and ten pieces of agricultural equipment, such as discs and plows were observed. Several administrators reported steel canoes and launches in addition to the universal wooden canoe. All of the machinery was reported from the Arriba and Balao Regions where there are extensive plantings of rice or sugarcane in addition to cacao.

The use of machinery for cultivation purposes is difficult in old established cacao plantations, owing to the irregular spacing and leaning habit of the cacao nacional trees.

ANIMAL INDUSTRY

The animal industry of the Coastal Region is not well developed, as is illustrated by table 11. Animals of all classes are few in number, usually of inferior stock and poorly managed. Approximately 76 percent of the haciendas surveyed reported ownership of horses, 60 percent of cows, 25 percent of bulls, and 65 percent of mules. The percentage of haciendas by regions reporting livestock is:

Region	Horses (Percent)	Mules (Percent)	Cows (Percent)	Bulls (Percent)
Arriba	77	68	66	25
Balao	100	97	58	45
Baba	71	42	74	26
Machala ...	57	49	27	10
All regions	76	65	60	25

Of the total number of animals reported, 75 percent are in the Balao Region while the Machala Region has the fewest, 4 percent. It was found also that the average number of horses per hacienda was 7, mules 11, cows 66, and bulls 5.

The survey data indicate a direct relationship between the size of the hacienda and the number of horses, mules, and cows. These animals increase in number from 1 horse, 1 mule, and 1 cow per small hacienda

to 13, 38, and 136, respectively, on the largest haciendas. Burros are not important in any of the regions.

On all haciendas there are a few pigs, chickens, ducks, and turkeys. On small haciendas they belong to the owner, but on large haciendas they usually are the property of the laborer and are used for food. Goats were reported on several haciendas.

Despite the presence of poultry and dairy animals, there is a scarcity of eggs and milk. When available, they are expensive.

A number of growers are trying to improve the quality of the dairy stock by crossing selected native stock with Holstein-Friesian, Brown Swiss, or other dairy breeds. To improve the beef stock, native cattle are being bred with selected Brahman, Shorthorn, or Hereford bulls. Results thus far have been encouraging, especially with Brahman, and a demand for improved stock is developing. Most hacendados believe that a cross with one-eighth or one-fourth Brahman blood is sufficient to give the needed resistance to disease and insects. A few dipping vats were observed during the survey, particularly in the Bahía Region.

OTHER CROPS CULTIVATED

The monoculture system of agriculture adhered to religiously by the growers appears to have retarded the development of other crops. For this reason, subsistence and cash crops other than cacao are grown only to a limited extent as indicated in table 11.

Rice

One of the most important secondary crops grown is the upland-type rice. Recent increased demands owing to war conditions have prompted many cacao growers to extend its cultivation. This is especially true in the Balao and Arriba Regions. Little rice is grown in the Machala and Bahía Regions. The area in rice cultivation increases gradually from about an acre on small haciendas to an average of about 600 acres on the largest ones studied.

Two varieties of rice are commonly planted - Canilla and Fortuna. The latter was introduced into Ecuador from the United States about 1919.

Corn

A small quantity of corn or maíz is grown each year on the small haciendas - usually less than 2 acres - and is used mostly as animal feed, especial-



FIGURE 29.--A typical hacienda house, Hda. Pichilingue.

ly for chickens and pigs. Roasting ears, when in season, are highly prized by people.

The largest average plantings observed, about 27 acres, were on haciendas with an average area between 700 the 1,000 acres. Concerning regional averages, the cacao growers in the Arriba and Bahía Regions plant an average of 7 acres of corn, while in the Machala and Balao Regions they plant an average of approximately 2 and 5 acres, respectively.

There is practically no sweet corn grown. Along with corn, beans of various classes are frequently planted.

Bananas

Bananas are becoming increasingly important in world markets, and many hacendados are extending their banana plantations.

The Balao Region is by far the most important producing region, with an average of about 452 acres per hacienda, about 8 times the average for all regions. In general, the area in banana cultivation increases from approximately 1 acre on small haciendas of 125 acres or less to an average planting of about 565 acres on large haciendas of several thousand acres.

Both cooking and eating bananas are grown. Despite the demand for cooking bananas, there are relatively few plantations of any size producing them.

Coffee

Small quantities of coffee are grown in all regions averaging about 5 acres per hacienda. Many of these plantings are neglected and in many cases are abandoned. There are relatively few new plantings. Originally, coffee was grown with cacao, but the trend now is toward growing it as a small-farm enterprise.

On the small haciendas, coffee is the most important secondary crop, averaging about 15 acres in area or about one-fourth of the total average area of those haciendas with 125 acres or less. On large haciendas, coffee is not an important crop. The largest average plantings, about 42 acres, were observed on haciendas with an area between 1,000 and 1,250 acres.

The Arabian variety predominates, but there is some Robusta coffee.

Cassava

Recently there has been an increase in the cultivation of cassava or yuca as a source of starch. Two varieties are commonly planted: The



FIGURE 30.--Many varieties of rice are being studied at the Tropical Agricultural Station for possible commercial introduction into Ecuador.

6-month and the 12-month types. The usual size of planting for each family is about 0.5 acre.

Other Crops

Oranges, lemons, avocados, mangos, and pineapples are also grown on cacao haciendas. Occasionally cotton and soybeans are planted. There is a little production of vegetables, however. Sugarcane is grown to some extent in the Balao and Machala Regions.

Timberland

Many of the haciendas have large tracts of timberland, which contain laurel (*Cordia alliodora*), fernansanchez (*Triplaris guayaquilensis*), roble (*Tabebuia pentaphylla*), moral bobo (*Clarisia racemosa*), moral fino (*Clorophora tinctoria*), balsa (*Ochroma lagopus*), bamboo (*Guadua* sp.), and cedro colorado (*Ocotea* sp.).

These trees are slowly being exploited by the hacendados. Wild rubber (*Castilla panamensis*), vegetable ivory palm (*Phytelephas aequatorialis*), and other palms are also being exploited.

Pasture Land

Each hacienda, regardless of size, has pasture land. The average area increases from about 5 acres on small haciendas of 125 acres or less to about 1,645 acres on middle-sized haciendas of 1,250 to 2,500 acres and decreases to approximately 950 acres on large haciendas of 25,000 acres or more. Although the Arriba Region has the greatest number of animals, its haciendas report the smallest average area of pasture. Owing to the small number of animals, few pastures are overgrazed. Once a year the more progressive growers clean their pastures of rank weeds and uneaten stemmy grasses.

The most common pasture grasses are Janeiro (*Panicum mertensii*), Hierba de Saobya (*Panicum* sp.), Elephantgrass (*Pennisetum purpureum*), Venezuela grass (*Paspalum fasciculatum*), and Pará (*Panicum barbinode*). Molassesgrass (*Melinis minutiflora*) and Guineagrass (*Panicum maximum*), are also used occasionally.

ENCUMBRANCES

No study was made concerning the financial status or obligations of the haciendas. The inspectors reported, however, that a large number of the haciendas visited were mortgaged and that many have been possessed by companies or banks.

SUGGESTIONS RECEIVED FOR CACAO IMPROVEMENT

The concensus among the growers is that the Government should assist the industry through long-time loans at low interest rates. They also believe that a national rehabilitation program should be undertaken immediately in which selected superior cacao plants would be made available to interested persons for replacing unthrifty trees or establishing new plantations. Many growers indicated their willingness, if necessary, to make the facilities of their haciendas available for this program.

Also stressed was the need for an extension service, whereby technical information and guidance on improved methods of cultivation could be made available to growers. It was felt, too, that there should be some control on the price of cacao and the wage scale of laborers.

OUTLOOK

According to data obtained during the study, the outlook for the cacao industry of Ecuador depends largely upon price stability and improvement of production through good cacao cultivation and the use of improved resistant strains and varieties. This naturally includes available cheap working capital and efficient management.

For its best development the industry needs basic information concerning plant sanitation and disease and pest control involving spraying, poisoning campaigns, weed control, and cleaning trees of epiphytic and diseased plant materials. It also needs knowledge regarding improved orchard management and practices, such as pruning and thinning, shade requirements of cacao, methods of rehabilitation, harvesting methods, and fertilizer requirements.

The era of abnormally low prices and productivity practically bankrupted the growers and had disastrous effects upon the industry. The uphill fight to restore the industry to a semblance of its former position will be long and hard. It means that the old haphazard system of cacao cultivation practiced for centuries in Ecuador must be replaced with new methods based on superior sorts of cacao plants and methods of cultivation developed through sound research. Unless this is done, production will continue to remain low.

As the acreage under cultivation of cacao may be extended in all regions, an appreciable increase in production may be realized trees do not bear until at least 2½ years old by planting these potential areas. Suitable submarginal lands also may become productive through irrigation.



FIGURE 31.--Budding offers a method of rehabilitating old cacao plantations with high-yielding and disease-resistant plants.

Fortunately there still remains much latent interest in cacao cultivation, which if revived and properly guided will again make the growing of cacao a profitable Ecuadorean industry.

CONCLUSIONS

Ecuadorean cacao has long been highly prized by the cacao trade for its excellent quality. The present drastic reduction in availability of this highly flavored cacao is most unfortunate for the consumer and disastrous to the economy of a region based primarily on a single culture. Now that the price of cacao has greatly improved, it is believed that the efficient industrious hacendado can make cacao growing a successful enterprise.

Briefly, the condition of the cacao industry today is that:

1. The area under good cultivation has decreased about 20 percent during the past 25 years;
2. The quality of the product has deteriorated, owing to hybridization between the high-quality type, cacao nacional, and the lower-quality types of cacao venezuela;
3. Semiabandonment is widespread and is estimated at 50 percent;
4. Prices, which were abnormally low, have recovered to a point where cacao growing is now a profitable business;
5. There is little working capital;
6. Standard of management has been lowered;
7. One-crop system of agriculture prevails;
8. Diseases and pests are a limiting factor to production in all regions;
9. Improvement in efficiency of marketing of cacao is needed, including the establishment of standards and grades; and
10. Scientific information on cacao culture is lacking.

1. Low Prices. The era of low prices that prevailed for many years prior to and during the recent World War had a demoralizing effect upon the industry. As there was little differential between the selling price and production costs, growers reduced maintenance of the plantations to a minimum, which facilitated the spread of the diseases.

The result was a decrease, by about 10 percent, in the total number of acres under cultivation; semiabandonment and abandonment of plantations increased. Now that the price of cacao has improved, many growers are again maintaining their cacao plantings and are establishing new ones.

To obtain maximum prices for cacao, the pods should be harvested when ripe and the beans well cured. All black or diseased beans and trash should be removed.

2. Diseases and Insect and Animal Pests. Under the prevailing system of monoculture, the spread of serious cacao diseases and pests was greatly facilitated, resulting in heavy losses in production. Efforts made to control these organisms through artificial methods have not been too successful. Improved resistant strains and types of cacao are needed for commercial plantings and should be developed through a carefully planned selection, breeding, and disease-testing program.

3. Inefficient Administration. During recent years the standard of management has been lowered in many haciendas by the inability of the owner to find good administrators or pay attractive salaries to hold them. When in addition, supervision by the owner or delegate is inadequate, a plantation cannot be operated efficiently. Consequently, changes in land use or methods of farming were not made to increase the production of cacao or other crops or livestock and either to improve the efficiency of the laborers or to reduce the amount required.

To improve the administration of the haciendas, this study indicates a need for closer supervision of the hacienda operations, employment of experienced, trained agriculturists as administrators, and keeping of accurate production records for the various selections of the plantation.

The study reveals a need for the development of a training program in tropical agriculture for administrators and other interested persons, which might possibly be established in connection with the University of Guayas in Guayaquil or some other institution.

4. Lack of Adequate Capital. The lack of capital acted as a check on both expansion and improvement of cacao plantations. With the availability of long-time agricultural credit at reasonable rates of interest, it would be possible for hacendados to carry out needed improvements on the plantations.



FIGURE 32.--One of the many superior selections of cacao introduced into Ecuador by the Tropical Agricultural Station.

5. Problems of Labor. Poor administration on the haciendas has also resulted from labor shortages. Competition for the limited supply of available labor has increased wages to the point where during the era of low prices many growers could not afford to maintain their cacao plantings in a husbandrylike manner. Instead, they used their available labor on those crops that gave the largest immediate cash returns, such as rice or bananas.

Poor health and sickness take a yearly heavy toll in man-days of work and reduce the effectiveness of those who are at work.

This study reveals a need for giving more attention toward improving the standard of living on the haciendas, so that the employees as well as the owners may enjoy some of the modern conveniences of the cities and towns. Thus, problems of rural housing, education, and health including adequate medical and dental care, sanitation, and diet should be studied.

6. Need for Standardization and Inspection of Cacao. The establishment of standards for grades of cacao and a system of inspection would be of great help to both the grower and the exporter. A system of standardization would not only improve the efficiency in marketing but would also encourage the grower to prepare his cacao beans so as to get the maximum price entitled him according to the quality of his product and the condition of the market.

7. System of Agriculture. Without an alternative for cacao, the hacendados were practically wiped out financially by low production and depression. As the practice of monoculture is always a dangerous risk both economically and biologically, giving no security to the grower, it should be discouraged. Instead, a system of diversification in agriculture including cacao should be adopted.

