Republic of the Philippines
Department of Agriculture and Natural Resources
BUREAU OF SOILS
Manila

Soil Report 31

SOIL SURVEY OF CAPIZ PROVINCE PHILIPPINES

RECONNAISSANCE SOIL SURVEY

BY

FRANCISCO CALIMBAS
Chief of Party

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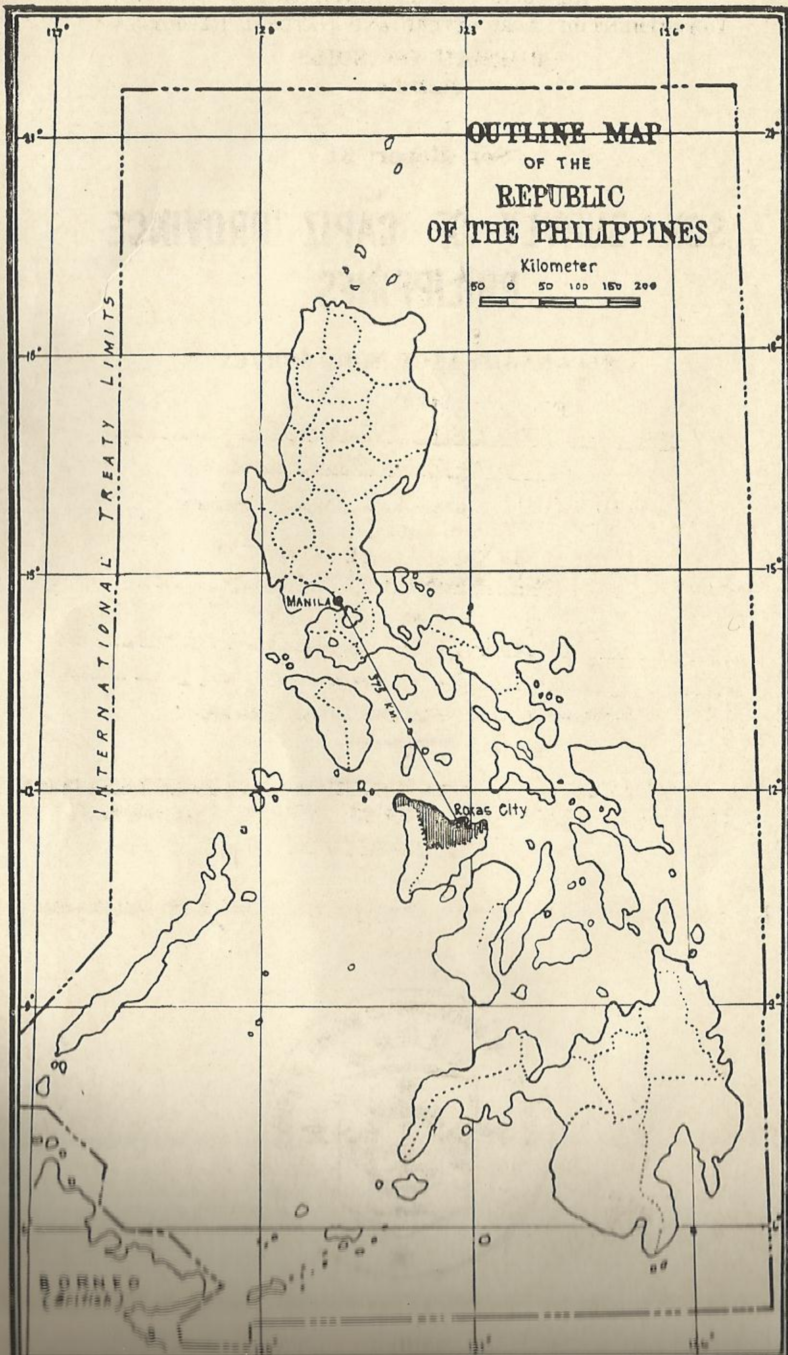

Figure 1. Map of the Philippines showing location of Capiz Province.

REPUBLIC OF THE PHILIPPINES
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WITH A DISCUSSION ON THE CHEMICAL CHARACTERISTICS AND FERTILIZER REQUIREMENTS OF THE SOILS OF CAPIZ PROVINCE

BY
EUSEBIO A. AFAGA, MARTIN V. TIANGCO AND GLORIA B. QUERIJERO

MANILA
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TEXT FIGURES

INTRODUCTION

Proper land use and efficient soil management are basic foundations of scientific agriculture. Unfortunately, a vast majority of our farmers fail to realize the significance and advantages of the scientific methods of farming.

Before any piece of land can be properly used the soils of the area must first be studied. Soil classification involves the thorough investigation of the physical, chemical, and biological characteristics of the different kinds of soils. From reconnaissance and soil erosion surveys the capabilities of a particular soil are determined together with the corresponding management practices necessary. When a piece of land is used according to its capabilities and treated accordingly agriculture is bound to be successful and progressive.

The reconnaissance and soil erosion surveys of Capiz Province were conducted from June 20, 1948 to September 15, 1948, inclusive, by the Bureau of Soil Conservation (now the Bureau of Soils) under the directorship of Dr. Marcos M. Alicante and during the incumbency of Hon. Mariano Garchitorena as Secretary of Agriculture and Natural Resources. The soil report was updated and edited by Mr. Agripino F. Corpuz, Soil Survey Supervisor, and proofread by Mr. Juan N. Rodenas, Soil Technologist.

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SUMMARY

Capiz Province is one of the three provinces of Panay Island in the Visayan group. It has an approximate area of 441,011 hectares and a population of 405,285 in 1939 and 441,870 in 1948. Roxas City, the capital, is 375 aerial kilometers south of Manila.

The western and southern regions of the province bordering Antique and Iloilo Provinces, respectively, are rolling, hilly and mountainous with long and meandering streams. The coast is somewhat irregular in some places. Elsewhere, the coastal area consists of hills and low mountains separated by small alluvial valleys. The bigger level areas are found near the mouths of the Panay and Aklan Rivers. Plains are also found in Pilar, Dumarao, Dumalag, Cuartero, Sigma, Mambusao, Balete, Makato, Ibajay, and Nabas. The swamps and marshes are found along the coast from Pilar to Ibajay.

In general, the province is well drained. Panay and Aklan Rivers are the two important rivers that drain the province.

The vegetation is divided into four main types; namely, forest, grass, swamps and marshes, and cultivated crops. The forests, which are primary and secondary, are usually found on the higher hills and mountains. The grass vegetation covers principally the rolling and undulating areas. The swamps and marshes are quite extensive along the coast occupied mostly by mangroves, nipa palms, and *talahib*. The cultivated crops are mostly on the plains, valleys, and parts of the rolling and undulating area.

The history of Capiz Province began when ten datus from Borneo bought Panay Island from the native Negritos. They divided the island into three *sakops*. One of the *sakops* was ruled by Datu Bankaya and was named "Aklan" which later became the province of Capiz. The Spaniards occupied the province from 1569 to 1898, then the Philippine revolutionists took over control of the province. The American occupation followed and civil government was established in the province on April 15, 1901.

In the province there are 248.40 kilometers of first class national road and 257.30 kilometers of first, second, and third

class provincial roads. An inter-provincial road connects Roxas City with Iloilo City, Iloilo, and San Jose de Buenavista, Antique. A railway line connects Roxas City with Iloilo City.

Roxas City and New Washington are the two ports of the province. Inter-island ships call at these ports for passengers and cargos every week. These ports are also capable of handling ocean going steamers. The Philippine Airlines, Incorporated, operates an air service between Manila and Roxas City via Iloilo City everyday except Sunday.

There are thirty-one towns in the province. Public schools with primary and intermediate grades are found in all these towns as well as in some barrios. The central provincial high school is located at the capital. Regional public high schools are found in some of the towns. A rural high school is located at Bañga. Private schools offering the elementary and secondary courses are also found in some of the towns.

The Provincial Hospital is located in Kalibo while the Emmanuel Hospital, maintained by American missionaries, is in the capital. Puericulture centers are in operation in almost all the towns of the province.

Farming is the main industry of the people. Fishing, trading, nipa thatch making, mat weaving, and pottery making are some of the important industries of the people.

There are two types of rainfall occurring in two different regions of the province. The first type of rainfall occurs on the western part and the third type on the central and eastern parts. The first type of rainfall has a higher annual precipitation than the third type.

The temperature in the province slightly varies throughout the year except where there are great differences in elevation. The average annual temperature at Roxas City is 26.8° C, which is lower than that of San Jose de Buenavista, Antique, and very slightly higher than that of Iloilo City.

Rice is the principal crop grown in the province. Coconut, sugar cane, corn, root crops, vegetables, and fruit trees are the other important crops. In the 1948 census, the total farm area cultivated in the province was 81,678.59 hectares with a total value of production of about ₱29,220,474.

The method of farming in the province is the one commonly followed throughout the country. The wooden plow, harrow, and carabao are the principal tools of the farmers. The use of fertilizers is seldom practiced except on farms connected

with the sugar centrals and farms of some progressive landowners. Irrigation facilities are lacking in the province. Water supply is mostly from rain. The lack of irrigation is one of the chief causes of low rice production in the province.

The average size of farms in Capiz is 3.05 hectares and the average size of farms cultivated is 1.82 hectares. The average size of farms cultivated by all tenants is 1.71 hectares.

The soils of the province were classified under three general groups; namely (1) soils of the plains and valleys, (2) soils of the hills and mountains, and (3) miscellaneous land types. There are nine soil types in the first group, seven soil types and one soil complex in the second group, and three land types in the third group. The distribution of each soil type, soil complex, and land type is indicated on the soil map of the province.

Hydrosol, a miscellaneous land type, is best suited for fishponds and the growing of nipa palms. Beach sand, another miscellaneous land type, is important for the growing of coconuts. Rice, the most important crop in the province, is planted intensively on Bantog clay, San Manuel clay loam, Sta. Rita clay, Maligaya clay, and Makato clay. Sara clay loam is principally planted to sugar cane with rice as the secondary crop.

Alimodian clay loam is the widest in extent and is the most important soil type of the hills and mountains. It is principally planted to corn and upland rice. Luisiana clay loam is mostly planted to upland rice and corn. The Sapian, Sigcay, San Rafael, and Bauang series are not extensively cultivated as the Alimodian and Luisiana soils. The Alimodian-Barotac complex is principally devoted to grazing. The soils of the hills and mountains are readily susceptible to erosion due to runoff. Systematic crop rotation, terracing, addition of organic matter, contour and strip cropping are some measures and practices necessary to reduce runoff and minimize erosion in the province.

The productivity rating, land capability classification, and erosion class of each soil type are found in this report.

I. RECONNAISSANCE SOIL SURVEY

DESCRIPTION OF THE AREA

Location and extent.—Capiz is one of the three provinces of Panay Island in the Visayas. Its form is like that of an isoceles triangle with the apex pointed toward the center of the island (fig. 1). North of the province lies the Sibuyan Sea; on the east and south is Iloilo Province; and on the west is Antique Province. It has an area of 4,410.11 square kilometers, or 441,011 hectares. Roxas City, the capital, is 375 kilometers by air south of Manila.

Relief and drainage.—The southwestern part of the province is mountainous. Along the Antique provincial boundary are prominent mountain peaks, such as Baloy, Mantud, Magosalon, Toctocan, Balabac, Tinayunga, and Mausang. The elevations of these peaks range from 1,330 meters (Magosalon) to 1,728 meters (Baloy). The bedrocks consist of shale, sandstone, basalt, diorite, quartzite, and limestone. At the foot of these mountains toward the coast is a wide expanse of rolling area.

The coast is somewhat irregular. Almost the whole coastal area consists of hills and low mountains separated by small valleys. Along the coast are small islands which are of coral or of sandbar origin.

Alluvial plains are found along and near the mouths of the Panay, Aklan, Ibajay, and Alimbo Rivers. Along the northern coast, from Pilar on the east to Nabas on the west, are found extensive swamps and marshes which are under water throughout the year.

TABLE 1.—*The approximate area of the actual soil cover of Capiz Province, 1946* [1]

Type of cover	Area in hectares	Percentage
Commercial forest	47,065.00	10.67
Non-commercial forest	51,506.00	11.67
Open land	237,381.41	53.83
Cultivated land	81,678.59	18.52
Swamps (fresh marsh and mangroves)	23,380.00	5.31
Total	441,011.00	100.00

[1] Bureau of the Census and Statistics, *Yearbook of Philippine Statistics: 1946* (Manila: Bureau of Printing, 1947), p. 132; Bureau of the Census and Statistics, *Summary and General Report on the 1948 Census of Population and Agriculture.* Vol. III. (Manila: Bureau of Printing, 1954), p. 2884.

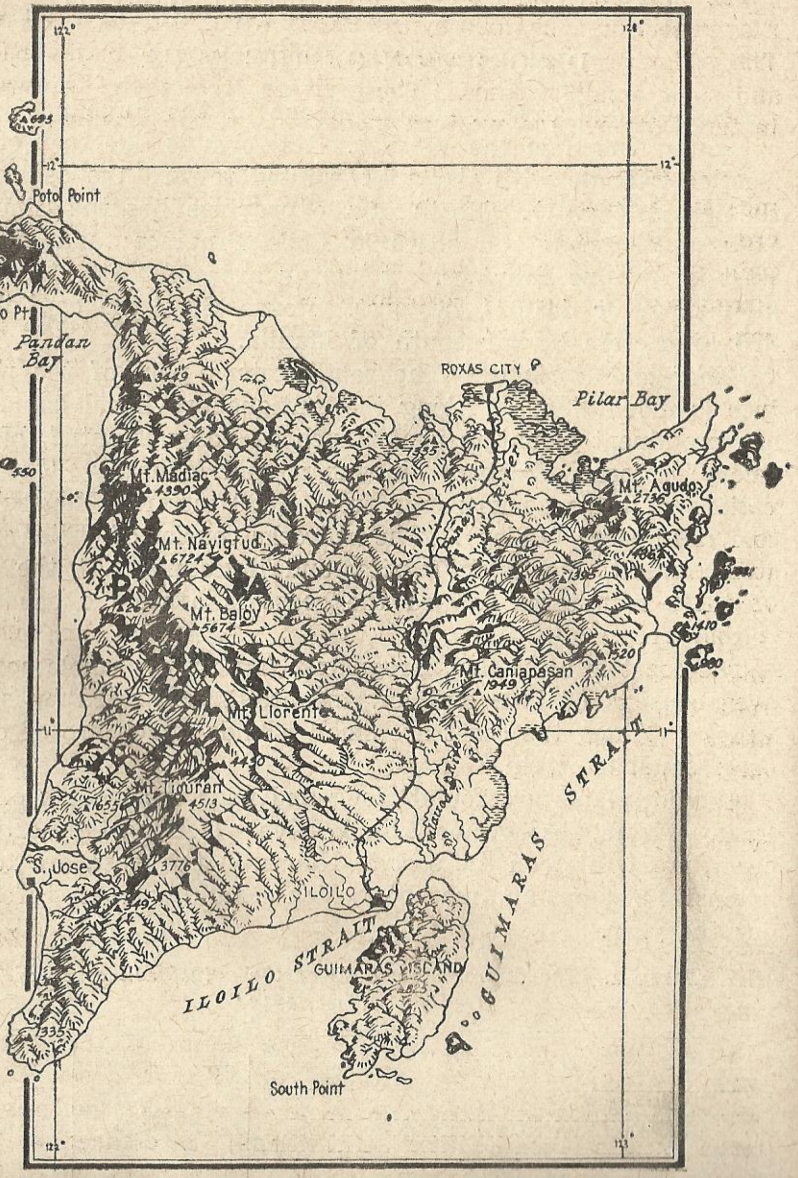

Figure 2. Map of Panay Island showing relief and drainage pattern.

The province is drained in a northward direction. The Elayan section is drained by the Panay River and its tributaries. The Aklan section is drained by the Aklan and Ibajay Rivers and some small streams. These rivers have their headwaters in the southern and western mountains of the province.

Vegetation.—The four main types of vegetation in the province are forests, grasses, swamps and marshes, and cultivated crops. Forests are of the primary and secondary types. The primary forests are found mainly on the higher slopes and summits of the western cordillera and on the southern mountain ranges of the province. They are also found scattered on some of the higher hills. The secondary forests were developed as a result of the logging and *kaingin* operations.

Considerable portions of the primary forests were burned and cleared by the native method of clearing. These were cultivated for some time and later abandoned, allowing grasses and shrubs to grow. At present, due to this wasteful method of farming, the secondary forests in Capiz have become more extensive than the primary forests.

The grass vegetation is extensive. It covers the western and southern uplands, the foothills of the cordilleras, and the rolling and hilly regions in the central part including those along and near the coast of the province. Cogon is the dominant grass in association with *talahib*.

Swamps and marshes consist of areas covered by fresh or brackish water and grown with nipa palms and other halophytic plants like *bakauan, lañgarai, api-api,* and *dungon-late.*

The cultivated crops are mostly found on the plains, valleys, and parts of the rolling areas. The most common crops are rice, corn, sugar cane, coconut, banana, vegetables, root crops, and fruit trees.

Organization and population.—The name of the province was derived from either "Kapis" or "Kapid," two Visayan words; the former being the name of a pearl shell and the latter means "twin." The word "kapid" is claimed by some people to have been the origin of the name of the town of Capiz in memory of the first twins who were born in that settlement in its early days. Later the province came to bear the same name. The ancient name of Capiz was Aklan.

The history of Capiz Province dates back to the time when ten datus from Borneo bought Panay Island from the native Negritos. These datus divided the island into three *sakops:* Aklan, Hantik, and Irong-irong. Aklan, which later became the province of Capiz, was ruled by datu Bankaya who was the founder of the first Malay settlement in the province.

Spanish influence in Capiz started in 1569. Legaspi built the first Spanish settlement on what is now the site of the town of Panay. The native settlements were organized into towns by the Spaniards; namely, Aklan, Dumarao, Ibajay, and Dumalag. Batan and Mambusao were organized into towns during the early part of the seventeenth century. Capiz Province was then included under the jurisdiction of Oton, Iloilo Province.

In 1716, Capiz Province became a separate politico-military province. This status lasted until the end of the Spanish rule. It included the islands of Romblon, Maestro de Campo, Tablas, and Sibuyan. The Spaniards abandoned the province in 1898 and it fell under the jurisdiction of the Philippine revolutionary government. Ananias Diokno was the civil and military commander of Capiz. Civil government under the American rule was established in Capiz on April 15, 1901.

The population of the province in 1918 was 292,665; in 1939, 405,285; and in 1948, 441,870.

Transportation.—The province has national, provincial, and municipal roads that connect all towns and big barrios to the provincial capital. National highways connect Roxas City with Iloilo and Antique Provinces.

TABLE 2.—*Lengths of the different classes of roads in Capiz Province* [1]

Class of road	National	Provincial
	km.	*km.*
First	248.40	167.90
Second		49.50
Third		89.90
Total	248.40	257.30

[1] Bureau of the Census and Statistics, *Yearbook of Philippine Statistics: 1946* (Manila: Bureau of Printing, 1947), p. 306.

A railway line connects Roxas City with Iloilo City. It passes through the towns of Dumarao, Cuartero, Dao, and Panitan.

Roxas City and New Washington are the ports of the province. Inter-island ships call at these ports for passengers and cargos. These ports are also capable of handling ocean-going vessels. The port of Capiz is well protected from the northeast and southwest winds.

The Philippine Air Lines, Inc., operates an air service between Roxas City and Manila via Iloilo City.

Other cultural features.—The province has thirty one municipalities. Tangalan, Lezo, and Madalag are the newly organized towns of the province.

All towns and big barrios have public schools with primary and intermediate grades. Small barrios have primary grades only. The central high school is located in Roxas City while junior public high schools are found in some towns. A rural high school is located in Banga. There are private schools in some towns that offer elementary and secondary courses. The private schools in Roxas City and Kalibo offer collegiate courses as well as the elementary and high school curricula.

The provincial hospital is located in Kalibo. In Roxas City is located the Emmanuel Hospital and maintained by American missionaries. Puericulture centers exist in nearly all towns of the province.

The predominating religion is Roman Catholicism. Roman Catholics are found in every town; Protestant and Aglipayan churches are also found in the province.

Industries.—Farming is the main industry of the people. Fishing, making of nipa thatch, weaving, and pottery making are the other important industries.

Fishing is the main source of livelihood of the people who live along the coast. Fish supply for the province is adequate. Excess catch is salted and dried and then sold in the interior towns or shipped to other provinces. The culture of *bañgos* is not yet well developed. There is, however, a good outlook for its expansion and development, hydrosol areas of the province being extensive and suitable for fish pond sites.

The making of nipa thatch is an important home industry in Roxas City, Panay, Pontevedra, Sapian, Altavas, and Ibajay,

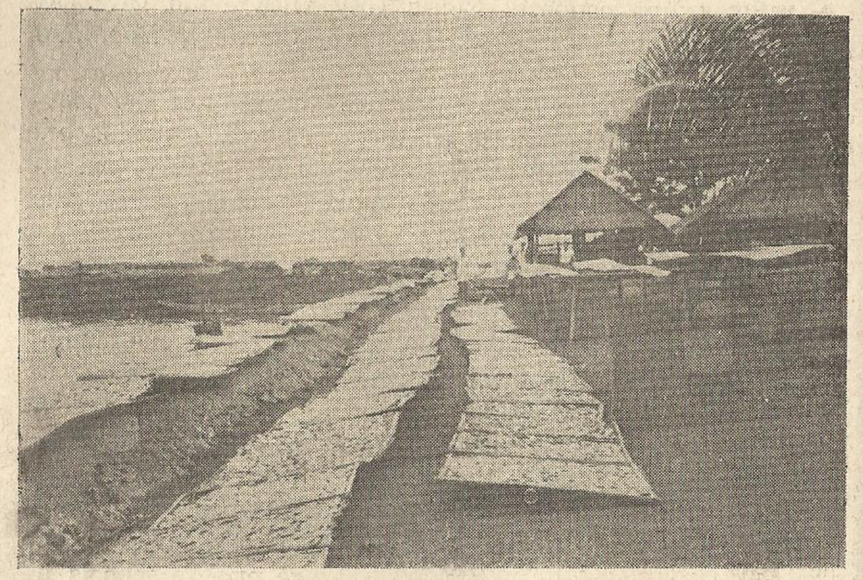

Figure 3. The supply of fish in the province is adequate. Excess catch is salted, dried, and sold in the interior towns.

Figure 4. Mat and hat weaving are important cottage industries of Capiz.

PLATE 1

Before World War II, the weaving industry was well developed. It was, however, almost abandoned during the Japanese occupation. It has not yet been fully rehabilitated. Mat and hat weaving are the other cottage industries of the province which provide additional income for the people. In addition, the manufacture of shoes, slippers, and clay pots are also common.

CLIMATE

The province of Capiz has two types of rainfall, the first and third types. The first type of rainfall occurs along the western part of the province bordering Antique. There are two long pronounced seasons, dry from November to April, and wet during the rest of the year. July and August have the highest precipitation while February and March are practically rainless months.

The third type of rainfall occurs in the eastern part of the province. It has no pronounced rainy period and no dry season. In this type, October has the greatest precipitation and March has the least.

Table 3 presents data on the monthly and annual average rainfall and the number of rainy days from two weather stations in the province representing the two types. Ibajay, which represents the first type of rainfall, has the highest average annual rainfall but has the least number of rainy days. Roxas City, which represents the third type of rainfall, has the highest number of rainy days but has the least average annual rainfall. Dao, on the other hand, which also represents the third type of rainfall, has a higher number of rainy days than that of Ibajay but lower than that of Roxas City. Dao has a lower average annual rainfall than Ibajay but higher than that of Roxas City.

The temperature slightly varies throughout the year except where there are great variations in elevation. The lowest temperature occurs during the months of January and February with 25.6°C and the highest is in May with 28.0°C. The average annual temperature is 26.8°C, which is lower than that of San Jose de Buenavista, Antique, and very slightly higher than that of Iloilo City. Table 4 gives the comparative mean annual temperatures of Roxas City, San Jose de Buenavista, Antique, and Iloilo City, Iloilo.

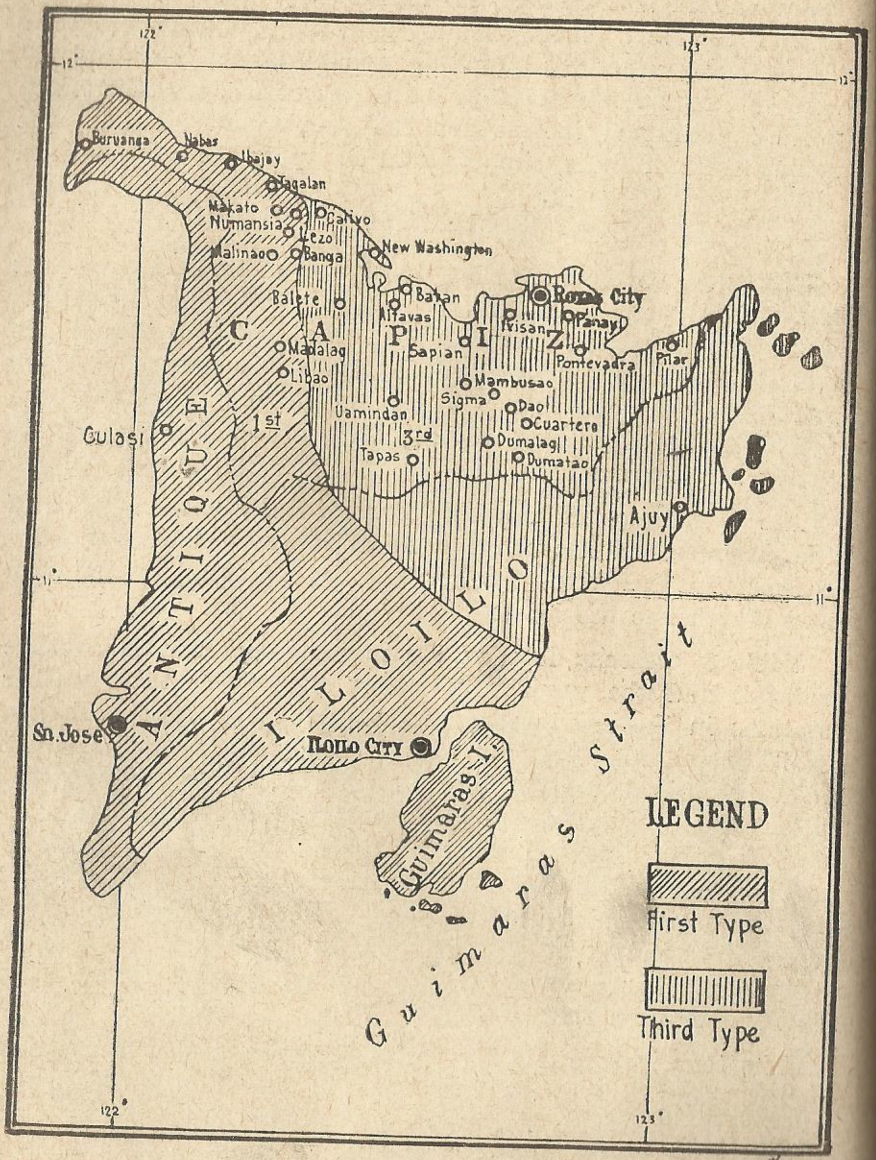

Figure 5. Climate map of Panay Island.

The relative humidity is high at all times. The north and northeast winds occur from November to May and the southwest wind from June to October. Typhoons are relatively frequent in the northern half of the province.

TABLE 3.—*Monthly and annual average rainfall and number of rainy days in different stations of Capiz Province.*[1]

Month	First type of rainfall		Third type of rainfall			
	Ibajay 12 years		Roxas City 47 years		Dao 20 years	
	inches	*days*	*inches*	*days*	*inches*	*days*
January	5.42	12	5.48	17	6.07	14
February	2.44	8	3.38	12	4.61	10
March	1.98	8	2.06	9	3.27	10
April	3.14	7	2.12	8	2.77	6
May	7.46	11	7.11	14	8.77	14
June	9.18	14	10.62	19	10.37	16
July	19.68	19	10.44	20	9.07	15
August	16.39	17	8.86	17	8.16	14
September	13.75	16	9.95	17	9.97	16
October	17.68	20	14.59	21	12.51	17
November	12.71	16	11.75	20	14.45	18
December	7.46	14	8.93	19	9.14	15
Annual	117.29	162	95.29	193	99.16	165

TABLE 4.—*Comparative mean annual temperature in the provinces of Capiz, Antique, and Iloilo for 16 years.*[2]

Month	San Jose Antique Province	Roxas City Capiz Province	Iloilo Iloilo Province
	°*C*	°*C*	°*C*
January	26.2	25.6	25.6
February	26.4	25.6	25.8
March	27.3	26.6	26.8
April	28.2	27.6	27.8
May	28.3	28.0	27.9
June	27.5	27.5	27.3
July	26.8	27.0	26.8
August	26.9	27.0	26.8
September	26.8	26.7	26.6
October	26.1	26.7	26.6
November	26.0	26.6	26.4
December	26.8	26.3	26.0
Mean annual	27.1	26.8	26.7

AGRICULTURE

The principal occupation of the people is farming. The data and statistics cited in this section of the report are from census reports published by the Bureau of the Census and Statistics. In 1918 the total farm area of the province was 99,784 hectares of which 56,555 hectares were cultivated. In 1948, the recorded farm area was 81,678.59 hectares with the value of production estimated at ₱29,220,474. The increase

[1] Weather Bureau, "Monthly Average Rainfall and Rainy Days in the Philippines" (Manila: Weather Bureau, 1956), p. 8. (Mimeographed.)

[2] Census Office of the Philippine Islands, *Census of the Philippines 1918*. Vol. 1 (Manila: Bureau of Printing, 1920), pp. 298-99.

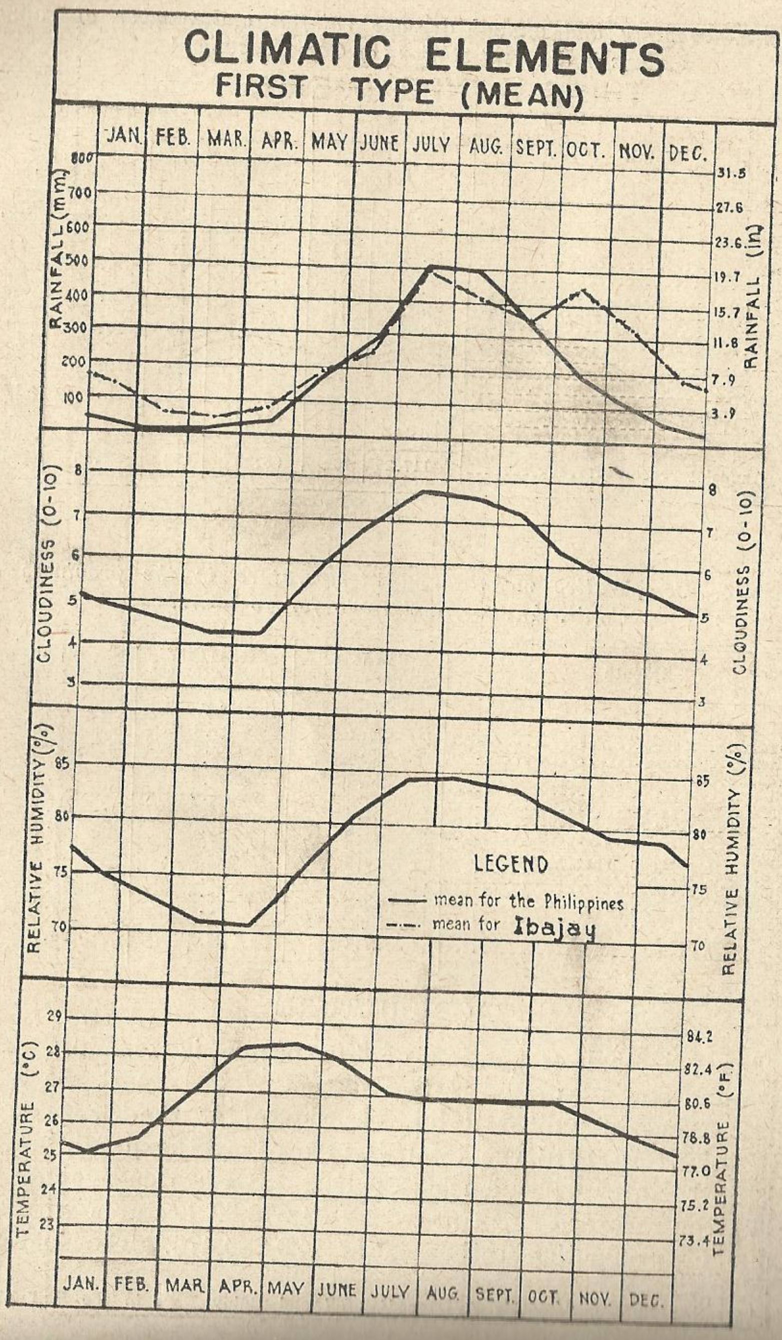

Figure 6. Graph of the first type of climate in the Philippines and of Ibajay, Capiz.

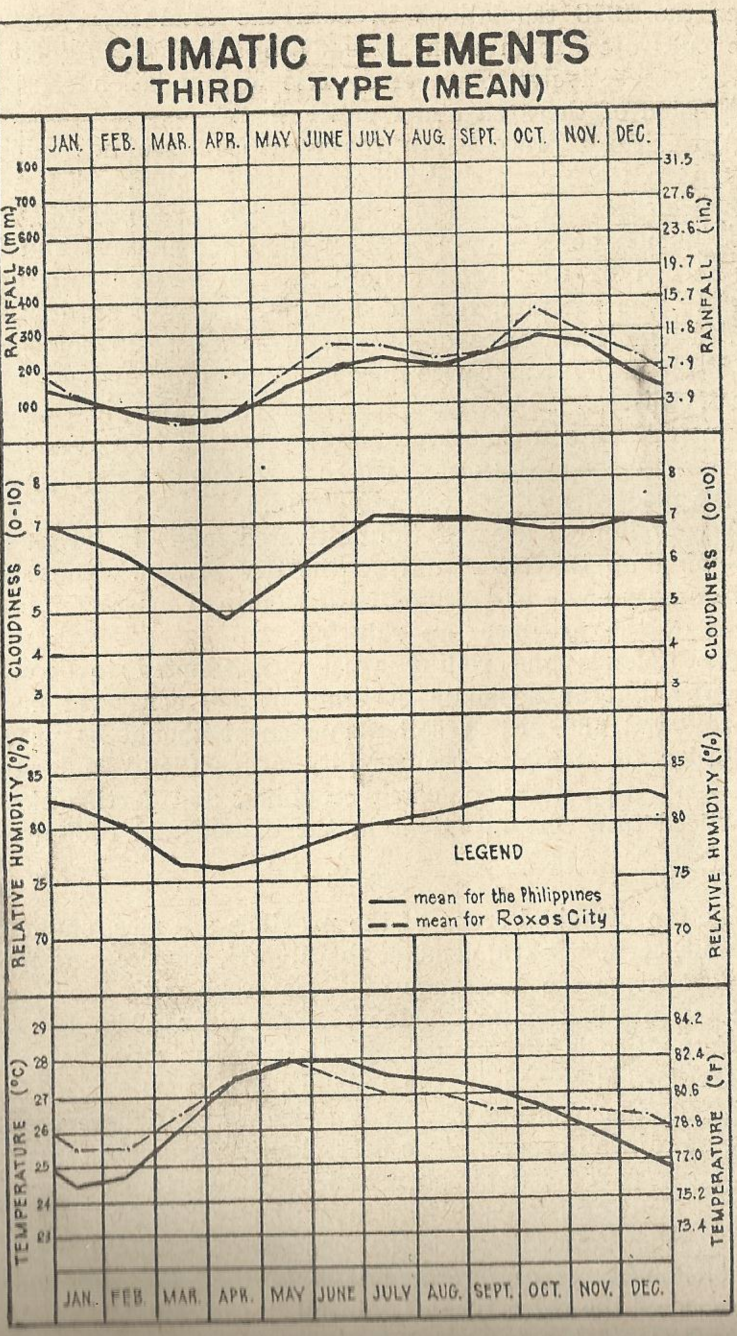

Figure 7. Graph of the third type of climate in the Philippines and of Roxas City, Capiz.

over the 1918 tabulations in both the total farm area and the cultivated farm area were 37,274.49 and 25,123.59 hectares, respectively. The steady rise in population caused the expansion of the area under cultivation.

Agricultural practices in the province have not improved much from the centuries' old ways of farming. The wooden plow, harrow, and the carabao, which are generally used throughout the Philippines, are the principal tools and beast of burden of the farmers both in the lowland and upland areas. The farmers, like in most parts of the country, have not availed themselves of the scientific aids. In some sugar cane plantations and rice fields a few progressive farmers use fertilizers. This practice has increased the yields. Green manuring and soil conservation are practiced to a very limited extent. In general, most farmers still do not take advantage of the modern methods of agriculture.

A very limited area of the cultivated lands is irrigated by damming up the rivers during the dry season. There is no government sponsored irrigation system and most of the farm lands of the province are rain-fed.

The uplands and rolling areas are adapted to diversified farming, but an adequate program of soil conservation must be followed and proper soil management should be practiced in order to maintain the fertility of the land and prevent erosion. Crop rotation, catch cropping, and fertilization are practiced to a certain extent in the upland and rolling areas.

CROPS

The ten principal crops of the province are rice, sugar cane, coconut, corn, cassava, camote, abaca, gabi, tobacco, and mungo. Table 5 gives the hectarage of these crops with their corresponding production and value for the year 1948.

Rice.—Rice is the main crop. It is grown quite extensively in the lowlands and in the uplands. In some places of the lowlands, the planting of rice is twice a year where the third type of rainfall occurs. The first planting usually starts about the early part of September and continues to October. The second planting begins in November; harvest is from February to March. According to the census of 1948, there were 5,935.69 hectares of irrigated land in the province. The occurrence of the third type of rainfall in the central and eastern part of Capiz has increased the area planted to lowland rice

Figure 8. Rice is the main crop in the province.

Figure 9. Banana and coconut groves on a hilly area of the province.

PLATE 2

for the second planting to 9,932.94 hectares. An irrigation system is a must for the province.

The range in production of lowland rice in unfertilized fields is from 15 to 40 cavans of palay per hectare; in fertilized fields, it is from 50 to 70 cavans. In the uplands, the production is from 5 to 25 cavans of palay per hectare. The common varieties of lowland rice are *Elon-elon, Pinili Puti, Casicad, Amarillo, Dadidit, Apostol,* and *Kalubag.* The upland rice varieties are *Guinatos, Kutsiam, Karibo, Guinangang,* and *Sulig.*

In 1948, rice production in Capiz were as follows:

Crop	*Area in Ha.*	*Production in Cav.*	*Value*
Lowland rice, first crop	37,475.59	944,728	₱10,865,157
Lowland rice, second crop	9,932.94	184,270	2,180,343
Upland rice	9,954.77	167,367	2,027,393

TABLE 5.—*Area, production, and value of the ten principal crops of Capiz Province, 1948*

Crops	Area in hectares	Production	Value
Rice	57.363.30	1,296,365.0 cav.	₱15,072,893
Sugar cane	4,322.75	155,232.8 tons	5,204,931
Coconut	17,080.13	52,084,751.0 nuts	3,501,328
Corn	6,168.95	70,789.0 cav.	674,206
Cassava	2,055.39	7,266,288.0 kg.	636,308
Camote	1,564.63	3,610,942.0 kg.	323,804
Abaca	971.88	310,606.0 kg.	199,565
Gabe	312.44	757,444.0 kg.	93,631
Tobacco	92.68	30,436.0 kg.	33,786
Mungo	88.06	16,194.0 kg.	10,071

Sugar cane.—There were 4,322.75 hectares planted to sugar cane in 1948. The two sugar centrals operating, the Pilar Sugar Central and the Astoria Sugar Central, were partly damaged during the Japanese occupation. They have been rehabilitated but they are not yet operating to their full capacities. The planting of sugar cane is concentrated around and near these two centrals. Small scattered plantings are also found in many parts of the province.

Coconut.—The area planted to coconut in 1948 was 17,080.13 hectares. There were 2,094,333 coconut trees of which 1,580,529 were bearing. The production for the same year was 52,084,751 nuts valued at ₱3,501,328. Most of the coconut trees are found along the shores and on the hilly areas, while some are along the banks of rivers. The five towns which lead in coconut production are Buruanga, Ibajay, Makato, Batan, and Nabas.

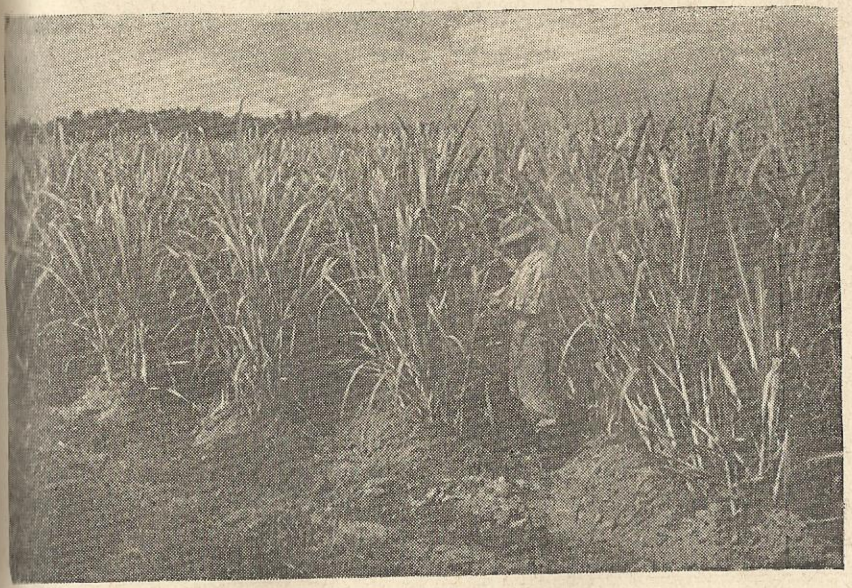

Figure 10. A fertilized field of sugar cane. Large plantations of this crop in the province are well managed.

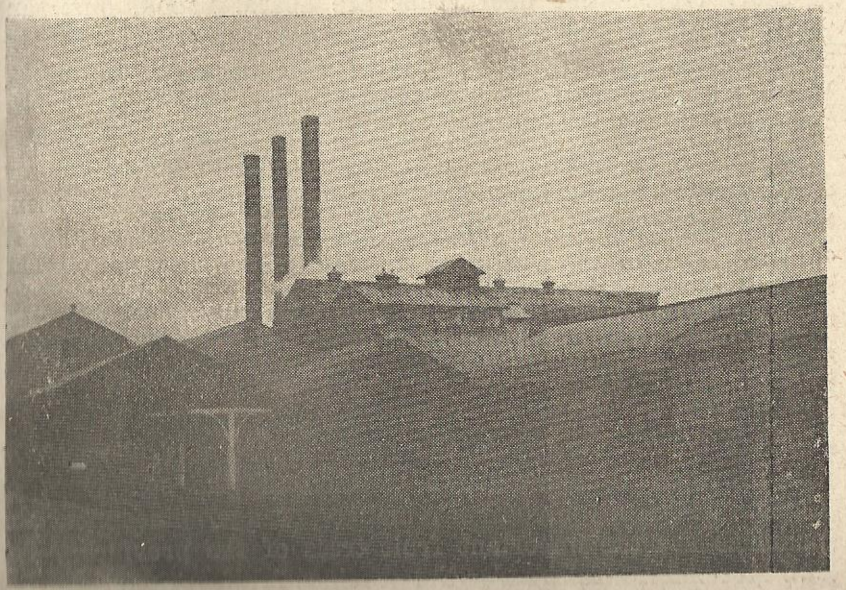

Figure 11. Sugar central at Pres. Roxas, Capiz.

Corn.—Corn is second to rice as food crop of the people. It is planted both in the lowland and in the upland areas. Two plantings a year is a usual practice throughout the province although a third planting is also done when possible. The common varieties of corn planted are the White and Yellow Flints. A white glutinous variety is planted in small scale. The production of corn ranges from 6 to 25 cavans of shelled corn per hectare in the lowland, and 4 to 12 cavans per hectare in the upland.

Root crops.—The leading root crops are camote, cassava, and gabe. In 1948, there were 3,932.46 hectares cultivated to these crops giving a total value of ₱1,053,743.

Legumes.—The leguminous crops of the province are peanut, mungo, soybeans, cowpeas, patani, cadius, and other beans. These are planted in rotation with the major crops like rice and corn. Sometimes they are planted as catch crops. The aggregate area planted to legumes in 1948 was 164.43 hectares.

Vegetables.—Vegetables are planted in small scattered areas. They are mostly in home yards and gardens. The supply of vegetables is quite adequate for the province.

Fiber crops.—The fiber crops are abaca, kapok, *buri*, and cotton. Abaca and *buri* were the most important crops before World War II. The value of the abaca fiber produced from 2,037 hectares in 1939 was ₱50,523 and that of *buri* leaves from 11,753 trees was ₱53,030. In 1948 the abaca fiber produced from 971.88 hectares was valued at ₱199,565, and that of *buri* leaves from 3,406 trees at ₱7,729. At present, abaca production is declining. The fields formerly planted to abaca are for the most part devoted to corn.

Tobacco.—Tobacco is a minor crop with only 92.68 hectares, producing 30,436 kilograms of leaves valued at ₱33,786. The tobacco leaves produced are for local consumption as well as for export.

Fruit trees.—Banana is the most important fruit crop of the province. Banana grows well on all the soil types of Capiz. Jackfruit, breadfruit, mango, orange, pineapple, and pummelo are the important fruit trees of the province. The two types of rainfall render the province for favorable growing of various kinds of fruits.

TABLE 6.—*Number of trees, production, and value of ten leading fruit crops in Capiz Province, 1948*

Fruit trees	Number	Production	Value
Banana	1,141,261	1,158,541 bunches	P1,017,670
Jackfruit	98,639	634,783 fruits	177,378
Papaya	50,322	1,150,517 kilos	105,896
Santol	27,898	11,308,894 fruits	37,672
Cacao	8,632	17,232 kilos	34,705
Breadfruit	11,486	565,409 fruits	28,309
Guava	3,364	166,921 kilos	22,193
Mango	5,129	325,516 fruits	21,925
Orange	15,063	211,966 fruits	12,558
Pummelo	3,528	63,056 fruits	4,298

Others crops.—Other important crops of Capiz are bamboo, betel nut, and *sabutan* fiber. Bamboos are used for the construction of houses and farm sheds; *sabutan* fiber is used for hat weaving and rope making. The aggregate value of these crops in 1939 was ₱78,785.

LIVESTOCK AND POULTRY INDUSTRY

In 1948 the principal livestocks in the province were carabaos, cattle, hogs, horses, and goats; in poultry, the leading fowls were chickens, ducks, turkeys, geese, and guinea fowls. Table 7 gives the number and value of livestock and poultry for the same year.

TABLE 7.—*Kinds, number, and values of livestock and poultry in Capiz Province, 1948*

Livestock and poultry	Number	Value in pesos
Carabaos	68,853	P9,476,867
Hogs	96,340	3,160,883
Cattle	8,198	901,813
Goats	6,398	53,184
Horses	347	30,995
Chickens	683,540	692,818
Ducks	25,474	30,640
Turkeys	116	534
Geese	75	228
Pigeons	29	20

The raising of livestock is one of the sources of income of the people. There is no commercial livestock raising in the province, hence the raising of livestock is confined to backyards in the farms and homes. The government maintains a stock farm in the municipality of Dumarao. This stock farm was operating quite satisfactorily before World War II, but during the Japanese occupation, nearly all the animals were slaughtered. New breeds of carabaos and swine were imported to rehabilitate the remaining stocks. A dairy herd is maintained by the stock farm and the dairy products are sold in Dumarao and neighboring towns. It also maintains a poultry project wherein foreign breeds of chicken are raised.

LAND-USE CHANGES

Land-use changes in the province were influenced by the economic needs and the increase in population. Forests, open grasslands, and some areas that are better suited for grazing were turned into croplands.

The total farm area of the province according to the census of 1918 was 99,784 hectares of which 56,555 hectares were cultivated. In 1948, there were 137,058.49 hectares of farm area. Out of this farm area were 81,678.59 hectares, cultivated; 23,207.85 hectares, idle land; 15,224.47 hectares, pasture land; 9,402.75 hectares, forest land; and, 7,544.83 hectares of other land. This shows that from 1918 to 1948, the increase of the farm lands and cultivated lands was 37,274.49 hectares and 25,123.59 hectares, respectively. Cultivated land means the farm area devoted to the cultivation and raising of different crops, and idle lands are those lands which are not cultivated, neither are they forest nor pasture lands. On the other hand, pasture lands are those farm lands which are devoted to grazing, and forest lands are those lands occupied by forest. Other lands include urban lands, home lots, and waste lands.

FARM TENURE

In 1948, there were 44,956 farms operated by all farmers in the province. Of these farms, 47.3 per cent were operated by full owners; 9.8 per cent by part-owners; 25.9 per cent by share tenants; 0.3 per cent by share-cash tenants; 0.8 per cent by cash tenants; 15.9 per cent by other tenants; and less than 0.1 per cent by farm managers. The area of farms operated by all farmers was 137,058.49 hectares divided into (1) full owners, 57.3 per cent; (2) part owners, 11.1 per cent; (3) share tenants, 17.8 per cent; (4) share-cash tenants, 0.5 per cent; (5) cash tenants, 0.6 per cent; (6) other tenants, 11.5 per cent; and, (7) farm managers, 1.2 per cent. The average size of farm cultivated is 1.82 hectares, but the average size of farm cultivated by full owners is 1.79 hectares, while the average size of farm cultivated by all tenants is 1.71 hectares.

The yield from this area gives the tenants an income which would hardly be enough for the support of their families. It is, therefore, necessary for the tenants to have a supplementary source of income in order to live decently. The farm area of the province is more or less equitably distributed among the farmers which accounts for the absence of tenancy disputes.

FARM INVESTMENT

There are no records to show the different farm investments in the province. In 1948 the following farm equipment and their values were:

Kind	*Number*	*Value*
Plows	37,062	₱1,029,148
Harrows	31,340	
Carts	1,492	
Sleds	12,870	
Tractors	13	
Stripping machines	3	

TYPES OF FARM

The 1939 census of the Philippines gives twelve kinds of farm types defined as follows:

1. Palay farms are farms on which the area planted to lowland and/or upland palay was equal to 50 per cent or more of the area of cultivated land.

2. Corn farms are farms on which the area planted to corn was equal to 50 per cent or more of the area of cultivated land.

3. Abaca farms are farms on which the area planted to abaca was equal to 50 per cent or more of the area of cultivated land.

4. Sugar cane farms are farms on which the area planted to sugar cane was equal to 50 per cent or more of the area of cultivated land.

5. Coconut farms are farms on which 50 per cent or more of the cultivated land was planted to coconuts.

6. Fruit farms are farms on which the cultivated area planted to fruit trees was equal to 50 per cent or more of the area of cultivated land.

7. Tobacco farms are farms on which the area planted to tobacco was equal to 50 per cent or more of the area of cultivated land.

8. Palay-tobacco farms are farms on which the area planted to palay was equal to at least 25 per cent and the area planted

to tobacco was equal to at least 25 per cent of the area of cultivated land.

9. Vegetable farms are farms on which the area planted to camote, mungo, soybeans, sitao, cowpeas, patani, beans, cadios, onions, radish, eggplants, cabbages, gabe, watermelons, and/or potatoes was equal to 50 per cent or more of the area of cultivated land.

10. Livestock farms are farms which have (1) an area of 10 hectares or more, (2) more than 10 heads of cattle, horses, goats, and sheep, and (3) less than 20 per cent of the total farm area is used for the production of crops, fruits, or nuts.

11. Poultry farms are farms on which there are more than 300 chicken or 200 ducks and less than 2 hectares of cultivated land.

12. Other farms are farms which could not be classified under any of the above eleven groups.

TABLE 8.—*Number and per cent distribution of type of farms in Capiz, 1948*

Type of farms	Number of farms	Per cent distribution
Palay	31,411	70.0
Corn	665	1.5
Abaca	138	0.3
Sugar cane	102	0.2
Coconut	6,694	14.9
Fruit	536	1.2
Tobacco	15	less than 0.1
Vegetable	7	less than 0.1
Root crops	207	0.4
Livestock	----------	----------
Poultry	----------	----------
Others	5,181	11.5
Total	44,956	100.0

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of (1) the determination of the morphological characteristics of soils, (2) the grouping and classification of soils into units according to their characteristics, (3) their delineation on maps, and (4) the description of their characteristics in relation to agriculture and other activities of man.

The soils, their landscapes, and underlying formation, are examined in as many sites as possible. Borings with the soil auger are made, test pits are dug, and exposures, such as roads and railroad cuts are studied. An excavation or road cut exposes a series of layers or horizons called collectively the soil profile. These horizons as well as the parent material beneath are studied in detail, and the color, structure, porosity, consistency, texture, and content of organic matter, roots, gravels and stones are noted. The reaction of the soil and its content of available plant nutrients are determined in the laboratory. The drainage, both external and internal, and other features such as the relief of the land, climate, as well as the natural and cultural features, are taken into consideration, and the inter-relationships of the soil and the vegetation and other environmental features are studied.

On the basis of both external and internal characteristics, the soils are grouped into classification units, of which the three principal ones are (1) soil series, (2) soil type, and (3) soil phase. When two or more of these principal mapping units are in such intimate or mixed pattern that they cannot be clearly shown on a small-scale map, they are mapped or grouped into a (4) soil complex. Areas of land that have no true soil, such as river beds, coastal beaches, or bare rocky mountainsides are called (5) miscellaneous land types. Areas that are inaccessible like mountain and great forest areas whose classification is of no agricultural importance for the present are classified as (6) undifferentiated soils.

A series is a group of soils that have the same genetic horizons, similar important morphological characteristics, and have the same parent material. It comprises soils having essentially the same general color, structure, consistency, range of relief, natural drainage condition, and other internal and external characteristics. In the establishment of a series, a geographic name is selected, taken usually from the locality where the soil was first identified. For example, the Sapian series was first found and classified in the vicinity of Sapian town in Capiz Province.

A soil series has one or more soil types defined according to the texture of the surface soil. The textural class name such as sand, loamy sand, sandy loam, etc., is added to the series name to give a complete name of the soil. For example, Sigcay clay is a soil type within the Sigcay series. The soil type, therefore, has the same general characteristics as the soil series except for the texture of the surface soil. The soil type is the principal mapping unit. Because of its certain specific characteristics, it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the soil type only in some minor features, generally external, that may be of special practical significance. Differences in relief, stoniness, and extent or degree of erosion are shown as phases. A minor difference in relief may cause a change in agricultural operation or a change in the kind of machinery to be used. The phase of a type with a slight degree of accelerated erosion may present different fertilizer requirements and other cultural management problems from the real soil type. A phase of a type due mainly to degree of erosion, degree of slope, and amount of gravels and stones in the surface soil is usually segregated on the map if the area can be delineated.

A soil complex is a soil association composed of such intimate mixture of series, types, or phases that cannot be indicated separately on a small-scale map. This is mapped as a unit and is called a soil complex. If there are several series in an area, such as Sara, Sta. Rita, Alimodian, and others, that are mixed together, the two dominant series bear the name of the complex, as the case may be. If there is only one dominant constituent in a series, that series or type bears the name of the complex, as Sara complex or Alimodian complex.

Surface soil and subsoil samples for chemical and physical analyses are collected from each soil type or phase, the number of samples being determined by the importance and extent of such soil type or phase. Soil profiles of important soil types are obtained for morphological studies.

The soil survey party, composed of two or three soils men, maps the area and delineates the various soil types, phases, complexes, and miscellaneous land types.

All natural and cultural features found in the area, such as trails, roads, railroads, bridges, telegraph and telephone lines; barrios, towns, and cities; rivers and lakes; prominent mountains and others, are indicated on the soil map.

THE SOILS OF CAPIZ PROVINCE

The soils of Capiz Province consist of soils of recent alluvial fans and flood plains to soils on upland areas developed on consolidated materials.

The plains and valleys are principally devoted to the cultivation of lowland rice. The upland and rolling areas are suited to crop diversification, grazing, and fruit raising. The sea shores except those covered by swamps and marshes are suitable for the growing of coconuts.

The soils of the province were divided into three general groups; namely, (1) soils of the plains and valleys, (2) soils of the hills and mountains, and (3) miscellaneous land types. Table 9 shows the area and proportionate extent as well as the present land-use of each soil type; an accompanying soil map shows the distribution of each.

The different soil types and miscellaneous land types are as follows:

	Soil type Number
A. Soils of the plains and valleys:	
1. Umingan sandy loam	100
2. San Manuel clay loam	236
3. San Manuel sandy clay loam	596
4. Sara clay loam	237
5. Sara sandy loam	123
6. Bantog clay	228
7. Sta. Rita clay	120
8. Maligaya clay	220
9. Makato clay	221
B. Soils of the hills and mountains:	
1. Luisiana clay loam	140
2. San Rafael loam	133
3. Sigcay clay	222
4. Sapian clay	223
5. Alimodian clay loam	126
6. Alimodian-Barotac complex	125
7. Bauang clay	121
8. Faraon clay	132
C. Miscellaneous land types:	
1. Hydrosol	1
2. Mountain soils, undifferentiated	45
3. Beach sand	118

SOILS OF THE PLAINS AND VALLEYS

The soils of the plains and valleys occupy an area of 77,333.09 hectares, or 17.55 per cent of the provincial total. These soils are alluvial, developed from recent alluvial deposits. They vary widely in their characteristics. The surface soils range

TABLE 9.—*Area, percentage, and present use of each soil type in Capiz Province*[1]

Soil type No.	Soil type	Area in hectares	Per cent	Present uses
1	Hydrosol	25,754.31	5.84	Fishponds, nipa palms, and mangroves.
118	Beach sand	5,211.30	1.18	Planted to coconuts, corn, camote, vegetables, peanuts, and fruit trees.
100	Umingan sandy loam	1,965.20	0.45	Principally for rice and corn. Secondarily for tobacco, sugar cane, root crops, fruit trees, and bananas.
236	San Manuel clay loam	15,448.25	3.50	For lowland rice, sugar cane, corn, coconuts, fruit trees, root crops, bananas, vegetables.
596	San Manuel sandy clay loam	3,542.30	0.80	Lowland rice, coconuts, corn, camote, cassava, beans, peanuts, bananas, and fruit trees.
237	Sara clay loam	8,615.70	1.95	Sugar cane, lowland rice, corn, coconuts, bananas, root crops, vegetables, and fruit trees.
123	Sara sandy loam	1,370.65	0.31	Lowland rice, corn, sugar cane, coconuts, fruit trees, root crops, and vegetables.
228	Bantog clay	25,136.75	5.70	Lowland rice, corn, sugar cane, camote, cassava, bananas, some fruit trees, and coconuts.
120	Sta. Rita clay	4,045.15	0.92	Lowland rice, corn, camote, cassava, vegetables, sugar cane, bananas, and fruit trees.
220	Maligaya clay	10,833.69	2.46	Lowland rice, corn, sugar cane, camote, bananas, coconuts, and fruit trees.
221	Makato clay	6,375.40	1.46	Lowland rice, corn, sugar cane, coconuts, bananas, fruit trees, vegetables, and root crops.
140	Luisiana clay loam	18,717.40	4.24	Upland rice, corn, sugar cane, coconuts, bananas, fruit trees, vegetables, root crops, mungo, and beans.
133	San Rafael loam	8,342.75	1.89	Major part is forest and cogonal. Small portion cultivated for upland rice, corn, bananas, coconuts, and fruit trees.
223	Sapian clay	20,841.15	4.73	Small portion cultivated to upland rice, corn, coconuts, bananas, beans, mungo, and fruit trees; rest is forest and cogonal. Good for grazing.
222	Sigcay clay	4,478.95	1.01	Small portion cultivated to upland rice, corn, camote, cassava, vegetables, bamboos, bananas, and fruit trees. The rest is forest and cogonal.
126	Alimodian clay loam	145,584.95	33.01	Some parts cultivated for upland rice, corn, sugar cane, coconuts, bananas, fruit trees, and root crops. The rest is cogonal and forest. Good for grazing.
125	Alimodian-Barotac complex	13,391.35	3.04	Pasture land; also for upland rice, corn, coconuts, bananas, beans, mungo, and cassava.
121	Bauang clay	7,873.75	1.78	Upland rice, corn, coconuts, bananas, root crops, some fruit trees, vegetables, and bamboos.
132	Faraon clay	10,900.35	2.47	Small portion cultivated to upland rice, corn, camote, cassava some fruit trees, coconuts, and bananas. The rest is forest and cogonal.
45	Mountain soils, undifferentiated	102,581.65	23.26	A greater part is covered with primary and secondary forests. The rest is cogonal.
	Total	441,011.00	100.00	

[1] The area of each soil type was determined by the use of planimeter.

from silt loam to clay; from reddish brown to brown, and dark brown to almost black. Their profiles range from undeveloped to slightly developed.

UMINGAN SERIES

The Umingan series was first identified and mapped in Pangasinan Province. In Capiz it occurs along the banks of the Aklan River. Its relief is level to slightly undulating. Drainage is good to excessive. Soils of the series receive yearly depositions of alluvial soil materials.

Umingan sandy loam (100).—This soil type covers an area of about 1,965 hectares. It is found in Madalag and Libacao. The surface soil is from 25 to 40 centimeters deep. The soils in areas adjacent to the uplands have finer textures than those along river banks. The soil is loose and friable. It can be plowed any time without the danger of puddling. The subsoil is about 20 centimeters thick. It consists of friable and structureless sandy loam and is slightly lighter colored than the surface soil. Underlying the subsoil is a layer of gravels which vary in depth from 40 to 100 centimeters from the surface. This layer of gravels is the distinguishing characteristic of the Umingan series, differentiating the series from other alluvial soils. Beneath this layer is another layer similar to the surface soil.

The soil is good for diversified farming. One great hazard to this series is the yearly overflow of the river which usually occurs after an intense rain or storm. The loose surface soil is highly erodible. Soils of the Umingan series, because of the nature of their profiles, have low water retentive capacities.

Lowland rice yields from 30 to 35 cavans of palay per hectare; corn from 10 to 15 cavans of shelled corn per hectare for the first planting, and 6 to 10 cavans for the second planting.

SAN MANUEL SERIES

The soils of this series consist of brown to pale brownish gray clay loam to sandy loam developed from soil materials derived from recent alluvial deposits. They occur on low lying and flat areas thus they are subject to occasional floods. They are well drained.

San Manuel clay loam (236).—This soil type has an area of about 15,448 hectares or 3.50 per cent of the provincial total.

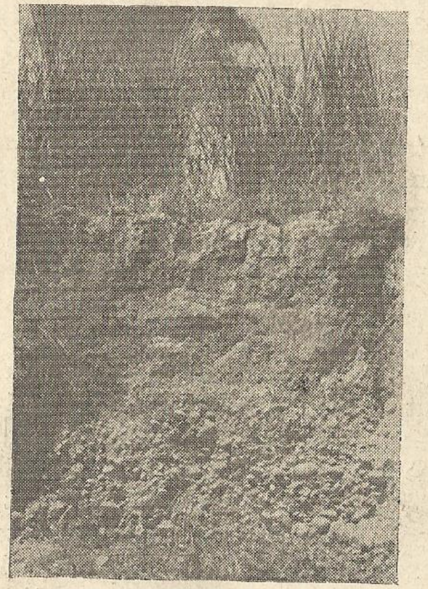

Figure 12. A profile of Umingan series. A layer of stones beneath the solum characterizes this series.

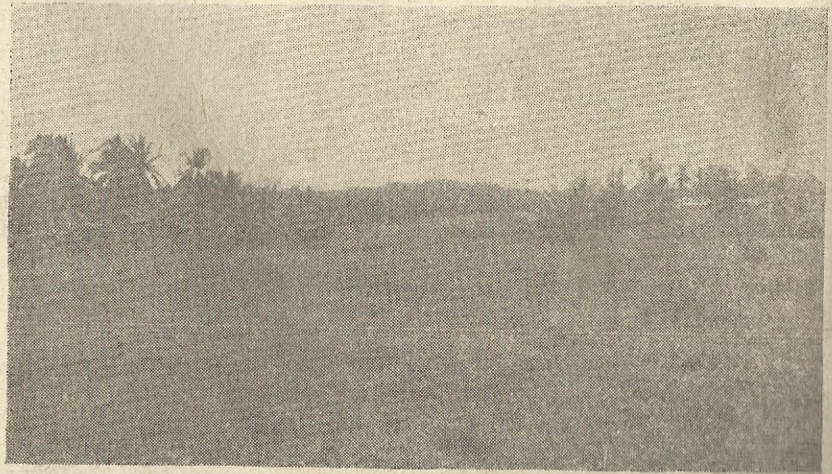

Figure 13. A landscape of Sara series. This series covers the gently rolling areas around Pilar, Dumarao, Dumalag and Banga.

It is found along the banks of the Aklan River and Panay River, and in Jamindan, Tapas, Dumarao, Balete, Ibajay, Buruanga, and Nabas.

Its typical profile characteristics are as follows:

Depth (cm.)	Characteristics
0– 25	Surface soil, clay loam; brown to pale brown; moderately granular in structure; slightly sticky; contains fair amount of organic matter; affords good root penetration; boundary with subsoil, clear and smooth.
25– 60	Subsoil, silty clay loam; pale brown; fine granular structure; friable; moderately rapid permeability; roots penetrate readily; boundary with underlying layer, wavy and clear.
60–100	Lower subsoil, sandy loam; yellowish brown; slightly compact and gritty; boundary with substratum, clear and smooth.
100–150	Substratum, fine sandy loam to fine sand; yellowish brown to light reddish brown; loose and structureless. The thickness of this layer is variable.

San Manuel clay loam is principally cultivated to lowland rice. The production normally ranges from 30 to 55 cavans of palay per hectare. This production is a fair average considering the fact that in many instances this soil type is planted to rice twice a year without the application of fertilizer. Corn is also an important crop on this soil type. In Jamindan and Tapas the yield is 30 cavans of shelled corn per hectare; in Numancia and Kalibo it is about 12 cavans. The disparity in yields may be attributed to erosion and tillage practices. Sugar cane is also extensively grown on this soil type especially in Dumarao, Dumalag, and Cuartero. The yield is 70 to 100 piculs of sugar per hectare.

There is a need for an adequate water supply to enable farmers to adopt higher yielding, late maturing rice varieties, as well as to promote a better practice of crop rotation.

San Manuel sandy clay loam (596).—This soil type is found in Roxas City, Batan, New Washington, and Nabas, with an aggregate area of about 3,542 hectares. Its relief is level; drainage is adequate. The surface soil is 20 to 25 centimeters deep and is brown to grayish brown. It is loose and friable. On lowland rice fields brick red streaks are usually found in the surface layer.

Lowland rice is the principal crop grown. The yield is from 20 to 30 cavans of palay per hectare. Corn is the secondary crop with an average production of six cavans of shelled corn per hectare. Coconut is also raised with an average annual production of 30 nuts per tree in Nabas and New Washington, and about 15 to 25 nuts in Roxas City. The other crops grown are camote, cassava, peanuts, beans, banana, and some fruit trees.

San Manuel sandy clay loam is apt to be deficient in organic matter. A regular application of farm and green manures should be observed.

SARA SERIES

Sara series was first identified and mapped in Sara, Iloilo. In Capiz, it is found on the gently undulating areas and plains of Pilar, Dumarao, Dumalag, and Banga.

The surface soils of this series are moderately loose and friable sandy loam to nearly compact clay loam. Concretions and gravels are found in the surface layer. Their substrata consist of compact silt loam. Drainage is fair to adequate.

Sara clay loam (237).—The profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 15	Surface soil, clay loam; brown to reddish brown when wet, grayish brown when dry; fine granular structure; moderately friable; concretions and gravels present; fair organic matter content; boundary with subsoil, clear and smooth.
15– 30	Subsoil, silt loam; yellowish brown to reddish brown; fine granular structure; crumbly; moderately compact; moderately rapid permeability; low organic matter content; concretions and gravels present; boundary with underlying layer, clear and smooth.
30– 80	Lower subsoil, silt loam; brown to gray with red streaks; fine granular structure; slightly friable when moist; some concretions present; boundary with lower horizon, clear and smooth.
80–150	Substratum, silt loam; grayish brown to reddish brown; medium granular structure; friable; slightly compact; some concretions present.

Sara clay loam has an aggregate area of approximately 8,615 hectares. It is unirrigated, but practically the whole area is cultivated to general farm crops. Sugar cane and rice are the main crops. Sugar cane yields about 80 to 110 piculs of sugar per hectare where the fields are fertilized and when seedlings are carefully selected. The fertilizers used are ammonium sulfate and ammonium phosphate applied at the rate

of 282 kilograms per hectare. The varieties planted are POJ 2883 and 2887, Alunan, DI 52, and LS 23 and 16.

In Dumarao and Dumalag where the rice fields are not fertilized, the yield of lowland rice is from 25 to 35 cavans of palay per hectare. In Pilar where some fields are fertilized with ammonium phosphate applied at the rate of 200 kilograms per hectare the yield is from 60 to 80 cavans; in unfertilized fields it is from 25 to 40 cavans. It is evident that Sara clay loam responds well to nitrogenous and phosphatic fertilizers. Liberal application of farm manure and the plowing under of green manures together with an adequate supply of water will increase the production.

Sara sandy loam (123).—This soil type is found on the eastern part of Pilar along the Pilar-Balasan road toward the Capiz-Iloilo provincial boundary at Balasan and Carles. It has a total area of about 1,370 hectares. About 90 per cent of the area is cultivated to crops as lowland rice, corn, sugar cane, root crops, vegetables, and tobacco. This soil type is rather low in fertility. Rice yields from 15 to 25 cavans of palay per hectare. The absence of irrigation facilities, the low organic matter content, and the lack of fertilization are the main causes of low production.

BANTOG SERIES

Soils of this series were developed from recent alluvial deposits washed down from the nearby hills and uplands. The relief of this series is level to very slightly undulating. Drainage is poor to fair.

Bantog clay (228).—This is one of the best soil types in the province for lowland rice culture. It occupies the greater portion of the Elayan plain and parts of Banga, Kalibo, New Washington, Numancia, and Ibajay of the Aklan section. Its approximate total area is 25,136 hectares or 5.70 per cent of the provincial total. The typical profile characteristics of Bantog clay are as follows.

Depth (cm.)	Characteristics
0– 30	Surface soil, clay; brown to dark brown with reddish streaks; granular structure; soft and slightly plastic, does not become very hard upon drying; fair organic matter content; affords good root penetration; boundary with the subsoil, diffused and smooth.

30– 90	Subsoil, clay; light yellowish brown; medium granular structure; hard and compact when dry, slightly plastic and sticky when wet; slow permeability; poor organic matter content.
90–150	Substratum, clay; gray with brown mottlings; medium granular structure; slightly crumbly when dry, slightly plastic when wet.

This soil type is fairly fertile. However, the growing of rice continuously, in some instances planting is done twice a year, depletes its fertility. Rotation of crops wherein soil building and organic matter-enhancing crops are included is necessary.

Lowland rice yields from 35 to 45 cavans of palay per hectare; corn, from 4 to 10 cavans of shelled corn per hectare. Generally, corn gives a better harvest from the first planting than from the second. The other crops grown are sugar cane, camote, cassava, banana, and vegetables.

STA. RITA SERIES

This soil series was first identified and mapped in Iloilo Province. The surface soil is black to dark brown clay, ranging in depth from 20 to 25 centimeters. The subsoil is also clay but with a lighter shade than the surface soil. The relief is level. Drainage is poor to fairly adequate.

Sta. Rita clay (120).—The typical profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 25	Surface soil, clay; dark brown to black; medium granular structure; soft and highly plastic when wet, shrinks and cracks and becomes hard upon drying; fair amount of organic matter; boundary with subsoil, diffused and smooth.
25– 70	Subsoil, clay; lighter colored than the surface soil; coarse granular structure; hard when dry, soft and plastic when wet; slow permeability; poor in organic matter; boundary with underlying layer, clear and smooth.
70– 95	Lower subsoil, silty clay; light brown to brown; medium granular structure; slightly compact.
95–150	Substratum, silt loam; light brown; fine granular structure; friable and soft.

Sta. Rita clay is mostly utilized for lowland rice culture. Its aggregate area is approximately 4,045 hectares. It occupies part of the plains of Sapian, Kalibo, and New Washington.

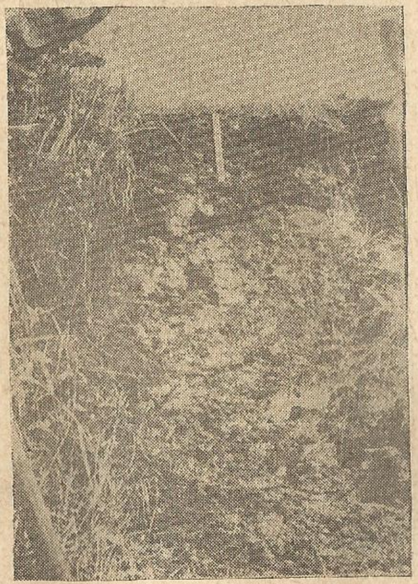

Figure 14. A profile of Bantog clay. In Capiz, this soil type is principally devoted to lowland rice.

Figure 15. Rice field of Bantog clay.

PLATE 5

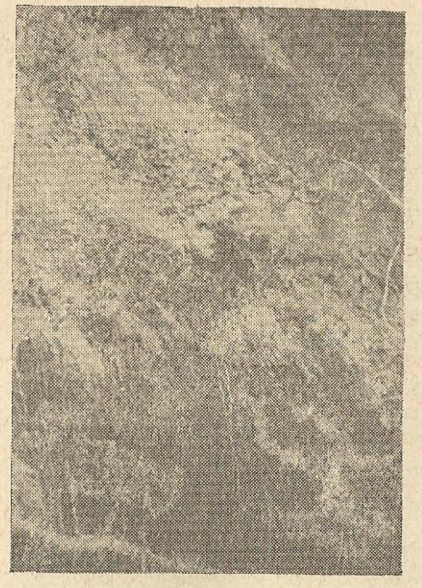

Figure 16. A profile of Sta. Rita clay. Like Bantog clay, it is mostly utilized for lowland rice culture.

Figure 17. Paddies, foreground, are on Sta. Rita clay which adjoin coconut groves on soils of Alimodian series, in the background.

In Sapian, the yield of lowland rice is from 35 to 45 cavans of palay per hectare; in Kalibo and New Washington it is from 25 to 40 cavans per hectare. The low yield is partly explained by the low yielding varieties planted, and the lack of adequate water supply. In Iloilo Province, Sta. Rita clay is irrigated and the standard late maturing rice varieties such as *Raminad, Elon-elon, Arabon,* and *Seraup Kechil 36* are planted. The yield is as high as 100 cavans of palay per hectare. In Capiz the same soil type is not irrigated and the common varieties such as *Pinili Puti, Casicad, Amarillo,* and *Kandidit* are planted. This soil type when provided with adequate irrigation and properly fertilized gives fairly high yields of palay. The other crops grown are corn, sugar cane, mungo, beans, and vegetables. Corn yields from 8 to 12 cavans of shelled corn per hectare.

MALIGAYA SERIES

The relief of this series is level to slightly undulating. The external drainage is fair. The internal drainage is rather poor because of the heavy and compact subsoil.

Maligaya clay (220).—A typical profile of the Maligaya series as represented by Maligaya clay is as follows:

Depth (cm.)	Characteristics
0– 30	Surface soil, clay; light brown to brown with reddish gray streaks; fine granular structure; hard and compact, very sticky and plastic when wet; bourdary with subsoil, clear and smooth.
30– 65	Subsoil, clay; light grayish brown to brown; fine granular structure; compact; very sticky and plastic when wet; slow permeability.
65– 95	Lower subsoil, silty clay to clay; light grayish brown to brown with reddish brown and dark gray mottlings; boundary with the substratum, clear and smooth.
95–150	Substratum, silty clay to clay; brown to grayish brown with reddish brown and dark gray mottlings; gritty.

Maligaya clay is mostly found on the plains in Dumalag, Dumarao, Cuartero, Dao, and Mambusao. It has an aggregate area of approximately 10,833 hectares. It is one of the soil types devoted extensively to rice culture in the province. Unlike the Maligaya clay found in Nueva Ecija where the production ranges between 50 and 80 cavans of palay per hectare, the soil in Capiz yields only between 30 and 40 cavans per hectare. This relatively low yield may be attributed to the insufficiency of water supply, the non-application of fertilizers, the varieties of rice planted, and the poor method of tillage. In Nueva Ecija where irrigation is quite adequate the high yielding, late maturing rice varieties, such as *Ramai*, *Quezon rice*, *Wagwag*, and *Elon-elon*, are extensively planted. In Capiz, on the other hand, the absence of irrigation makes the planting of these rice varieties inadvisable. Consequently, the medium early maturing rice varieties are planted which give correspondingly lower yields.

Maligaya clay is deficient in organic matter as indicated by the light color of the surface soil. This condition may be corrected by the proper utilization of all crop residues. Liberal application of farm manures and the turning under of legumes would maintain a good supply of organic matter in the soil. These practices could contribute much to the fertility and improve the tilth of this soil type.

MAKATO SERIES

Makato series is a new soil series which was first identified and mapped in Makato, Capiz. It belongs to the group of older alluvial soils which have moderately developed profiles. The presence of concretions in its profile makes this series different from the Maligaya, Sta. Rita, and Bauang series; while the absence of gravels in its profile makes it different from the Sara series. Another differentiating characteristic of the Makato series from the aforementioned series is the orange hue of its lower horizons.

The relief is level to very slightly undulating. The external drainage is fair to good, and while the internal drainage is fairly good in some places, it is poor in others. This soil series is principally cultivated to lowland rice.

Makato clay (221).—The profile characteristics of Makato clay are as follows:

Depth (cm.)	Characteristics
0– 25	Surface soil, clay; light brown to brown with reddish orange mottlings; medium coarse granular structure; very hard when dry, sticky when wet; some concretions present; affords fair root penetration; boundary with underlying layer, clear and smooth.
25– 40	Subsoil, clay to clay loam; brown to grayish brown with orange mottlings; medium granular structure; concretions present.
40– 60	Lower subsoil, clay to clay loam; grayish brown; friable, slightly loose; gritty.
60–150	Substratum, clay loam; gray with dark orange mottlings which tend to impart orange color to this layer; friable; concretions present; gritty.

Makato clay is found on the plains of Makato, Numancia, Lezo, Malinao, and Tangalan. It covers an aggregate area of about 6,375 hectares of which approximately 90 per cent are farm lands while the remainder is occupied by home lots or devoted for other miscellaneous purposes. Rice is grown most extensively. Corn, coconut, banana, fruit trees, sugar cane, camote, and vegetables are the secondary crops.

The yield of rice varies from 30 to 40 cavans of palay per hectare. For the last few years, however, the production was as low as 10 to 20 cavans per hectare due to the insufficiency of water. In most cases the lack of water has considerably delayed planting. Irrigation facilities are non-existent.

Makato clay is quite deficient in organic matter. The liberal application of farm manures and the plowing under of legumes are necessary.

SOILS OF THE HILLS AND MOUNTAINS

The soils of the hills and mountains comprise about three-fourths of the total area of the province, or 230,130.65 hectares. They are classified into seven soil series and one soil complex. They are primary soils developed in place from parent materials originating from hard igneous rocks and consolidated sedimentary rocks such as sandstone, limestone, and shale.

LUISIANA SERIES

The red soils of the Luisiana series were developed from highly weathered volcanic rock materials. The soils thus formed are deep, sometimes about three meters or more. The relief is rolling, hilly and mountainous; drainage is adequate to excessive.

The soils of Luisiana series differs from other red soils such as those of the Antipolo and Alaminos series. In the Luisiana series pebbles, gravels, and boulders are not found in the profile unlike that of the Antipolo series.

Luisiana clay loam (140).—The typical profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 20	Surface soil, clay loam; dark brown to reddish brown; fine granular structure; loose and friable; fair organic matter

content; affords deep root penetration; boundary with subsoil, clear and smooth.

20– 60 Subsoil, silt loam; yellowish brown to yellowish red, with red specks; slightly friable; poor in organic matter; boundary with substratum, smooth and diffused.

60–150 Substratum, silt loam; yellowish red to red, with dark red specks; slightly friable and compact.

Luisiana clay loam occupies parts of the rolling and hilly regions of Panitan, Sigma, Ivisan, Sapian, Capiz, Pilar, Pontevedra, and Dumarao. It covers a total area of about 18,717 hectares, or about 4.24 per cent of the provincial total. The external drainage is good to excessive depending upon the vegetation and slope of the area; internal drainage is good.

Upland rice is the main crop. Corn, sugar cane, mungo, beans, camote, cassava, banana, coconut, mango, citrus, and other fruit trees are also grown. The production of upland rice varies with the degree of slope and the extent of erosion. On the more level areas where erosion is slight, the yield is from 8 to 15 cavans of palay per hectare. In areas of severe erosion the yield is very low. The same is true for corn. Cultivation of this soil type requires intensive soil conservation measures.

SAN RAFAEL SERIES

San Rafael loam (133).—This soil type is hilly and mountainous. The elevation ranges from 500 to 2,000 feet above sea level. Most of the area is covered with secondary or primary forest.

The surface soil is dark gray to black, and shallow, about 10 to 12 centimeters. It is medium granular in structure, crumbly, and affords good root penetration. The boundary with the underlying layer is smooth and diffused.

The subsoil is about 12 to 30 centimeters from the surface; loam; brown; medium granular in structure; soft, friable, and crumbly. Its boundary with the substratum is also smooth and diffused.

The substratum is gray to reddish brown gravelly sand. It is structureless. Weathered andesitic rocks are sometimes present.

This soil type, being hilly and mountainous, is better suited for grazing or fruit raising provided soil conservation measures are observed. Drainage is good to excessive. The steep and rugged areas should remain as forest lands. Its total area is

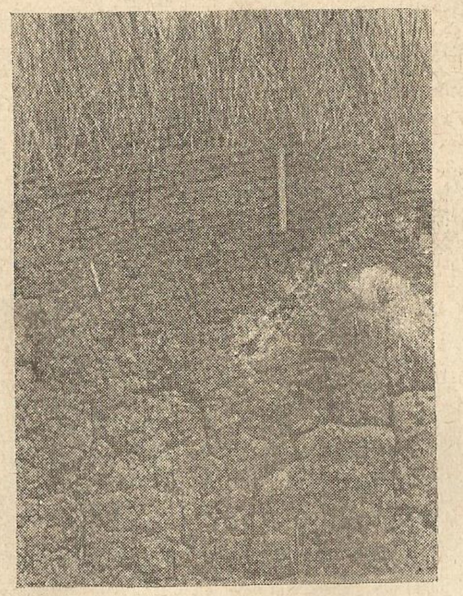

Figure 18. A profile of Luisiana clay loam. The soils of Luisiana series are deep and well drained.

Figure 19. A profile of Sapian clay. Unlike soils of the Luisiana series, Sapian soils are shallow.

PLATE 7

approximately 8,342 hectares and occupies the rough terrain on the eastern part of the province from Cuartero to Pilar, bordering Iloilo Province.

SIGCAY SERIES

Sigcay series was first identified and mapped in the barrio of Sigcay, municipality of Banga, Capiz. It consists of red soils and is found on rolling, hilly and mountainous places. The soils of this series were developed from parent materials derived from basaltic rocks and the solum is deep like that of the Luisiana series. Sigcay and Luisiana series have many similarities but they also differ especially in one particular respect. In the former, there is a deep layer of massive white soil materials, known locally as *isu,* below the subsoil which does not exist in the latter. The drainage is good to excessive. The native vegetation consists mostly of forest and grasses. The cultivated areas are planted to upland rice, corn, camote, cassava, vegetables, fruit trees, banana, coconut, and bamboo.

Sigcay clay (222).—The profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 35	Surface soil, clay; brownish red to yellowish brown; granular in structure; friable; fair organic matter content; affords good root penetration; boundary with subsoil, clear.
35–105	Subsoil, clay loam; yellowish brown to yellowish red, with a few orange splotches; columnar in structure; friable; poor organic matter content; boundary with underlying horizon, diffused and wavy.
105–150	Substratum, loam; brick red, with red and orange splotches; friable. Below this horizon, or within the horizon, a layer of massive white soil materials occurs. It is structureless and is locally known as *isu.* The depth of the substratum is often indefinite.

Sigcay clay has an approximate area of 4,479 hectares located between the towns of Banga and Libacao along the Banga-Libacao road. Very little of the area is cultivated; the greater part being grassland or forest land. The cultivated crops are upland rice, corn, camote, cassava, banana, vegetables, coconut, and fruit trees. The production for upland rice is from 5 to 10 cavans of palay per hectare.

SAPIAN SERIES

Sapian series was identified and mapped in the town of Sapian, Capiz. Unlike the soils of the Luisiana and Sigcay series, Sapian soils are shallow, and are light brown to brown. The soils of this series are developed from basaltic and sandstone rocks. The relief is rolling to hilly and mountainous. Drainage is good to excessive. Rock outcrops are found in many places. Two kilometers north of Sapian along the road to Altavas the bedrock underlying the substratum is quarried for road surfacing purposes.

The native vegetation on the rolling areas and on some of the lower hills is cogon. The higher hills and mountains are covered with secondary forests wherein scattered clearings are planted to upland rice and corn. Banana, coconut, and some fruit trees are also planted. The cultivated areas are not productive. Upland rice yields an average of only seven cavans of palay per hectare; corn, six cavans of shelled corn. Other crops planted are camote, cassava, banana, mungo, beans, vegetables, and fruit trees such as mango, star apple, pummelo, and avocado.

Sapian clay (223).—The profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 25	Surface soil, clay; light brown to brown; medium coarse granular structure; slightly sticky and plastic when wet; on open and almost bare places soil is hard and compact; poor organic matter content; boundary with subsoil, clear and smooth.
25– 50	Subsoil, clay loam to sandy loam; light brown to brown; coarse granular structure; slightly friable and loose; low in organic matter content; boundary with lower subsoil, clear and smooth.
50– 65	Lower subsoil, sandy clay loam; grayish brown; loose, friable, and gritty; some gravels present.
65–150	Substratum, highly weathered basaltic rocks; gray, with dark grayish brown mottlings; loose, friable, and gritty.

This soil type occupies the rolling and hilly to mountainous regions of Sapian; parts of the uplands of Ivisan, Altavas, Batan, and Capiz; and on both sides of the national highway from Ivisan to Altavas. It covers an aggregate area of approximately 20,841 hectares.

Sapian clay may be made more productive by better methods of cultivation. Good soil management such as the addition of farm manure and the turning under of legumes will increase the organic matter content of the soil. The steeper slopes should be kept under grass or trees permanently.

ALIMODIAN SERIES

This series is the extension of the Alimodian series mapped in Iloilo Province. It is found on the rolling, hilly and mountainous regions of the province. It is traversed by small creeks and rivers. The elevation ranges from a few hundred meters to 1000 meters above sea level. The drainage is fairly adequate to excessive. Soils of the series are developed from parent materials derived from the weathering of soft stratified sedimentary rocks such as shale and sandstone. The vegetation consists of cogon in association with *talahib* on the rolling areas and on slopes of lower hills; forests cover the higher hills and mountains.

Alimodian clay loam (126).—The typical profile characteristics of this soil type are as follows:

Depth (cm.)	Characteristics
0– 30	Surface soil, clay loam; brown to reddish brown; good, medium granular structure; slightly friable when moist, hard and brittle when dry; sometimes gravels and stones are present; fair organic matter content; easily penetrated by roots, boundary with the subsoil, clear and smooth.
30– 60	Subsoil, clay loam; light brown; slightly brittle, hard, and slightly compact; poor in organic matter content; boundary with substratum, clear and smooth.
60–150	Substratum, highly weathered shale or sandstone; gray to grayish brown; weak, coarse, platy structure; slightly compact; shale or sandstone stratified.

Alimodian clay loam is the most extensive soil type mapped in the province. It covers a total area of about 145,585 hectares, or 33.01 per cent of the provincial total. It has the largest area cultivated with the greatest number of people dependent upon it in comparison with the other soils of the group. The general farm crops grown are upland rice and corn. The yield of upland rice varies in many places depending upon the extent to which erosion has changed the physical make up of the surface soil. On the areas where the surface soil is already thin, or the subsoil is exposed, the production is quite low, ranging from 4 to 6 cavans of palay per hectare. On the areas where erosion has not done much damage to the surface soil, such as in small pockets, valleys and the more

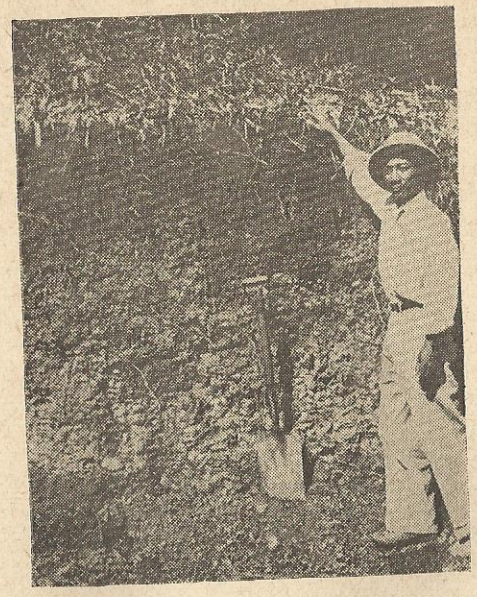

Figure 20. A profile of Alimodian clay loam. This soil has good, medium granular structure. It is the most extensive soil type in Capiz.

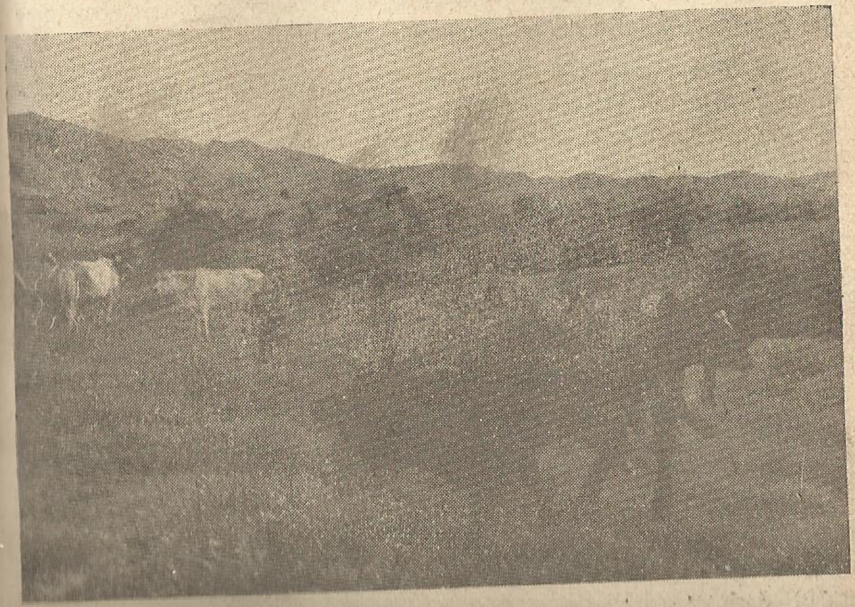

Figure 21. A landscape of Alimodian-Barotac complex at the Dumarao Stock Farm. A greater portion of this soil is devoted to pasture by the stock farm.

PLATE 8

level areas, the production ranges from 10 to 20 cavans of palay per hectare. This condition is the same for corn.

Farm management based on soil conservation principles should be adopted to make the land more productive and safeguard it from erosion. Its organic matter content should be maintained or replenished by the application of farm manure and a system of crop rotation with leguminous crops included in the sequence should be a part of the farm program. The application of the right kind and quantity of fertilizer will help maintain the fertility of the soil.

Alimodian-Barotac complex (125).—This soil complex is found on the southeastern part of Dumarao and Cuartero. It occupies a rolling and hilly region. It has an approximate total area of 13,391 hectares. The whole Dumarao Stock Farm is within this area. It is called Alimodian-Barotac complex because the two components, Alimodian and Barotac soils, are so closely associated that one cannot be mapped separately from the other. The Alimodian soil characteristics are more dominant than those of the Barotac soils. The predominating soil texture is clay loam. In some places stones are found on the surface. These do not, however, interfere with tillage operations. Drainage is good to excessive.

A greater portion of this soil is devoted to pasture by the Dumarao Stock Farm. Within the pasture lands are spot cultivations of upland rice, corn, vegetables, mungo, beans, camote, and cassava. Outside the pasture land are wider areas cultivated to diversified farm crops. This soil should certainly be devoted for pasture. If cultivated, the soil must be protected from erosion. Intensive soil conservation practices should be followed.

BAUANG SERIES

Bauang clay (121).—The soil is developed through the weathering of soft and porous sedimentary rocks of stratified shale and sandstone. The dominant relief is hilly to mountainous; drainage is good to excessive. It is brown and friable. The stratification of the shale and sandstone in this series is more prominent than in soils of the Alimodian series. Vegetation consists of cogon or secondary forest. Bauang clay was first identified and mapped in the province of La Union.

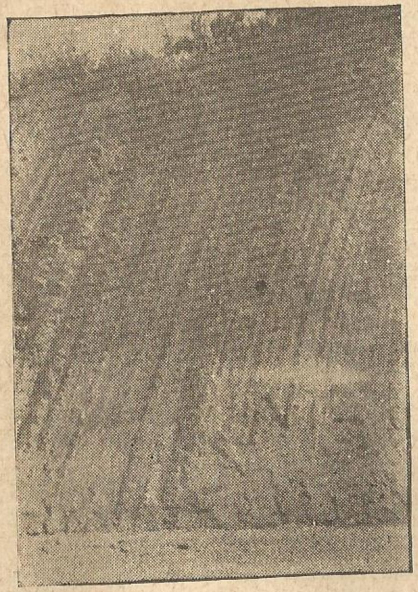

Figure 22. A profile of Bauang series. The soil is developed through the weathering of soft and porous sedimentary rocks of stratified shale and sandstone

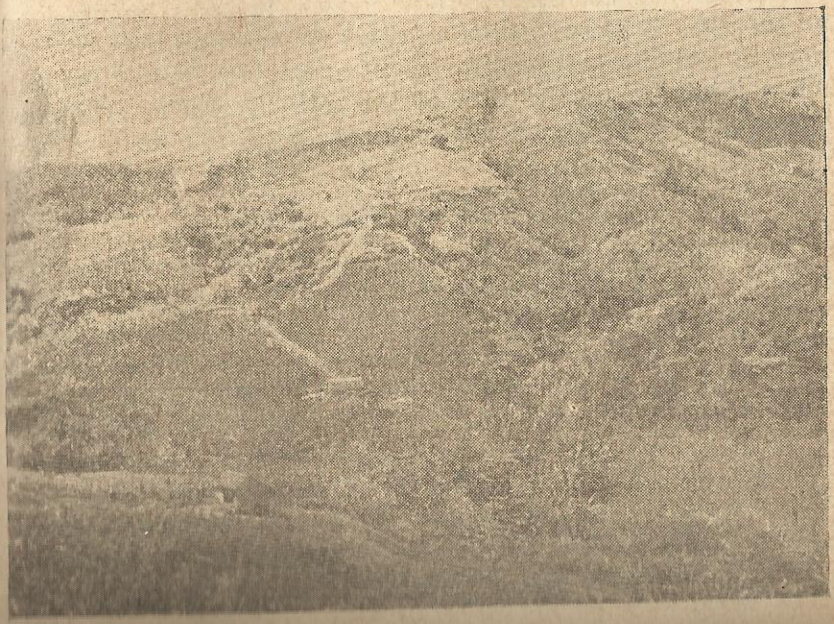

Figure 23. A landscape of Bauang series. Hilly and mountainous, perennial crops, rather than seasonal crops, should be cultivated.

PLATE 9

The typical profile characteristics of Bauang clay are as follows:

Depth (cm.)	Characteristics
0– 25	Surface soil, clay; light brown to brown; coarse granular structure; friable and loose; fine granules on the surface usually present; poor to fair organic matter content; affords good root penetration; boundary with subsoil, clear and gradual.
25– 90	Subsoil, sandy texture, highly weathered stratified shale and sandstone of cubical to hexagonal particles; poor organic matter content.
90–150	Substratum, stratified shale and sandstone that become powdery when pulverized, sometimes stratification is very deep. Below this horizon are sometimes beds of sandstone rocks.

This soil type occupies the rolling to hilly and mountainous regions along both sides of the national highway between Tangalan and Ibajay. Its area is approximately 7,873 hectares.

A small portion is farmed and grown to upland rice, corn, coconut, banana, camote, cassava, vegetables, beans, mungo, and some fruit trees. The yield of upland rice is quite low, from four to seven cavans of palay per hectare. Corn also has a very low yield. This soil is good for the growing of fruit trees such as mangoes, star apples, bananas, pummelos, and oranges. The application of farm manure and the plowing under of legumes are good means of supplying organic matter and maintaining the fertility of the soil. Terracing, contour tillage, and crop rotation are necessary practices for the cultivated sloping areas.

FARAON SERIES

Faraon clay (132).—This soil type occupies the limestone hilly areas of Dumalag, Dumarao, and Pilar with an approximate area of 10,900 hectares. Faraon clay, like the other upland soils of the province, is rolling, hilly and mountainous. The soil is developed through the weathering of soft and porous coralline limestone. The limestone rock is generally grayish but upon weathering under forest conditions, it turns orange to dark yellowish gray. Drainage is excessive. The native vegetation is cogon and forest. Erosion is serious in some places. In a normal soil profile, the surface soil is 30 centimeters thick, black clay, compact, very sticky and highly plastic when wet, but upon drying it becomes hard. The subsoil is from 15 to 20 centimeters thick, dark yellowish gray clay and is highly plastic.

The profile characteristics of Faraon clay are as follows:

Depth (cm.)	Characteristics
0– 30	Surface soil, clay; black; medium granular structure; sticky and plastic when wet, hard and slightly brittle when dry; limestone rocks sometimes present; fair organic matter content; affords fair root penetration; boundary with subsoil, clear and smooth.
30– 45	Subsoil, clay; dark yellowish gray; highly plastic when wet, hard and brittle when dry; particles of weathered limestone rocks present; boundary with substratum, clear and smooth.
45– 60	Highly weathered limestone rocks, yellowish gray; coarse granular structure; soft.
60–150	Limestone rocks; grayish or white; porous, soft and easily crushed.

This soil type is not extensively cultivated in the province. Many areas have shallow surface soils, and in some places the limestone bedrock is visible. The cultivated areas should be protected from erosion. Contour tillage, cover cropping, and fertilization should be observed. Addition of organic matter is important.

Upland rice and corn are the principal crops; banana, coconut, citrus, and root crops are secondary crops. The production of upland rice and corn is rather low. This soil type is better suited for permanent crops especially fruit trees. Orchards for citrus and mango if properly managed may prove profitable.

MISCELLANEOUS LAND TYPES

Hydrosol (1).—The hydrosol is generally characterized by a brackish aqueous horizon or surface water ranging in depth from 5 to 100 centimeters. This horizon is the most important medium for the growth of algae and other aquatic plants which are the food of fishes. The subaqueous horizon, equivalent to horizon "A" in the soil profile, is of slimy, light brown to gray clay with plenty of undecomposed organic debris. The depth ranges from 20 to 60 centimeters. This subaqueous layer is underlain by a basal horizon of gray slimy clay with depth of from 20 to 60 to more than 150 centimeters. The mangroves, nipa swamps, and fishponds fall under this miscellaneous land type.

Figure 24. A profile of Faraon series. The soil is developed through the weathering of soft and porous coralline limestone.

Figure 25. A landscape of Faraon series. Note limestone rocks, a distinguishing characteristic of the series.

PLATE 16

The hydrosol has an approximate area of 25,754.31 hectares, or 5.84 per cent of the total area of the province. Hydrosol areas are extensive in Pilar, Pontevedra, Panay, Roxas City, Sapian, New Washington, Kalibo, Makato, and Ibajay. The halophytic trees which grow in these places like the *api-api, bakauan*, and *daluru*, are good sources of firewood and housing materials. The nipa leaves are made into thatch for houses, while the nipa inflorescence is tapped for *tuba* and vinegar. Parts of the hydrosol are made into fishponds especially in Pilar, Capiz, and Sapian.

Mountain soils, undifferentiated (45).—This miscellaneous land type has an area of 102,581.65 hectares or 23.26 per cent of the total area of the province. It occupies the rough terrain and high mountains on the western part of the province bordering Antique Province and the high mountains between Dumalag and Jamindan. This area is unfit for agriculture and should be under forest only. There are clearings on some of the slopes for the cultivation of upland rice, corn, and camote which should not be so. On the other hand, open land that is bare of trees should be timbered to enlarge and increase the natural water reservoir of the province.

Beach sand (118).—It is a narrow strip of land along the seashore. The relief is level to very slightly undulating. The profile is undeveloped so that to a depth of 150 centimeters from the surface the layer is structureless, dark-gray to brown sand with low organic matter content. The external and internal drainage are good.

The soil textural class and consistency vary directly with the distance from the shore; coarse and loose near the shore and fine and slightly compact inland. This miscellaneous land type may be profitably grown to coconut and fruit trees such as *atis, guayabano, siniguelas, casoy*, breadfruits, *nangka*, bananas, oranges, and chico. The area of the beach sand is 5,211.30 hectares or 1.18 per cent.

MORPHOLOGY AND GENESIS OF SOILS

"Soils are natural media for the growth of plants. They are mixtures of fragmented and partly or wholly weathered rocks and minerals, organic matter, water, and air, in greatly varying proportions, and have more or less distinct layers or horizons developed under the influence of climate and living organisms." The five major factors of soil formation, parent materials, climate, living organisms, relief, and time are responsible for the rise of various soil types and their characteristics. Thus there are soil types with marked differences from one another and there are soil types whose differences are broad in many respects. There are also wide areas whose soils may appear similar but have distinct dissimilarities in characteristics.

In the province of Capiz, various rocks such as basalt, coralline limestone, sandstone, slate, shale, igneous and sedimentary rocks formed the parent materials of the soils. Basaltic rocks are found as outcrops in Ivisan, Sapian, Altavas, Buruanga, Roxas City, Balete, Ibajay, Pilar, Dumalag, Dumarao, Nabas, and Batan. These are dark brown rocks and are the parent materials of the soils of San Rafael, Sapian, Luisiana, and Sigcay. The soils developed from these rocks are brown to reddish brown.

Shale and sandstone are the dominant rocks in the province. They are found in most of the upland, rolling, and hilly regions. They appear as thin, yellowish-brown to gray plates in horizontal layers and in stratification. Sometimes the sandstones are in massive boulders. They are the parent materials of the Alimodian and the Bauang soils.

Coralline limestone rocks are found in the hills south and west of Dumalag, south and east of Dumarao, and parts of the hills east of Pilar proper along the national highway. These are rough rocks with many sharp and irregular edges. The soils developed from these rocks are generally black clay and very sticky. They are classified under the Faraon series.

The metamorphic rocks are either igneous or sedimentary rocks, the physical properties of which have been altered by pressure or temperature or both. These are found in the mountains along the Capiz-Antique boundary.

The soils of Capiz Province are of two general formations, the primary and the secondary soils. The primary soils are those soils which have been formed through the weathering process of the parent materials. These are the soils that have well developed profile characteristics as represented by the upland soils of the province. The secondary soils are those soils which have been transported by the action of water and wind, and the alluvial soils of the plains and valleys deposited at different times. They have undeveloped to slightly and moderately developed profiles.

These two generally formed soils of the province are classified into their respective profile groups. The preliminary outline of the profile studies and classification of Philippine soils adopted by the Division of Soil Survey from the University of California have established nine profile groups on the basis of topography, mode of formation, and kind of profile. Under these groupings the soils of Capiz Province are divided into six groups arranged as follows:

Profile Group I
1. Coastal beach sand

Profile Group II
1. Umiñgan series
2. San Manuel series

Profile Group III
1. Sara series
2. Bantog series
3. Sta. Rita series
4. Maligaya series
5. Makato series

Profile Group VII
1. Luisiana series
2. San Rafael series
3. Sigcay series
4. Sapian series

Profile Group VIII
1. Alimodian series
2. Bauang series

Profile Group IX
1. Faraon series

Profile group I, as represented by the coastal beach sand, consists of soils of young alluvial fans, flood plains or other secondary deposits having undeveloped profiles. The profile of the coastal beach sand is a layer of fine to coarse structureless sand.

Under profile group II are the Umingan and San Manuel series. These are soils of young alluvial fans, flood plains or other secondary deposits with slightly developed profiles, underlain by unconsolidated materials. These soils are much more developed than the coastal beach sand. The Umingan and San Manuel series, although they are in the same profile group have characteristics distinct from each other. The Umingan series has in its profile a layer or layers of gravels, stones, and pebbles which are absent in the San Manuel series. They have similar topographical characteristics and both are fitted to lowland rice culture.

Profile group III are soils on older alluvial fans, alluvial plains or terraces having moderately developed profiles underlain by unconsolidated material. These are generally deep soils and they are not underlain by claypan or hardpan but their subsoils are moderately dense. Under this profile group are the Sara, Bantog, Sta. Rita, Maligaya, and Makato series.

The Sara series differs from the other series under the group in color, and in the presence of concretions and gravels from the subsoils to the lower horizons. This series belongs to the red soils of the tropics. The Bantog, Maligaya, and the Sta. Rita series have no concretions nor gravels in their profiles, characteristics distinguishing them from the rest of the series in the group. The Sta. Rita, however, differs from Bantog and Maligaya series by its dark surface and subsoils and a silt loam substratum. The Makato series, on the other hand, has few concretions in all its horizons and an orange color in the lower horizons. The relief of this group of soil series is level to slightly undulating. They are extensively cultivated to general farm crops especially lowland rice.

The soils of profile group VII are developed on hard igneous bed rocks. These soils are formed from parent materials derived from the underlying igneous rocks, and occupy a rolling to steep topography. The Luisiana, San Rafael, Sigcay, and Sapian series belong to this group of soils. The Luisiana and Sigcay series are red and deep soils, and are considered the oldest and most weathered among the group. The Sigcay series differs from the Luisiana series by a deep massive white soil material usually found 50 centimeters below the surface in many parts of the area. The San Rafael and Sapian series have shallow soils of dark brown color. They differ from each other by the textural characteristics of their profiles. These soils are primary soils.

The Alimodian and the Bauang series are classified under profile group VIII. These are the soils on upland areas developed from consolidated sedimentary rocks. They have been

formed on stratified rocks such as limestones, sandstones, and shales. The topography is generally rolling and steep. These two series differ from each other in the color of their surface soils, friability, and the prominence and character of the stratification. They are primary soils.

Faraon series is the only soil series under profile group IX. The soils under this group are developed on lightly consolidated materials. They are generally formed from the marly or soft sandstone-like materials. The topography is generally rolling and steep. The Faraon series differs from that of the Bolinao series, which is also a soil of limestone formation, in that the former has a black soil as a result of the weathering of the soft and porous coralline limestone while the latter has a red soil.

LAND-USE AND SOIL MANAGEMENT

The importance of proper soil management in farming has been long recognized. When the soil is given the right attention, it responds readily and thus crop yields are increased. It is a fact, however, that in spite of the many and various correct farm practices already known, crops have not fared so well and farm production has not increased in accordance with scientific advances. The province of Capiz is not an exception.

During the survey of Capiz Province it was noted that there were many farmers who were working on lands already submarginal in production. These lands might have been originally poor, or perhaps a good portion were at first not bad, but due to faulty soil management practices, they have become so depleted in fertility that they could not sustain a good level of production. This illustrates how soils are exhausted in their fertility either by soil erosion, or due to incorrect farm practices. It is essential that farmers should know their soils in order to determine the right basis for their treatment, to insure good yields, and to improve soil conditions in general.

The soils of the province of Capiz have been continuously farmed for centuries. Livestock grazing is concentrated only to a small portion. The factors that limit to a large degree the success of agricultural operations in a place are climate, soil, character of relief, and stoniness, which were discussed in the previous chapter of this report.

The various soil types of Capiz Province are grouped into different land capability classes which appear in table 13.

Crop rotation should be planned to provide in sequence some leguminous crops. This measure provides cover for the soil for a certain period, thus lessening the hazards of erosion, as well as it increases the organic matter in the soil. Strip and contour cropping greatly reduce runoff, thus minimizing soil losses. These measures also insure greater percolation of water and its subsequent retention in the soil for plant use. The alternation of corn or upland rice with legumes along the contour of sloping land checks the flow of runoff and hastens its absorption by the soil. The terracing of land following the contours and at right angles to the slope accompanied by a good system of soil management is necessary especially for the soils on sloping land now under cultivation. The intervals between terraces depend upon the steepness of the slope. Keeping the land not cultivated under cover with grasses, legumes or other close growing crops, and trees is also important for soil conservation. The steep slopes should never be cultivated but left under grass or better still be reforested. Planting of more trees on the hill and mountain slopes should be seriously undertaken.

WATER CONTROL ON THE LAND

Water is a cause of soil erosion but at the same time it is also an important factor in crop production. Its control is, therefore, imperative to minimize erosion as well as to assure adequate water supply for farming operations. The supply of water for crop needs depend upon the amount of rainfall, relief, the types of crops grown on the land, tillage practices, and the physical characteristics of the soil. There are also operations on the farm, such as runoff and erosion control, drainage and irrigation, which collectively contribute to the success or failure of water control on the land. The control of runoff and erosion are the most important of these activities. Protection of bottom lands from flooding or overflow also deserves attention. Irrigation facilities are important to supplement rain water.

The soils of the swamps and marshes of the province do not need much protection from runoff and erosion because they are nearly level so that there is a negligible loss of surface soil through erosion. On the other hand, they receive soil materials from the adjacent lands.

The soils of the plains and valleys need a minimal protection from runoff and erosion because they are almost level or very

moderately undulating. The construction of paddies on rice farms to impound rain or irrigation water immediately prevents erosion.

The soils of the rolling areas, hills and mountains are moderately to severely eroded and so these areas need more attention where the control of runoff and erosion especially in the cultivated regions is concerned. Sheet and gully erosions are quite severe in these places especially when farm operations seldom include conservation measures. In the Alimodian and Bauang series, erosion has gained headway. Many of the cultivated areas have become submarginal lands. They need soil conservation and soil building practices. In the Luisiana and Sigcay series, sheet and gully erosions are common. These also prevail in the other series like Faraon, Sapian, and San Rafael. In many instances their subsoils are already exposed, and in extreme cases the surface soils and subsoils having been eroded completely exposing the substratum. If no attempt is made to minimize or control erosion due to runoff the accumulative yearly losses may someday create a problem of social unrest.

Soil types which are susceptible to erosion must be handled by a well planned cropping system which embodies (1) crop rotation to include a leguminous crop, (2) strip cropping by alternate planting of grains and legume crops, (3) applying correct kind and quantity of fertilizers and lime, (4) liberal application of farm manure and the plowing under of legumes to increase the organic matter content of the soil, (5) contouring or terracing on slopes, and (6) cover cropping of critical areas with grasses, legumes and other close growing crops, and trees. Applying the proper conservation practices where they are needed will greatly help in controlling erosion. Steeply sloping lands should be reforested.

Other areas which are neither suited for cropping nor pasture because of unfavorable relief should be planted to trees and left to wildlife or recreational purposes.

PRODUCTIVITY RATINGS OF THE SOILS OF CAPIZ PROVINCE

The productivity ratings of soils are included in the soil survey report because they supplement the soil types descriptions and at the same time present in figures the previous performance of the soil as to crop yields. They also indicate the suitability or unsuitability of the land for particular crop or set of crops.

The productivity ratings of the soil types of Capiz Province were obtained by the deductive method. Data of crop yields for a long period are considered excellent sources to furnish information on crops and the suitability of certain soil types for these same crops. However, such data are seldom compiled by farmers and even government agencies on agriculture have inadequate statistics. The average yields of the different crops on the various soils of the province were gathered through inquiries directly from farmers, as well as studies from census, bulletins, and reports of various provincial agricultural officials. These figures are based on local farm practices without the addition of commercial fertilizers or amendments.

Table 10 gives the productivity ratings of the soils of Capiz for the major crops grown in the province. The table indicates that the soils of Capiz Province vary in their production for each of the major crops herein considered. These variations in productivity ratings are significant because they show which of the soil types need improvement.

TABLE 10.—*Productivity ratings of the soils of Capiz Province*

Soil type No.	Soil type	Crop productivity index for [1]							
		Low-land rice 100 = 60 cav.	Up-land rice 100 = 20 cav.	Corn 100 = 17 cav.	Sugar cane 100 = 80 piculs	Coco-nut 100 = 3,750 nuts	Ca-mote 100 = 8 tons	Cas-sava 100 = 15 tons	Mun-go 100 = 7 cav.
236	San Manuel clay loam	85	------	85	105[2]	85	75	70	100
228	Bantog clay	75	------	70	70	75	------	------	85
120	Sta. Rita clay	75	------	70	------	70	------	70	80
237	Sara clay loam	65	------	60	115[2]	75	60	55	75
220	Maligaya clay	65	------	60	------	------	------	------	75
221	Makato clay	60	------	45	------	75	55	------	70
100	Umingan sandy loam	55	------	80	------	------	75	70	------
596	San Manuel sandy clay loam	40	------	35	------	100	60	55	------
123	Sara sandy loam	35	------	35	50	60	55	50	60
126	Alimodian clay loam	------	75	60	65	65	60	55	70
140	Luisiana clay loam	------	60	40	75	50	45	50	60
223	Sapian clay	------	40	30	------	55	45	45	------
121	Bauang clay	------	35	35	------	40	------	------	------
222	Sigcay clay	------	40	40	------	50	35	35	------
132	Faraon clay	------	35	35	------	70	30	------	65
133	San Rafael loam	------	50	25	------	------	40	------	------
118	Beach sand	35	------	25	------	80	------	------	------
1	Hydrosol	------	------	------	------	------	------	------	------
45	Mountain soils, undifferentiated	------	------	------	------	------	------	------	------

[1] Soils are given indexes that give the approximate average production of each crop in per cent of the standard of reference. The standard represents the approximate average yield obtained without the use of fertilizer or soil amendments on the more extensive and better soil types of the Philippines on which the crop is most widely grown.

[2] This rating for this soil type for this particular crop was from fertilized fields.

KEY TO THE SOILS OF CAPIZ PROVINCE

TABLE 11.—*Key to the soils of Capiz and soil conservation practices recommended*

Soil type No.	Soil type	Parent materials	Dominant relief	Drainage		Conservation practices necessary	Present land use
				External	Internal		
100 236 596	Umingan sandy loam San Manuel clay loam San Manuel sandy clay loam	Alluvial soil	Flat	Good	Good	Green manuring; fertilization; liming; crop rotation.	Rice, corn, tobacco, sugar cane, and root crops.
237 123 228 120	Sara clay loam Sara sandy loam Bantog clay Sta. Rita clay	Recent alluvial deposits	Level to gently rolling	Fair	Poor	Green manuring; irrigation and drainage, fertilization; crop rotation.	Lowland rice, sugar cane, corn, coconut, banana, root crops, vegetables and fruit trees.
220 221	Maligaya clay Makato clay	Recent alluvial deposits	Level to slightly undulating	Fair	Poor	Irrigation and drainage; fertilization; green manuring.	Lowland rice, corn, sugar cane, camote, banana, coconut, and fruit trees.
140 133 223 222	Luisiana clay loam San Rafael loam Sapian clay Sigcay clay	Residual soil from igneous rock	Rolling to mountainous	Excessive	Good	Contour and strip cropping; terracing, crop rotation.[1]	Upland rice, corn, sugar cane, coconut, banana, fruit trees, vegetables, root crops and mongo.
126 120 121	Alimodian clay loam Alimodian–Barotac complex Bauang clay	Shale and sandstone	Rolling to hilly and mountainous	Excessive	Good	Terracing; contour and strip cropping; grassed water ways; cover cropping.[1]	Upland rice, corn, sugar cane, coconut, banana, fruit trees, and root crops.
132	Faraon clay	Coralline limestone	Rolling to hilly and mountainous	Excessive	Poor	Contouring; pasture; fertilization; cover cropping.[1]	Citrus and mangoes.

[1] As usual requires crop rotation, green manuring, liming, fertilization and irrigation or drainage.

FIELD DETERMINATION OF SOIL TEXTURAL CLASS

The determination of the soil textural class is made in the field mainly by feeling the soil with the fingers. While this requires skill and experience, accuracy can be had if the field scientist frequently checks his field textural classification against laboratory results.

Hereunder are definitions and descriptions of the basic soil textural classes in terms of field determination.

Sand.—Sand is loose and single-grained. The individual grains can readily be seen or felt. Squeezed in the hand when dry, individual particles will fall apart when the pressure is released. Squeezed when moist, the particles will form a cast, but will crumble when touched.

Sandy loam.—Sandy loam contains much sand with enough silt and clay to make it somewhat coherent. The individual sand grains can be readily seen and felt. Squeezed when dry, the soil particles will form a cast which readily fall apart, but if squeezed when moist, a cast can be formed which will bear careful handling without breaking.

Loam.—Loam consists of a relatively even mixture of different grades of sand, silt, and clay. It is mellow with a somewhat gritty feel, yet fairly smooth and slightly plastic. Squeezed when dry, the soil particles will form a cast that will bear careful handling, while the cast formed by squeezing the moist soil can be handled quite freely without breaking.

Silt loam.—Silt loam contains a moderate amount of the fine grades of sand and only a small amount of clay, over half of the particles being of the soil separate called "silt." When dry it may appear cloddy but the lumps can be readily broken, and when pulverized it feels soft and floury. When wet the soil readily runs together and puddles. Either dry or moist, the soil particles will form into a cast which can be freely handled without breaking. When moistened and squeezed between the fingers, it will not "ribbon" but will give a broken appearance.

Clay loam.—Clay loam is a fine-textured soil which usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and fingers, it will form a thin "ribbon" which breaks readily, barely sustaining its own weight. The moist soil is plastic and can be formed into a cast that will bear much handling. When kneaded in the hand it does not crumble readily but tends to form into a heavy compact mass.

Clay.—Clay is a fine-textured soil that usually forms very hard lumps or clods when dry, and is quite plastic and usually sticky when wet. When the moist soil is pinched between the thumb and fingers, it will form into a long, flexible "ribbon." Some fine clays very high in colloids are friable and lack plasticity under all conditions of moisture.

The above definitions are descriptive only. None could be made in these or similar terms that would apply adequately to all soils. The dependable difinitions, the standards, are those developed from mechanical analysis.

MECHANICAL ANALYSIS OF CAPIZ SOILS

The mechanical analysis of the surface soils of the different soil sypes mapped in Capiz Province was conducted in the laboratory in order to check the field classification. The general trend of the results agree with the field classification. In the doubtful field classification of some textural grades, the results of the mechanical analysis were used. On the other hand, some clayey soils exhibit a high state of friability, mellowness and ease of cultivation. These soils have high humus content and are usually given the field classification, except when the clay content is quite high. In such case, the textural class determined from the field analysis is followed.

The modified hydrometer method of mechanical analysis devised by Bouyoucos was used. Table 12 shows the results of the mechanical analyses of the surface soils of the different soil types mapped in the Province of Capiz.

TABLE 12.—*Mechanical analysis of the surface soils of the important soil types in Capiz Province*

Soil Type No.	Soil Type	Sand 2.0-0.05 mm.	Silt 0.05-0.002 mm.	Clay below .002 mm.
100	Umingan sandy loam	53.6	28.8	17.6
236	San Manuel clay loam	38.8	32.8	28.4
596	San Manuel sandy clay loam	67.0	11.8	21.2
237	Sara clay loam	42.8	28.8	28.4
123	Sara sandy loam	71.6	16.8	11.6
228	Bantog clay	8.0	30.8	61.2
120	Sta. Rita clay	16.2	21.4	62.4
220	Maligaya clay	11.4	24.6	64.0
221	Makato clay	9.2	29.4	61.4
140	Luisiana clay loam	46.6	21.4	32.0
222	Sigcay clay	38.8	28.8	32.4
223	Sapian clay	28.8	26.8	44.4
126	Alimodian clay loam	38.6	29.8	31.6
121	Bauang clay	29.2	26.4	44.4
132	Faraon clay	14.4	28.6	57.0

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LAND CAPABILITY CLASSIFICATION AND CONSERVATION GUIDE FOR THE SOILS OF CAPIZ

The seventeen soil types and three miscellaneous land types found in the province are grouped into their respective land capability classes. A land capability class is a unit of classification to which a soil type belongs from the standpoint of its apparent and potential agricultural or economic capabilities. It is, therefore, a necessity for one to know the physical as well as chemical characteristics of each soil type to enable one to judge correctly the capability of any soil type. The three major factors to consider in land capability classification are (1) the soil type, (2) the slope of the land, and (3) the degree of erosion. In the Philippines the three major problems on soils are (1) erosion and runoff, (2) wetness and drainage, and (3) root zone and tillage limitations, such as shallowness, stoniness, droughtiness, and salinity. The aforementioned problems further divides each class into subclasses for the soil type and are indicated by "e" for erosion and runoff; "w" for wetness and drainage; and, "s" for root zone and tillage limitations.

The different land capabilities are as follows:

Class A—This is a good land that can be cultivated safely and extensively to crops with ordinary good farming practices.

Class B—This is a good land that can be cultivated safely using easily applied conservation practices.

Class C—Moderately good land that can be used regularly for cultivated crops in a good rotation but needs intensive conservation treatments.

Class D—This is a fairly good land that is best suited for pasture but can be cultivated to crops in a good rotation with intensive conservation treatments.

Class L—This land is flat but is too wet or stony and is suited for pasture or forestry.

Class M—This land is too steep, eroded, or shallow for cultivation but is suited for grazing or forestry if well managed.

Class N—Land is very steep, eroded, rough, shallow, or dry. Good only for forestry or grazing if handled with great care.

Class X—Land is level but wet most of the time and cannot be economically drained. Can be used for farm pond or recreation.

Class Y—This land is too steep, eroded, barren, and rugged, and should be reserved only for wildlife or recreation.

TABLE 13.—*Land capability classification of the different soil types in Capiz Province*

Soil type No.	Soil type	Possible soil Unit[1] Slope-erosion	Land capability class
10 23 596	Umingan sandy loam San Manuel clay loam San Manuel sandy clay loam	a–0	A
121 126	Bauang clay Alimodian clay loam	a–0	Bw
120 220 221 228	Sta. Rita clay Maligaya clay Makato clay Bantog clay	b–0	Bw
123 237	Sara sandy loam Sara clay loam	b–0	Bs
121 126 132 140 222	Bauang clay Alimodian clay loam Faraon clay Luisiana clay loam Sigcay clay	b–1 c–2 d–2	Be Ce De
118	Beach sand	----------	Ds
121 125 132 133 223	Bauang clay Alimodian–Barotac complex Faraon clay San Rafael loam Sapian clay	----------	M
45 125 126	Mountain soils, undifferentiated Alimodian–Barotac complex Alimodian clay loam	----------	N
1	Hydrosol	----------	X

LAND CAPABILITY CLASS A

Soil types: Umingan sandy loam
San Manuel clay loam
San Manuel sandy clay loam

Deep, level, well drained easily worked soil

Class A land is nearly level. The soils are deep, dark and usually fertile or can be made fertile under good management. They are usually deep alluvial soils which vary from silty to

[1] The slope-erosion units are the possible conditions that may exist in each soil type. Any other unit with an erosion class more than the one specified above will be classed under the next capability class, thus, Alimodian clay loam with a b–2 classification will be classed Ce.

sandy texture. Erosion is not much of a problem. They do not need drainage or other special practices. The land is rarely flooded. They are easy to work and can be cultivated safely with ordinary good farming methods.

Class A land is suited for intensive cropping. All crops common to the area can be grown on this land. Since soils of this class have good permeability, they are better adapted for crops other than rice. When used for lowland rice puddling of the soil is usually necessary to prevent excess seepage.

Conservation farming requires such practices as liming (agricultural lime) when needed; the use of the correct kind and quantity of fertilizers; and rotation of crops, which includes a legume or a soil-improving crop for sustained production.

For better efficiency in the use of lime and fertilizers, a regular practice of green manuring or the plowing under of young green plants such as any legume crop or any farm manure or compost is advisable. Waterways through or adjacent to this class of land should be well vegetated with adapted grass, shrubs, or trees.

LAND CAPABILITY CLASS BW

Soil types: Bauang clay
Alimodian clay loam
Sta. Rita clay
Maligaya clay
Makato clay
Bantog clay

Land that can be cultivated safely but needs drainage in addition to good farm management practices to maintain productivity.

Class Bw is good land but because of poor drainage condition some effort to drain the excess water is needed. Included in this class are wet lands that can be easily drained. They usually occur on low bottoms near large streams. The soils are deep but the subsoils are heavy or the water table is very shallow thus restricting water movement. Small ditches are needed to drain off surplus water. Diversion ditches should be constructed for runoff coming from adjoining uplands. Protection from occasional overflow of nearby streams may be needed.

When properly drained, corn, sugar cane, legumes, and many other row crops common in the area may be grown. Lowland

rice is especially suited to this land with the construction of paddies.

Lime and fertilizers of the recommended kinds and quantities, soil-improving crops, farm manure, and compost are needed to maintain the productive capacity of this class of land.

LAND CAPABILITY CLASS BS

Soil types: Sara clay loam
Sara sandy loam

Land that can be cultivated safely but because of low fertility needs special soil management practices to maintain productivity.

Class Bs land is potentially good land but because of low fertility it needs special soil management and improvement practices to restore and maintain its productivity. This land is smooth to gently sloping. The soils are deep but have sandy loam subsoils that are porous and allow water to percolate rapidly making them somewhat droughty. Furthermore, fertility losses through leaching are relatively high.

This class of land is especially good for fruit trees, vegetables, and other truck and special crops.

Maintenance of the productivity of this land calls for sustaining its plant nutrient and organic matter content at the highest possible level. This means using a system of crop rotation that will include a legume at least once in every 3 or 4 years. These soils need additions of farm manure or compost and mineral fertilizers. The addition of organic matter to the soil will increase its water holding capacity as well as maintaining its fertility. Supplemental irrigation may be needed during the dry season for best growth of all crops.

LAND CAPABILITY CLASS BE

Soil types: Luisiana clay loam
Sigcay clay
Alimodian clay loam
Bauang clay
Faraon clay

Good land that can be cultivated safely but needs certain erosion control measures in addition to good farm management practices to maintain productivity.

Class Be land is good from various standpoints but certain physical characteristics make it susceptible to moderate erosion due to the gently sloping relief. The soils are deep but their subsoils are rather heavy. The slope in any place is not more than 8 per cent and the soil is susceptible to moderate erosion when unprotected. This land, therefore, needs protection against erosion such as contour farming, terracing, and strip cropping. Excess water must be channeled into grass waterways. Diversion ditches should be constructed for the runoff from the adjoining uplands.

All crops common to the area can be grown. Liming and fertilizing with the recommended quantities and kinds should be done. Crop rotation, with a legume or soil improving crop such as mungo or soybean at least once in 3 or 4 years, should be observed. For all legumes, the soil should be well supplied with lime and phosphate carrying fertilizer and if the soil does not contain the right kind of bacteria inoculation should be done. The use of farm manure or compost is recommended.

Land Capability Class Ce

Soil types: Bauang clay
Alimodian clay loam
Faraon clay
Luisiana clay loam
Sigcay clay

Moderately good upland that can be cultivated safely if a carefully planned combination of conservation practices is applied.

Class Ce is moderately good land suitable for cultivation provided soil conservation practices are carefully observed to prevent erosion. The soils are good, deep to moderately deep, with slopes that range from 8 to 15 per cent. This class of land is moderately to severely eroded or is subject to erosion if unprotected.

To farm this land safely terracing supported by contour farming and strip cropping is necessary. Terraces should empty into well grassed waterways or natural drainage.

After establishing the needed conservation measures, a good soil management program should be adopted. This should include a good crop rotation using a legume as a green manure crop, judicious use of lime and fertilizers, farm manure, and compost to build up the soil.

Many crops common in the area can be grown but contouring should be observed. Fruit trees should also be planted on the contours and a leguminous cover crop should be maintained to protect the soil from erosion.

Land Capability Class De

Soil types: Bauang clay
Alimodian clay loam
Faraon clay
Luisiana clay loam
Sigcay clay

Land good enough for occasional cultivation if handled with care but best suited to pasture and forest.

Class De land has slopes up to 25 per cent with moderate to severe erosion or is subject to moderate to severe erosion if left unprotected. The topsoil is generally thin with heavy, slowly permeable subsoil. It is fairly good land that can be cultivated occasionally with proper safeguards.

To farm the land a system of properly laid out terraces, with suitable outlets included in the absence of natural outlets, should be installed. Terrace outlets must have a vegetative cover, preferably grass at all times. If the grass is not well established, reseeding and fertilizing are necessary.

Plowing and other farm operations must be done on the contour. Planting of row crops is not advisable. Close growing crops like grains and legumes in rotation are preferable. This land when used for orchards, trees should be planted on the contour and a good stand of leguminous cover crop should be maintained.

Where erosion on a moderately deep soil is not severe, gullies should be smoothened and then seeded either to grass or legumes. The soil thus scraped should be limed and fertilized to give a good start for the grass or legume. In this case legume seeds will need inoculation.

Land Capability Class Ds

Soil type: Beach sand

Land good enough for occasional cultivation if handled with care but best suited to pasture and forest.

Class Ds land is nearly level to sloping. The soil may be deep but the topsoil is usually thin and light. The subsoil has rapid permeability with low available moisture. Included in this class are level or nearly level lands with deep soils but because of climatic conditions enough moisture is not available for good crop growth in which case artificial irrigation is needed.

This class of land is subject to erosion during intermittent rainfalls of heavy intensity or when there is an excess application of irrigation water.

This land is best suited to vegetables or truck farming. Root crops may do well too if planted at such time of the year when rainfall is abundant.

The application of animal manures is necessary to increase the organic matter content as well as the water holding capacity of the soil.

It is not likely that this soil will need any lime, but should it be desired, lime may be added only after soil analysis is done. Fertilizers needed, as soil analysis may show, would be nitrogenous ones for leafy vegetables and ammonium phosphate or complete fertilizers for the fruiting vegetables.

Land Capability Class M

Soil types: Bauang clay
Alimodian-Barotac complex
Faraon clay
San Rafael loam
Sapian clay

Land not suited for cultivation but good for grazing or forestry if handled with great care.

Class M land is usually on steep slopes up to 40 per cent. The soil is generally shallow or highly eroded making it unfit for seasonal cultivation. Stones or gravels may be present or even numerous that they interfere with tillage operations. The land may be used for pasture or trees with careful management. In order to grow good legumes or grass for pasture the land should be well prepared using lime and fertilizers as recommended in order to give the young plants a good start. Diversion terraces around the heads of active gullies, if any, should be constructed. Gullies that are about to develop should be smoothened and sodded. Newly developed pastures should not be grazed severely. On well established pastures grazing should be well controlled and rotated. Wherever possible, stock ponds should be constructed to supply water for the animals.

Where climatic conditions permit, this land can be devoted to orchards such as citrus, coffee, mango, or the like. The trees should be planted along the contours and a good cover crop to protect the soil from washing should be provided.

As for forest purposes, native trees should be protected from fires or *kaiñgin* and the bare spaces planted to wood trees like *ipil-ipil.*

Land Capability Class N

Soil types: Alimodian clay loam
Alimodian-Barotac complex
Mountain soils, undifferentiated

Very steep land, eroded, rough, with shallow soils that can be used for grazing or for forestry if handled with great care.

This kind of land is not suitable for tillage except those which are needed to establish permanent vegetation for permanent pasture land or woodland. This class has slopes up to or more than 40 per cent. The land is rugged and broken by many large gullies. The soil is badly eroded or very shallow. Stones may also be very abundant making cultivation difficult or impractical.

This land has very limited use. Where grasses grow grazing may be allowed but must be managed very carefully to prevent erosion. The pasture land will need very liberal fertilization, liming, and reseeding.

Gullied lands are best used for trees which grow well in the locality. *Ipil-ipil* is specially recommended. Where trees are already growing, they should be protected from fires or *kaiñgin.*

Land Capability Class X

Soil type: Hydrosol

Land suited only for wildlife or recreation

Land in this class is usually level or is slightly depressed wherein water, either sea or fresh, stays most of the time making it unsuitable for cropland, pasture land or forest. This land type is termed hydrosol.

This land class may be used for salt bed or fish pond sites. Ordinarily, this land is covered by mangroves or nipa palms when inundated by sea water or grasses as in the case of fresh water ponds. When the site is made into fish ponds or salt beds the trees or palms may be disposed off but a wide strip should be left standing along the outer borders of the shore line to protect the site from the scouring effect of waves.

For fish ponds the site should be dug to not less than a meter in depth. To produce a good growth of algae, the feed for most fishes, the water in the pond should be fertilized.

CHEMICAL CHARACTERISTICS AND FERTILIZER REQUIREMENTS OF THE SOILS OF CAPIZ PROVINCE

By

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The different soil types of Capiz Province were studied and classified according to their morphological and genetical characteristics found in the field. The physical, chemical and biological properties were determined in the laboratory. The results obtained in these investigations are important bases in the formulation and laying out of the program for farm management and cropping systems.

The chemical investigations comprise the determination of: (*a*) soil reaction, which serves as a guide for determining the natural crop adaptability of that soil; (*b*) the presence of the required plant nutrient elements whether in adequate, wanting or excessive amounts; (*c*) the presence of toxic substances and their degree of toxicity; and (*d*) the lime and fertilizer requirements of the different soil types for increased crop production.

The major nutrient elements are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulfur. They must be present in the soil in adequate amounts to satisfy the needs of the plants for their normal growth. Boron, iron, copper, manganese, zinc and molybdenum are the trace or minor elements which are also essential for normal plant growth, although needed in minute quantities. Carbon, hydrogen and oxygen come from the air, while the rest are derived from the soil. A deficiency of one or more of these elements certainly lowers the quality and yield of crops produced. On the other hand, too high concentrations of one or more of these elements, especially the trace elements, are harmful to the growth of plants. It is necessary therefore that all must be present proportionately in their available forms in accordance with the needs of the crops.

Agricultural soil is constantly subjected to nutrient depletion by: (1) *Erosion.*—Eroded soil carries with it large amounts

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of nutrient elements as well as organic matter; (2) *Crop removal.*—Crops harvested from the field carry with them plenty of mineral nutrients taken from the soil; (3) *Leaching.*—Nutrient elements in their available form are subject to leaching into the deeper layers of the soil where the shallow roots of crops cannot reach to absorb them; and (4) *Volatilization.*—This is true to all volatile gases carrying nutrient elements. According to figures from the table showing removal of nutrients, *Potash Pocket Book,* International Handlemaatschappif, voor meststoffen, N. V. Keizersgracht 331, Amsterdam, Holland, rice crop yielding about 4.34 tons of grains or about 98.6 cavans of palay and 3.32 tons of straw per hectare removes from the soil approximately 65.1 kgs. nitrogen, 20.2 kgs. phosphorus and 75.2 kgs. potassium; eighty nine tons sugar cane per hectare withdraws from the soil about 85.3 kgs. nitrogen, 60.6 kgs. phosphorus and 190.9 kgs. potassium; and about 130.2 kgs. nitrogen, 40.4 kgs. phosphorus and 240.2 kgs. potassium are removed from the soil by tobacco crop weighing 2.2 tons. Nutrient elements in their available forms are subjected to leaching into the deeper layer of the soil profile where the shallow rooted crops cannot make use of them. Nitrogen is also lost by the burning of weeds and crop residues commonly practiced by farmers.

Replenishment of plant nutrients lost or removed from the soil by erosion, leaching, volatilization and crop removal is imperative. Otherwise, the soil becomes impoverished and infertile. Replenishment of plant nutrients back in the soil can be attained by the application of organic and inorganic fertilizers, farm manures, composts and wood ashes. Green manuring and the practice of crop rotation also increase the soil content of nutrient elements.

METHODS OF CHEMICAL ANALYSIS

Total analysis for plant nutrient elements involves tedious qualitative and quantitative procedures, the results of which do not correlate with plant growth or the response of plants to fertilizer treatment. On the other hand, results obtained from the rapid micro-chemical tests show a distinct correlation. For these reasons the rapid chemical tests were employed in the analysis of soil samples obtained from the different soil types of Capiz Province. Total nitrogen and organic matter were also determined in as much as they can be converted into assimilable forms by micro-organisms under favorable conditions.

The rapid chemical tests are being used abroad successfully. These tests were calibrated under Philippine conditions with actual results of lime and fertilizer experiments conducted in pots and in the fields. Since there are no comprehensive data from local experiments, data from abroad are cited for comparison.

Soil samples gathered for chemical analysis were first air dried and then pulverized with a wooden mallet to avoid possible metallic contaminations. The pulverized soil was passed through a 20-mesh sieve after which it was thoroughly mixed.

Soil reactions or pH values were determined with the use of a Beckman pH-meter fitted with glass electrodes. Spurway [1] and Truog [2] methods were followed in the determinations of ammonia and nitrates, and available phosphorus, respectively. Available potassium, calcium, magnesium, manganese and iron were determined by Peech and English methods [3]. A leitz photoelectric colorimeter provided with suitable light filters was used in the colorimetric determinations of available potassium, calcium, magnesium, manganese and iron. Kjeldalh-modified method [4] was followed in the total nitrogen determinations. Organic matter was determined according to Walkley and Black method [5].

INTERPRETATION OF RESULTS OF THE CHEMICAL TESTS

Soil reaction or pH value.—This is the hydrogen ion concentration or the acidity or alkalinity of the soil expressed mathematically as the pH value. It is also defined as the logarithm of the reciprocal of the hydrogen ion concentration expressed in grams per liter solution. A neutral solution contains 1×10^{-7} gram of hydrogen ion per liter and has a pH value of 7. The pH values below 7.0 denote acidity while values above 7.0 indicate alkalinity. A change of one unit of pH value means a tenfold change in the concentration of hydrogen ions. This property of the soil affects the behaviour and availability of plant nutrient elements and those of the toxic substances. It

[1] C. H. Spurway, *Mich. Agr. Expt. Sta. Tech. Bull.*, 132 (1939)
[2] Emil. Truog, *J. Am. Soc. Agron.*, *22*, 874–882 (1930)
[3] Michael Peech and Leah English, *Soil Science*, 57, 167–195 (1944)
[4] Association of Official Agricultural Chemists, "Official Tentative Methods of Analysis,' 6th ed., Association of Off. Agr. Chemists, Washington, D.C., 1945, p. 27.
[5] A. Walkley and I. A. Black, "Determination of Organic Matter in Soils," *Soil Science*, 37, 29-38 (1934).

constitutes a very important limiting factor for plant growth and reproduction.

The pH value of the surface soils of Capiz Province ranges from 4.55 (that of Sigcay clay) to 6.85 (that of Faraon clay) as shown in table 14. According to Pettinger's chart, the sixteen soil types of Capiz Province fall under five classes of soil reactions; namely, (*a*) very strong acidity, (*b*) strong acidity, (*c*) medium acidity, (*d*) slight acidity, and (*e*) very slight acidity. Sigcay clay, Luisiana clay loam, Alimodian clay loam, Maligaya clay, and Sara sandy loam fall under very strong acidity class; while Bantog clay has a soil reaction of strong acidity. The soil types that are medium acid in reaction are San Manuel clay loam, Sta. Rita clay, Sara clay loam, Makato clay, San Manuel sandy clay loam, Sapian clay, and Bauang clay. Umingan sandy loam is light acid in reaction while Faraon clay falls under the very slight acidity class.

Definite soil reaction or pH preference is required by different plants for their proper growth. The pH value requirements of some of the economic plants are shown in table 15. Under Philippine conditions rice, pineapple and tobacco prefer to grow from pH range of 5.5 to 6.1. However, these crops may grow fairly well within the range of pH 4.8 to 6.9. Citrus, sugar cane and alfalfa grow well from pH 6.2 to 7.8 but their tolerance limit is from pH 5.5 to 8.5. Corn, tomato, and other crops have a narrower optimum pH requirements, pH 6.2 to 7.0, but nevertheless, these crops have a rather wide pH tolerance limit, pH 4.8 to 8.5.

Basing from the soil reaction of the soil types of Capiz Province as shown in table 14, San Manuel clay loam, Sta. Rita clay, Sara clay loam, Makato clay, San Manuel sandy clay loam, Sapian clay, and Bauang clay have soil reactions most favorable for rice. On the other hand, rice grow fairly well on Bantog clay, Maligaya clay, Umingan sandy loam, Sara sandy loam, Alimodian clay loam, and Faraon clay. The rest of the soil types are more likely not suited to rice growth due to their very strong acidity in reaction. The crop productivity indexes as shown in table 10 show that Makato clay has a more favorable soil reaction than Maligaya clay for rice growth. Nevertheless, the productivity of Makato clay is lower than that of Maligaya clay. This instance shows that the pH value, although it is the limiting factor for plant growth, is not the

TABLE 14.—*Chemical analysis of the different soil types of Capiz Province*

Soil types	pH Value	Organic matter %	Nitrogen %	C:N	Available constituents in parts per million (NH$_3$)	(NO$_3$)	(P)	(K)	(Ca)	(Mg)	(Mn)	(Fe)
San Manuel clay loam	5.60	4.18	0.27	8.98:1	2	25	47	128	4000	1060	151	5
Bantog clay	5.05	4.16	0.12	20.05:1	10	10	16	41	3600	460	83	22
Sta. Rita clay	5.90	5.92	0.25	13.71:1	2	25	46	57	3700	1500	68	2
Sara clay loam	5.65	3.55	0.15	13.72:1	10	10	11	214	1900	470	202	1
Maligaya clay	4.95	0.99	0.23	2.50:1	10	10	28	119	2900	200	111	35
Makato clay	5.65	3.59	0.15	13.85:1	2	10	63	92	3100	210	152	3
Umingan sandy loam	6.45	2.62	0.09	16.88:1	2	10	131	160	3700	1040	7	1
San Manuel sandy clay loam	5.75	4.12	0.13	18.68:1	2	5	34	41	1700	460	33	1
Sara sandy loam	4.85	1.84	0.10	10.67:1	2	5	9	81	300	200	126	10
Alimodian clay loam	4.85	3.06	0.20	8.87:1	10	10	6	262	2900	1450	112	15
Luisiana clay loam	4.60	2.60	0.12	12.57:1	2	25	9	32	1600	470	185	3
Sapian clay	5.95	3.90	0.18	12.56:1	2	10	26	57	4000	1950	35	1
Sigcay clay	4.55	1.76	0.10	10.20:1	25	10	5	160	100	210	15	6
Bauang clay	5.95	3.07	0.11	16.20:1	10	trace	6	105	3200	1100	103	1
Faraon clay	6.85	10.46	0.40	15.15:1	10	5	13	220	9000	800	42	trace

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only basis for normal crop production. The other bases are climate, soil type, availability of plant nutrients, insects and pests, variety, seeds and farming practices.

The availability of nutrient elements for plant nutrition depends on soil reaction. At pH 6.5, generally most of the nutrient elements in the soil are available for plant needs. Figure 26 indicates the general relationship between the availability of a certain nutrient element and the soil reaction. In the chart each element is represented by a band which falls within a pH range (the wider the band the more favorable the influence of reaction on the availability of the given nutrient element). A wide band does not necessarily mean a satisfactory supply of the element in its available form, however; or a narrow band a deficiency. The chart only shows

TABLE 15.—*The pH requirements of some economic plants*

Plants	Strongly acid pH 4.2–5.4	Medium acid pH 5.5–6.1	Slightly acid pH 6.2–6.9	Neutral pH 7.0	Slightly alkaline pH 7.1–7.8	Medium alkaline pH 7.9–8.5
Abaca, *Musa textilis* Nee [1]	Y	X	X	X	Y	O
Caimito, *Chrysophyllum cainito* Linn.[1]	Y	X	X	Y	O	O
Coffee, *Coffea arabica* Linn.[1]	Y	X	X	Y	O	O
Cowpea, *Vigna sinensis* Linn. Savi [2]	Y	Y	X	Y	Y	----
Corn, *Zea mays* Linn. [2]	Y	Y	X	X	Y	Y
Durian, *Durio zibethinus* Linn. [1]	Y	X	X	Y	O	O
Peanut, *Arachis hypogaea* Linn. [2]	Y	Y	X	X	Y	----
Petsai, *Brassica pekinensis* Rupr. [4]	Y	Y	X	X	X	X
Rice, *Oryza sativa* Linn.[1]	Y	X	X	Y	X	O
Sugar cane, *Saccharum officinarum* Linn.[2]	O	Y	X	X	X	Y
Tobacco, *Nicotiana tabacum* Linn. [2]	Y	X	Y	O	O	O
Sweet potato, *Ipomoea batatas* (Linn.) Poir [1]	Y	X	X	Y	O	O
Cassava, *Manihot esculenta* Crantz	Y	X	X	X	Y	Y
Pineapple, *Ananas comosus* (Linn.) Merr.[1]	Y	X	Y	O	O	O
Banana, *Musa sapientum* Linn. [1]	Y	Y	X	X	Y	O
Tomato, *Lycopersicum esculentum* Mill. [2]	Y	Y	X	X	Y	Y
Onion, *Allium cepa* Linn.[2]	O	Y	X	Y	Y	Y
Soybean, *Glycine max* (Linn) Merr. [2]	Y	X	X	X	Y	Y
Orange, *Citrus aurentium* Linn. [3]	----	X	X	X	X	Y

LEGEND:

X—most favorable reaction

Y—reaction at which plants grow fairly well or normally

O—unfavorable reaction

[1] Based from the soil reactions where they are grown with the productivity ratings of the soil types in 11 provinces, a pH range of 5.7 to 6.2 was found to be most suitable for the growth of upland rice, variety *Inintiw*, by Rola, Nena A., and N. L. Galvez. 1949. Effects of soil reaction on the growth of upland rice and on its nitrogen, calcium, phosphorus and iron content. Philippine Agriculturist 33: 120–125.

[2] Data taken mostly from Weir Wilbert Weir. 1936. Soil Science. Its principles and practice. J. B. Lippincott C. Chicago and Philadelphia.

[3] From Spurway, G. H. 1941. Soil reaction (pH) preferences of plants, Mich. Agr. Expt. Sta. Bull. 306. Optimum range given was pH 6.0–7.5.

[4] From Arciaga, Antonio N., and N. L. Galvez. 1948. The effect of soil reaction on the growth of pet-sai plants and on their nitrogen, calcium and phosphorus content. Philippine Agriculturist 33: 55–59. Normal growth reported was in pH 4.2 to 8.6; optimum range was pH 5.9–8.6

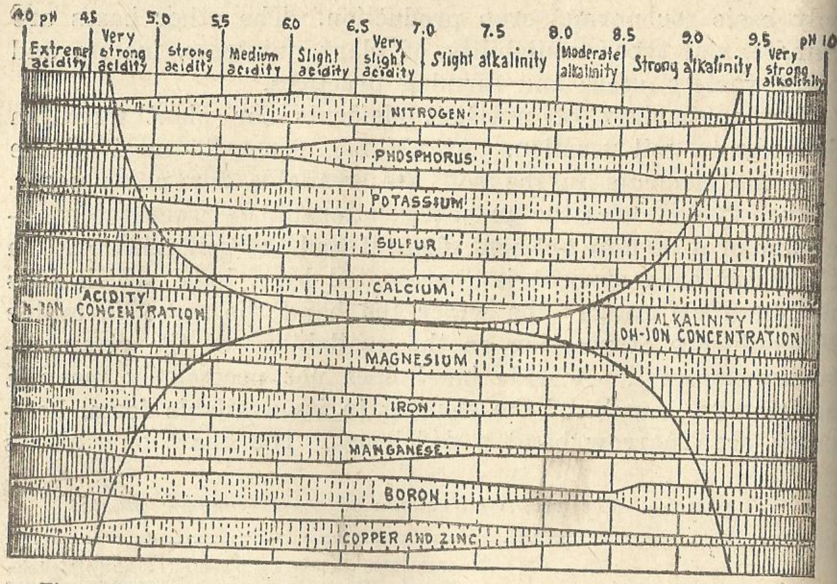

Figure 26. Chart showing general trend of relation of reaction to availability of plant nutrients.

that soil reaction is a factor for the availability of a nutrient element to plants wherein reaction is more favorable when the band is wider and less favorable when the band is narrower for that given element as a readily available plant nutrient.

Ammonia and Nitrates.—The most important growth factor is nitrogen. Its various compounds found in plant make up 2 to 4 per cent of the plant's average dry weight. An essential component of the protoplasm of every living cell of plants, nitrogen promotes vegetative growth and reproduction. Its shortage in the soil results in the growth retardation and the yellowing of the leaves of plants.

Nitrogen from organic matter must be converted into the ammonium and nitrate forms to be of value for plant nutrition. This conversion is called ammonification or nitrification depending upon the degree of decomposition of the organic matter. Ammonia is first formed. Under favorable conditions, the ammonia is further oxidized to nitrites and finally to nitrates. The ammonia or nitrite forms prevail under unfavorable conditions or when denitrification takes place. Nitrate forms are reconverted to nitrites, to ammonia and then finally to the elemental nitrogen. All these various chemical changes of the organic matter constitute the nitrogen cycle. The three major

stages of this cycle are (*a*) ammonification, (*b*) nitrification, and (*c*) denitrification.

Both the nitrate and ammonium forms are water soluble. Normally, plants assimilate nitrogen in the nitrate form, but rice and other members of the grass family absorb ammonium as well. These two forms of nitrogen are subject to leaching. The ammonium form can be fixed by the clay particles and humic compounds and released only when it is needed by plants. The nitrate form, on the other hand, cannot be fixed by the soil so that it is more easily leached than the ammonium form.

Soil samples analyzing 2 to 5 p.p.m. of either ammonia or nitrates are considered low, 10 to 25 p.p.m. as medium or normal supply, and 100 p.p.m. or more as very high or excessive. Low analysis of ammonia or nitrate may indicate that the soil is deficient in organic matter or it has not been fertilized with nitrogenous fertilizers; high values mean high organic content or high in nitrate inorganic fertilizers. High ammonia value simply means that (*a*) the ammonification process exceeds the nitrification process, (*b*) that leaching of the ammonia form is not appreciable, and (*c*) that the field has been recently fertilized with ammoniacal fertilizers. Low test for ammonia may mean that it is used by plants as fast as it is formed; that it is fixed in the base exchange complex; or that it is converted into nitrate form, while low in nitrate value may indicate that nitrification is slow; that it is leached or used up by plants and organisms; and the field is not fertilized with nitrate fertilizers.

Table 14 shows that San Manuel sandy clay loam and Sara sandy loam contain low available ammonia and nitrates supply, while Bantog clay, Sara clay loam, Maligaya clay, Makato clay, Umingan sandy loam, Alimodian clay loam, Sapian clay, Bauang clay, and Faraon clay have a normal supply of nitrogen. San Manuel clay loam, Sta. Rita clay, Luisiana clay loam, and Sigcay clay contain sufficient nitrogen.

Organic matter.—The sources of organic matter are roots, leaves, stems of plants, farm manures, grasses, green manures, and dead animal bodies. They are thoroughly incorporated into the soil by plowing or by other tillage operations. During the decomposition of the organic matter, micro-organisms assimilate nitrogen for their nutrition and while their needs are not yet satisfied there is nitrogen deficiency in the soil for plant use. This period is called nitrogen starvation. Large amounts of oxygen are needed during the decomposition stages of the organic matter to the extent that the plant roots are deprived of oxygen. Oxygen shortage causes the stunted growth of plants, decrease in yield, as well as poorer quality.

Soil's physical and chemical properties are influenced by the nature, quality, and amount of organic matter. Organic matter improves soil structure, aeration, and drainage; increases soil water-holding capacity, minimizes soil erosion, acts as cementing agent of soil particles especially in coarse-textured soils and provides food and home for the soil micro-organisms. It increases the availability of phosphorus. Humic acids and other organic acids formed by the decomposition of organic matter have great affinity with aluminum and iron, thereby liberating phosphorus from the insoluble compounds of aluminum phosphate or iron phosphate which are present in soils. Humus is highly and extensively decomposed organic matter. It is colloidal in nature with large number of negative charges and composed mainly of carbon, hydrogen, oxygen, nitrogen, sulfur and phosphates.

Mature straw has a C:N ratio of about 80:1 while that of leguminous is about 20:1.[1] These ratios narrow down to 10:1 in a relatively short time after these materials are worked thoroughly into the soil. This ratio means that for every pound of nitrogen there are 10 pounds of carbon present. The narrower the ratio, the higher is the degree of decomposition of the organic matter. A high nitrogen content indicates the presence of a large quantity of organic matter in untreated soil.

The determination of organic matter is usually based on organic carbon analysis. The result is multiplied by the conventional factor 1.724. This factor is obtained by assuming that the carbon content of organic matter is 58 per cent. There is a relationship between the amount of organic carbon and the total nitrogen and, therefore, the nitrogen analysis maybe taken as an approximate index of organic matter. The lower the percentage of nitrogen and the higher the percentage of carbon, the wider the C:N ratio is. When the percentage of carbon is low and percentage of nitrogen is high, the C:N ratio

[1] C. F Millar and L. M. Turk, "Fundamentals of Soil Science," John Wiley and Sons; Inc. New York, 1948 p. 239.

is low. The soil type having the narrowest C:N ratio is Maligaya clay while Bantog clay has the widest ratio.

Phosphorus.—Phosphorus, like nitrogen, is also indispensable to plants. Very minute quantities of phosphorus are contained in every cell of both plants and animals. Like nitrogen, it is also associated with plant growth and reproduction. It promotes root and seed development, hastens maturity, and offsets luxuriant growth due to excess nitrogen.

Phosphorus deficiency is not easily recognized by the distinct change in color of the leaves as in the case of yellowing of the leaves due to nitrogen deficiency. The darker and duller green of leaves of most plants seems to indicate phosphorus shortage. Corn and tomatoes exhibit purpling of leaves and stems. In orchard crops, their root system as well as their trunks fail to develop vigorously. Phosphorus shortage also delays the formation of fruits, seeds, and emergence of corn silk; increases the acidity of fruits; lowers the quality of sugar cane juice; and reduces the starch formation in root crops.

Salts of orthophosphoric acid, H_3PO_4, are usually found in nature. Apatite, $Ca_3(PO_4)_2$, is an important mineral of phosphorus. By the action of carbon dioxide and soil moisture, apatite and other phosphate minerals go into solution and become available for growing plants. Available phosphorus in the soil for normal plant growth differs according to soil types and climatic conditions. In conditions like those existing in Wisconsin, U. S. A., Truog set a minimum limit for readily available phosphorus at 37.5 p.p.m. for good fine-textured or clay soils and 25 p.p.m. for sandy soils. He also stated that for certain sections of southern United States where the climate permits a longer growing period than in the northern part, 10 to 15 p.p.m. of readily available phosphorus might be sufficient for a good crop of corn.[1] Basing on data on several Philippine soil types, Marfori, on the other hand, stated that 30 to 40 p.p.m. of readily available phosphorus as determined by Truog method seems to be the normal requirement for rice and other grain.[2]

Table 14 indicates that San Manuel clay loam, Sta. Rita clay, Makato clay, Umingan sandy loam, and San Manuel sandy

[1] Emil Truog, "The Determination of the Readily Available Phosphorus of Soils," Jour. Amer. Soc. Agron., 22, 874-882 (1930).

[2] R. T. Marfori, "Phosphorus of Soils as Determined by Truog Method," *Phil. Journal of Science*, 70, 133-142 (1939).

clay loam contain a sufficient supply of available phosphorus for optimum crop growth. The rest of the soil types need phosphatic fertilizer application to raise their available phosphorus content within the desired range.

Potassium.—The third important nutrient element needed in large quantities by plants is potassium. Unlike nitrogen and phosphorus, potassium is not localized in any part of the plant. It is vitally needed in the synthesis of sugar, starch, fat, and protein of plants. However, these plant products contain small amounts of potassium. Its concentration is higher in tops, buds, blossoms and fruits. It gives firmness to fruits and aid in their being well developed such as those of citrus, pineapple, tomatoes and bananas. Millar and Turk state that it increases plumpness in grains and makes the stalks or stems of plants more rigid so that lodging is minimized.[3]

Its deficiency results in the yellowing of the leaves or their turning to reddish brown which spreads from the tips and margins toward the centers, and irregular necrotic spots on the leaves. Undersized and deformed leaves, flowers, pods, fruits and tubers are also symptoms of potassium shortage. Other effects of potassium deficiency are wilting of the plants due to the loss of moisture through excessive transpiration especially during dry weather and decrease of plant resistance from infestation of pests and diseases.

According to figures from "Interpretation of Chemical Analysis" by Marfori,[4] 100 to 150 p.p.m. of available potassium is sufficient for most crops. Basing from this range of sufficiency, nine soil types have adequate supply of potassium. They are San Manuel clay loam, Sara clay loam, Maligaya clay, Umingan sandy loam, Alimodian clay loam, Sigcay clay, Bauang clay, and Faraon clay. Nevertheless, all soil types with the exception of Sara clay loam, Alimodian clay loam, and Faraon clay require application of potassic fertilizer.

In a critical study of the fertilizer requirements of lowland rice on some Philippine soil types, Marfori, *et al.*, found that where the soil is highly deficient in available potassium small application of potassic fertilizer generally will not give immediate significant increase in crop yield because of the fixation of the added potassium in the base-exchange complex of the

[3] C. E. Millar and L. M. Turk, "Fundamentals of Soil Science," John Wiley and Sons, Inc., New York, 1943, pp. 318–319.

[4] R. T. Marfori, "Interpretation of Chemical Analysis" (Manila: Bureau of Soil Conservation, 1956) (Mimeographed.)

soil.[5] However, large initial applications of potassic fertilizer on such a soil will satisfy or saturate its potassium-fixing capacity and leave enough readily available potassium for the immediate needs of plants, insuring higher crop yields. It was also found that on Buenavista silt loam and Maligaya clay loam with available potassium contents of 9 p.p.m. and 50 p.p.m., respectively, large applications of potassic fertilizer gave statistically significant increases in crop yield, using *Guinangang* rice as the plant indicator. On Marikina clay loam and San Manuel silt loam which contain 132 p.p.m. and 161 p.p.m. of available potassium, respectively, repeated large applications of potassic fertilizer did not give at all any statistically significant increase in yield, also using *Guinangang* rice as the crop indicator. In experiments on potash fertilization on sugar cane in various haciendas at Victorias, Occidental Negros, Locsin reported that soils containing 85 p.p.m. or less of available potassium, as determined by the Peech and English method, gave positive crop response to potash applications while soils containing 151 p.p.m. or more of available potassium gave negative crop response.[6] According to Bray for most Illinois or Corn Belt Soils, corn or clover will not respond to potassium fertilization when the available soil potassium is 150 p.p.m. or more.[7]

Calcium.—Calcium plays an important role in crop production. It promotes granulation, aeration, and drainage, hence soil structure is greatly improved. Calcium counteracts toxic concentrations of such elements as potassium, magnesium, sodium, and some other trace elements especially boron. It affects the availability of plant nutrients. Generally, most nutrient elements are rendered available at pH 6.5. Below this pH value, phosphorus becomes unavailable to plants due to the formation of insoluble phosphates of iron and aluminum. At higher pH values, 7.5 to 8.7, phosphorus is precipitated as tricalcium phosphate, which is also unavailable to plants. Calcium affects also microbial activities in the soil such as decomposition of organic matter, nitrification, and sulfofication. It promotes favorable conditions for the normal growth and functioning of symbiotic and non-symbiotic fixing bacteria. In plants, calcium is built into the walls of the cells to form protective sieves for nutrients to seep through in passing into the cells. It acts also as a binding agent between the individual cell walls to hold them together.

[5] R. T. Marfori, and others, *J. Soil Science Soc. of the Phil.*, 2, 155–172 (1950).

[6] Carlos L. Locsin, *J. Soil Science Soc. of the Phil.*, 2, 105–108 (1950).

[7] R. H. Bray, *University of Illinois, Dept. of Agron.* AG. 1230 (1944).

Liming affects plant composition. It increases the calcium content of cabbage leaves from 4.42 per cent to as much as 7.53 per cent. Yield of tomatoes and their vitamin C content were increased, and protein content of corn grains showed an increase of 40 per cent. These effects on plant composition were reported by Smith and Hester.[8] Increased yield of upland rice in the experiment performed by Madamba and Hernandez was due to lime application.[9]

Many Philippine soil types have been analyzed for their available calcium content. The soil types with 2000 to 6000 p.p.m. of available calcium gave high productivity ratings. Table 14 shows that the available calcium content of the different soil types of Capiz Province ranged from as low as 100 p.p.m., for Sigcay clay, to as high as 9000 p.p.m. for Faraon clay. Sara sandy loam and Sigcay clay have a rather low available calcium content and low pH value so that liming is indicative, especially for sugar cane, alfalfa, and other legumes which are classified as "high lime" crops. Sara clay loam, San Manuel sandy clay loam, and Luisiana clay loam require liming to raise their available calcium contents within the sufficiency range.

Magnesium.—Magnesium is an important constituent of chlorophyll, the green pigmentation in plant leaves. Without this nutritive element, the normal function of chlorophyll will be affected. It plays an important role in photosynthesis, the most important chemical phenomenom in nature.

Soil types analyzing 600 to 1700 p.p.m. of available magnesium are rated high in crop productivity. However, for certain species of citrus [pummelo or *Citrus maxima* (Brun. Merr.)], symptoms of magnesium deficiency have been observed on soils that contained even as much as 950 p.p.m. of available magnesium. Camp, *et al.*, at the Citrus Experimental Station in Florida, U.S.A., found that magnesium shortage resulted in the reduction of crop yield, size of fruits, and in the sugar and Vitamin C contents of juice.[10] Available magnesium content of the different soil types of Capiz Province ranged from 200 p.p.m. for Maligaya clay and Sara sandy loam to 1950 p.p.m. for Sapian clay. Seven soil types as shown in table 14 have sufficient available magnesium for crop production.

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[8] G. F. Smith and J. B. Hester, *J. Soil Science, 75*, 117-128 (1948)

[9] A. L. Madamba and C. C. Hernandez, *J. Soil Science Society of the Philippines, 1*, 204-209 (1948).

[10] A. F. Camp and others, "Hunger Signs in Crops," *Am. Soc. of Agron.* Washington, D.C., 1941, pp. 881-886.

They are San Manuel clay loam, Sta. Rita clay, Umingan sandy loam, Alimodian clay loam, Sapian clay, Bantog clay, and Faraon clay.

Magnesium deficiency results in the chlorosis of tobacco (known as "sand drown"), purplish red leaves of cotton, green veins and yellow color between the veins of corn leaves, and chlorotic leaves of leguminous plants. In fruit crops, especially citrus, the size and quality of fruits are affected by magnesium shortage.

Iron.—The need of plants for iron is relatively small ranging from 2 to 30 p.p.m. of available iron. It is mostly available in acid soils. Its availability in neutral and alkaline soils is very small as it is precipitated as hydroxide of iron. It is also rendered unavailable by the formation of insoluble ferric phosphate, both in very acidic and in alkaline soil reaction. Fixation of iron and phosphorus usually takes place in coarse-textured soils as the clayey soils have the ability to fix excess soluble phosphates. Availability of iron also depends on soil aeration being higher in anaerobic condition due to the reduction of the ferric ions to ferrous ions, the latter being more soluble. Chlorosis is a manifestation of iron deficiency. Iron deficiency is corrected by the application of ferrous sulfate. Except for Sara clay loam, Umingan sandy loam, San Manuel sandy clay loam, Sapian clay, Bauang clay, and Faraon clay, the soil types of Capiz fall within the range of sufficiency.

Manganese.—Manganese is generally present in very small amounts in agricultural soils, less than 0.1 per cent or 1000 p.p.m. Alkaline soils, especially those soils which are heavily limed, are deficient in manganese. Dwarfness of plants, chlorotic and spotted leaves especially of tomato, bean, and tobacco are manganese deficiency symptoms.

Soil types that rate high or at least medium in crop productivity contain varying amounts from 15 to 250 p.p.m., of available manganese. The different soil types of Capiz that were analyzed were found to have available manganese ranging from 7 p.p.m., that of Umingan sandy loam, to 202 p.p.m., that of Sara clay loam.

LIME AND FERTILIZER REQUIREMENTS

Pioneers in agricultural farming have experienced that the crop yields from their fields have declined after a few years under cultivation. They have also observed that crops grew normally where the following farm practices were observed: (*a*) crop rotation, (*b*) fallowing, (*c*) farm manuring, and (*d*) application of wood ashes. It was also established that plants grew normally in newly opened fields. Such experiences and observations in agricultural farming led to the studies of the normal nutrition of plants and of the vital importance of inorganic substances in the soil for plant nutrition. Plants build up their bodies out of carbon, hydrogen, and oxygen from the air and of the inorganic substances from the soil. Inorganic substances removed by plants or lost due to erosion, leaching, and volatilization must be returned to the soil to maintain this productivity level. The plant nutrient elements are returned to the soil by the application of inorganic and organic fertilizers. Ordinarily, fertilizers are classified as inorganic and organic; or nitrogenous, phosphatic and potassic, depending on the principal constituent they carry. The inorganic fertilizers are classified as ordinary or single element, incomplete or complete fertilizers. The percentages of nitrogen, phosphorus and potassium contained in any fertilizers are expressed in terms of (N), (P_2O_5) and (K_2O), respectively.

The amount of fertilizers to be applied in the soil depends on the balanced plant nutrient requirements. All the nutrients, whether they are needed in large or small quantities, are of equal importance to the plant. If any one of these elements is inadequately supplied or absent, the development of plants will be arrested. Stunted growth is a manifestation of a deficiency or a condition of unbalanced food elements.

Growth of plants is always restricted by any element which is unavailable or insufficient in amount in relation to the total requirement of the plant. This condition is referred to as "The Law of the Minimum." Soil types, climate, and cropping system practices determine also the quantity of fertilizers to be applied. To insure better fertilization results and quicker response, organic matter in the form of farm manures or compost is also applied with inorganic fertilizers. Green manuring is also a source of organic matter for the soil.

Liming is an agricultural practice to reduce soil acidity. Field crops grow best when soil reaction is suitable to them. Therefore, adjusting soil reaction to the proper range for any given crop is of primary importance. When soils are extremely acid, in spite of adequate fertility, field crops may still yield poorly. The addition of lime to reduce this extremely acid

condition to a slightly acid or neutral range is necessary. Since soils vary in their pH values and buffering capacities laboratory tests are conducted before any liming is instituted on any field. Furthermore, when soils are neutral or slightly alkaline, liming is more harmful than beneficial. In these tests the pH value as well as available calcium contents of the soil are considered because calcium and magnesium are usually removed by crops in large amounts, not considering those lost through leaching. The loss of these elements gradually develops acidity. Other beneficial effects of liming are the improvement of the physiological conditions of the soil and the increased supply of calcium and magnesium, two plant nutrient elements.

Agricultural lime is calcium carbonate or limestone pulverized to 20 mesh of which about 50 per cent should pass through 100 mesh. It is the most common liming material, although its neutralizing power is lower than its oxides and hydroxides. Pure calcium oxide or lime and magnesium oxide neutralizes 1.78 and 2.50 times as much acid, respectively, as the same weight of pure calcium carbonate. Hydroxides of calcium and magnesium and dolomite as well as magnesium carbonate and dolomite have also higher neutralizing power than limestone. Nevertheless, agricultural lime is still preferred over the other liming materials as mentioned above because of the following advantages: (*a*) cheapest among the other liming compounds in terms of cost per ton, (*b*) the ease with which it can be evenly spread and uniformly incorporated into the soil, and (*c*) its lack of caustic action on the skin and leaves of the plants.

More frequent liming with a lesser amount of lime in each application is required for sandy soils than for clayey soils. Soils subjected at a higher intensity of rainfall and degree of erosion require more frequent and heavier application of lime. This holds true also on soils where intensive farming and heavy applications of nitrogenous fertilizers are practiced. The residual effect of excessive application of nitrogenous fertilizers is a higher soil acidity. For lime maintenance in the soil, liming is necessary every five years.

Sixteen soil types of Capiz were analyzed for their available plant nutrients. The average chemical analysis of each soil type is tabulated in table 14, from which the fertilizer and lime requirements for lowland rice, upland rice, corn, sugar cane, coconut, camote, cassava, and mungo were based. The lime and fertilizer requirements for the above mentioned crops are given in table 16. Ten soil types of this province do not need liming for lowland rice, upland rice, corn, coconut, camote, cassava, and mungo. Their available calcium content range from 2900 to 9000 p.p.m. The rest of the soil types need lime application ranging from 0.25 to 4.75 tons per hectare for lowland rice, coconut, and camote; and from 0.50 to 9.50 tons per hectare for corn, cassava, mungo, and upland rice. For sugar cane grown on Umingan sandy loam and Faraon clay, liming is not necessary. The pH and available calcium for Umingan sandy loam are 6.45 and 3700 p.p.m., respectively; and for Faraon clay, 6.85 and 9000 p.p.m., respectively. The rest of the soil types requires lime varying from 0.50 to 9.50 tons per hectare. San Manuel clay loam, Sta. Rita clay, Luisiana clay loam, and Sigcay clay contain sufficient amounts of nitrogen for lowland rice, upland rice, and mungo; while the rest of the soil types requires application of ammonium sulfate (20% N) from 100 to 200 kilograms per hectare. Sugar cane, corn, cassava, camote, and coconut grown in all the soil types, except Sigcay clay, require ammonium sulfate (20% N) application ranging from 100 to 500 kilograms per hectare.

San Manuel clay loam, Sta. Rita clay, Makato clay, and Umingan sandy loam analyze high in available phosphorus. For most crops grown on these soil types phosphatic fertilization is not recommended. The rest requires fertilization with superphosphate (20% P_2O_5) ranging from 50 to 690 kilograms per hectare. Available potassium contents of Sara clay loam, Alimodian clay loam, and Faraon clay exceeds the amount of available potassium in soils needed for normal growth for most crops. The others are deficient in available potassium especially Bantog clay, Sta. Rita clay, Makato clay, San Manuel sandy clay loam, Sara sandy loam, Luisiana clay loam, and Sapian clay. San Manuel clay loam, Maligaya clay, Umingan sandy loam, Sigcay clay, and Bauang clay contain average amount of available potassium. For crops under the productivity indexes in table 14, the soil types deficient in available potassium require the application of muriate of potash (60% K_2O) ranging from 50 to 500 kilograms per hectare.

The most common methods of fertilization are broadcasting, localized placement, and a combination of broadcasting and localized placement. Broadcasting is merely distributing the fertilizer materials over the field and working it thoroughly into the soil with a plow or a harrow. Localized placement, on the other hand, is the application of the fertilizer in bands along the row, around the plants or in the furrow after which it is covered with a thin layer of soil. Drilling, ring or trench, perforation and foliar methods are also examples of localized placement. In fertilizing permanent crops, one half of the recommended fertilizers should be applied at plow depth and the other half placed within the subsoil for the roots in that layer to absorb. In orchard fertilization, the fertilizers are placed along the newly developed roots which are indicated by an imaginary drip-line from the canopy of the crown of each tree.

Whatever method of fertilizer application is employed, the fertilizer must be placed within easy reach of plant roots. This way each plant is provided with sufficient food elements and the loss of nitrogen by leaching and phosphorus and potassium fixations in varying degrees by the individual soil particles is greatly minimized. Phosphorus is a very immobile element in the soil especially if contained by these phosphatic fertilizers which are not readily soluble. This property of immobility prevents its free movement along with the soil moisture so that it is easily fixed in extremely acid soils as insoluble phosphates of aluminum, manganese and iron and as insoluble phosphates of calcium and magnesium in strongly alkaline soils.

Time is also an important factor to be considered in any fertilization program. Favorable weather conditions and sufficient soil moisture warrant the application of fertilizers. The nitrate form of nitrogenous fertilizers is applied just before planting and as top dressings to maintain proper vegetative growth, especially for vegetable crops. The ammonium form is not subject to rapid leaching as in the case of the nitrate form because it is fixed loosely by the soil particles. This form of fertilizer is especially recommended for rice and for other long-season crops. Superphosphates and muriate of potash should be supplied during the last harrowing of the field to be planted. Phosphate fertilizers as rock phosphate or basic slag are applied a few weeks before planting and sowing, whereas farm manures are mixed evenly with the soil a few months in advance because more time is required for their plant nutrient contents to be rendered available for plant needs.

The manner of lime application is similar to that of fertilizers and it requires the same favorable conditions. It is usually applied at least one month before planting. Split application rather than one heavy application is desirable when the lime requirement is relatively high. Split applications prevent overliming of certain spots of the area. An abrupt change of more than one unit of pH in one heavy application is detrimental to plants and bacteria as well. Because of their higher buffer capacities, heavy soils can tolerate heavier lime applications than light soils.

TABLE 16.—*Fertilizer and lime recommendations for crops indicated under productivity indexes in table 14 for the different soil types of Capiz Province.*

Soil types	Agricultural Lime [1] Tons/Ha.	Ammonium sulfate (20% N) Kgs./Ha.	Superphosphate (20% P_2O_5) Kgs./Ha.	Muriate of potash (60% K_2O) Kgs./Ha.
For Lowland Rice				
San Manuel clay loam	----------	----------	----------	50
Bantog clay	----------	100	200	200
Sta. Rita clay	----------	----------	----------	200
Sara clay loam	0.25	100	250	----------
Maligaya clay	----------	100	50	50
Makato clay	----------	200	----------	100
Umingan sandy loam	----------	200	----------	50
San Manuel sandy clay loam	0.75	200	50	200
Sara sandy loam	4.25	200	250	150
Alimodian clay loam	----------	100	300	----------
Luisiana clay loam	1.00	----------	250	250
Sapian clay	----------	200	100	200
Sigcay clay	4.75	----------	300	00
Bauang clay	----------	200	300	0.1
For Upland Rice				
San Manuel clay loam	----------	----------	----------	50
Bantog clay	----------	100	200	200
Sta. Rita clay	----------	----------	----------	200
Sara clay loam	0.50	100	250	----------
Maligaya clay	----------	100	50	50
Makato clay	----------	200	----------	001
Umingan sandy loam	----------	200	----------	50
San Manuel sandy clay loam	1.50	200	50	200
Sara sandy loam	8.50	200	250	150
Alimodian clay loam	----------	100	300	----------
Luisiana clay loam	2.00	----------	250	250
Sapian clay	----------	200	100	200
Sigcay clay	9.50	----------	300	50
Bauang clay	----------	200	300	100
Faraon clay	----------	200	200	----------

[1] Limestone ($CaCO_3$) pulverized to 20 mesh and 60% to pass 100 mesh.

TABLE 16.—*Fertilizer and lime recommendations for crops indicated under productivity indexes in table 14 for the different soil types of Capiz Province*—Continued.

Soil types	Agricultural Lime [1] Tons/Ha.	Ammonium sulfate (20% N) Kgs./Ha.	Superphosphate (20% P_2O_5) Kgs./Ha.	Muriate of potash (60% K_2O) Kgs./Ha.
For Corn				
San Manuel clay loam	----------	100	----------	100
Bantog clay	----------	150	200	250
Sta. Rita clay	----------	100	----------	250
Sara clay loam	0.50	150	250	----------
Maligaya clay	----------	150	50	100
Makato clay	----------	300	----------	150
Umingan sandy loam	----------	300	----------	50
San Manuel sandy clay loam	1.50	300	50	250
Sara sandy loam	8.50	300	250	200
Alimodian clay loam	----------	150	300	----------
Luisiana clay loam	2.00	100	250	350
Sapian clay	----------	300	100	350
Sigcay clay	9.50	----------	300	50
Bauang clay	----------	300	300	150
Faraon clay	----------	300	200	----------
For Sugar Cane				
San Manuel clay loam	1.50	100	----------	100
Bantog clay	2.50	250	345	400
Sta. Rita clay	1.50	100	----------	400
Sara clay loam	0.50	250	460	----------
Maligaya clay	2.50	250	50	100
Makato clay	1.50	500	----------	200
Umingan sandy loam	----------	500	----------	50
Sen Manuel sandy clay loam	1.50	500	50	400
Sara sandy loam	8.50	500	460	300
Alimodian clay loam	2.50	250	575	----------
Luisiana clay loam	2.00	100	460	500
Subian clay	1.50	500	115	400
Sigcay clay	9.50	----------	575	50
Bauang clay	1.50	500	575	200
Faraon clay	----------	500	345	----------
For Coconut				
San Manuel clay loam	----------	100	----------	50
Bantog clay	----------	150	200	200
Sta. Rita clay	----------	100	----------	200
Sara clay loam	0.25	150	250	----------
Maligaya clay	----------	150	50	50
Makato clay	----------	300	----------	100
Uminga sandy loam	----------	300	----------	50
San Manuel sandy clay loam	0.75	300	50	200
Sara sand loam	4.25	300	250	150
Alimodian clay loam	----------	150	300	----------
Luisiana clay loam	1.00	100	250	250
Sapian clay	----------	300	100	200
Sigcay clay	4.75	----------	300	50
Bauang clay	----------	300	300	100
Faraon clay	----------	300	200	----------
For Ca note				
San Manuel clay loam	----------	100	----------	100
Bantog clay	----------	150	200	400
Sta. Rita clay	----------	100	----------	400
Sara clay loam	0.25	150	250	----------
Maligaya clay	----------	150	50	100

TABLE 16.—*Fertilizer and lime recommendations for crops indicated under productivity indexes in table 14 for the different soil types of Capiz Province*—Continued.

Soil types	Agricultural Lime [1] Tons/Ha.	Ammonium sulfate (20% N) Kgs./Ha.	Super-phosphate (20% P_2O_5) Kgs./Ha.	Muriate of potash (60% K_2O) Kgs./Ha.
Makato clay	-----	300	-----	200
Umingan sandy loam	-----	300	-----	50
San Manuel sandy clay loam	0.75	300	50	400
Sara sandy loam	4.25	300	250	300
Alimodian clay loam	-----	150	300	-----
Luisiana clay loam	1.00	100	250	500
Sapian clay	-----	300	100	400
Sigcay clay	4.75	-----	300	50
Bauang clay	-----	300	300	200
Faraon clay	-----	300	200	-----
	For Cassava			
San Manuel clay loam	-----	100	-----	100
Bantog clay	-----	150	200	400
Sta. Rita clay	-----	100	-----	400
Sara clay loam	0.50	150	250	-----
Maligaya clay	-----	150	50	100
Makato clay	-----	300	-----	200
Umingan sandy loam	-----	300	-----	50
San Manuel sandy clay loam	1.50	300	50	400
Sara sandy loam	8.50	300	250	300
Alimodian clay loam	-----	150	300	-----
Luisiana clay loam	2.00	100	250	500
Sapian clay	-----	300	100	400
Sigcay clay	9.50	-----	300	50
Bauang clay	-----	300	300	200
Faraon clay	-----	300	200	-----
	For Mungo			
San Manuel clay loam	-----	-----	-----	50
Bantog clay	-----	-----	200	200
Sta. Rita clay	-----	-----	-----	200
Sara clay loam	0.50	-----	250	-----
Maligaya clay	-----	-----	50	50
Makato clay	-----	100	-----	100
Umingan sandy loam	-----	100	-----	50
San Manuel sandy clay loam	1.50	100	50	200
Sara sandy loam	8.50	100	250	150
Alimodian clay loam	-----	-----	300	-----
Luisiana clay loam	2.00	-----	250	250
Sapian clay	-----	100	100	200
Sigcay clay	9.50	-----	300	50
Bauang clay	-----	100	300	100
Faraon clay	-----	100	200	-----

II. SOIL EROSION SURVEY

SOIL EROSION DEFINED

Soil erosion is defined as the process of soil detachment and transportation by either wind or water. There are two kinds of erosion; namely, normal or geologic and accelerated erosion.

Normal or geologic erosion.—Normal or geologic erosion takes place in a natural or undisturbed condition under the canopy of forest, grasses, ground litter, and in underground network of binding roots. Geologic erosion is a slow process; the removal of the soil by either water or wind is balanced by the formation of soil from the parent material underneath. This kind of erosion is beneficial in the sense that there is a constant renewal of the fertility of the soil.

Accelerated erosion.—Accelerated erosion is the process brought about by man's activities on the land, thereby disturbing the equilibrium between soil building and environment. This kind of erosion is destructive as it removes soil particles very much faster than the formation of soils from the material beneath. The loss of the surface soil which contains most of the fertility means also the decline in crop yields. Soil erosion in the Philippines is caused mainly by water. The different kinds of accelerated soil erosion are: sheet, rill, gully, and stream bank erosion.

Sheet erosion.—This is the washing away, in a more or less uniform depth, of the upper part of the soil in the croplands. It occurs when farmers cultivate their sloping lands without employing any means of controlling the flow of the surface water or runoff. At the beginning, this kind of erosion is slow and is not noticeable, but it is treacherously destructive.

Rill erosion.—This kind of erosion is the washing off of the soil by the formation of tiny incisions of a few inches depth and width which run down the slopes of an unprotected cultivated land. This is attributed to the method of planning and arranging the furrows along the slope of the land. Such rills may be erased by ordinary plowing. This type of erosion marks the beginning of the formation of more serious kinds of erosion.

Gully erosion.—This erosion occurs on paths of concentrated flow down a slope and is the cutting of deep narrow strips or gullies on the face thereof. Gullies occur both on alluvial plains as well as on uplands. On a plain where drainage outlets are not protected, the edges of the plain are gradually eroded which consequently form into deep vertical cuts. These gullies, if not checked, gradually destroy the plain. On uplands, gullying occurs mostly on slopes where runoff continually drain. This happens when farmers plow their fields up and down the slopes. Some gullies are small, but others are so big that farm animals cannot cross. Gullies grow bigger each year.

Stream bank erosion.—This kind occurs along the banks of streams and rivers. It is very destructive particularly on such lands where the substrata are of coarse or medium-textured soils. The flowing water undermines the lower part of the river or stream bank particularly along its outer curve thus causing the upper part to fall by its own weight.

Factors Affecting Soil Erosion

Soil erosion occurs when water runs over the surface of a sloping land. This water running over the surface is called runoff. The rate of soil erosion will depend upon the speed of surface runoff. The volume of runoff as well as its speed depends upon the soil, slope, vegetation, and intensity of rainfall in the area.

SOIL

The soil possesses certain physical characteristics which influence its erodibility. Under similar conditions of climate, relief, and vegetative cover, there are marked differences in the erodibility of different soils. In some cases sandy loam soils are more susceptible to erosion than clay loam soils.

Porosity and permeability are important factors in the formation of runoff. The higher the absorbing quality of the soil or infiltration of water into the soil the less runoff will be formed. Different soil types differ in porosity and permeability. Also soils rich in organic matter are porous and will absorb more water readily than those poor in it.

SLOPE

Slope has a great influence on erosion. Runoff flows faster on a steeper slope than on one with lesser grade. Taking

other erosion factors equal, soil loss is greatest where runoff is fastest. Furthermore, on farm lands with the same grades of slopes, one with a longer slope will erode more than one with a shorter slope. This is so because as runoff acquires momentum its cutting power as well as its soil carrying capacity is increased considerably. A slope unprotected by vegetation or some mechanical devices to decrease the velocity of runoff suffers heavily during a heavy rainfall.

VEGETATION

The density of the vegetative cover of an area contributes a great deal to its resistance to erosion. In the heavily wooded portions of our forests the rate of soil loss is balanced by the formation of soil underneath. On cultivated farms the crops offer very little protection for the soil. Crops that can cover the ground well will give some protection for the soil but clean tilled row crops are conducive to erosion. Land on slopes exposed or bare of vegetative cover suffers heavy soil losses.

In the open areas where cogon predominates very little erosion takes place. The thick growth of cogon is quite adequate protection for the land. Even on steep slopes the grass cover, if preserved and improved, will give good protection.

INTENSITY OF RAINFALL

Rainfall intensity is a factor in erosion. A region with rainfall distributed throughout the year will have less soil erosion than another area where the same amount of rain occurs but only within a period of six months. In the latter area the intensity of rainfall is much bigger and hence the amount of runoff is correspondingly greater. In the former case, the intensity of rainfall is less giving more time for the water to infiltrate into the soil, hence, less runoff.

How much of the rain that falls run off the surface is shown by investigations conducted by the United States Department of Agriculture. At the Yazoo River Watershed, 27 inches of rain caused a disastrous flood, where 62 per cent of the rain water immediately ran off cultivated fields and carried soil at the rate of 34 tons per acre. Runoff from plots on barren abandoned fields was 54 per cent of the total rainfall. Surface runoff during the most intense rains increased from 75 to 95 per cent of the total precipitation.

On undisturbed oak forest only 0.5 per cent of the 27 inches of rain ran off the experimental plots while soil removed was only 75 pounds per acre.

Factors Promoting Soil Erosion

System of farming lands.—In the province, especially in the Aklan section, most of the farm lands are rolling and hilly as coastal plains are few and narrow. These are planted mostly to upland rice, corn, and cassava which are erosion promoting crops. No means of protection is employed in farming these sloping lands. Erosion is aggravated by the common farm practice of plowing up and down hill and laying the furrows along the slopes.

Crop rotation in the province is seldom practiced. Rice and corn are planted from year to year. Sometimes the field is fallowed after the rice crop. A good rotation of crops which includes a soil building legume helps conserve the soil.

The pasture lands are over grazed. As a result, hillsides have very scant grass cover and erosion is very much in evidence.

Kaiñgin.—This is another factor contributing to the destruction of soil and forest. Very often *kaiñgin* is made on steep slopes. The trees and other vegetation are burned, leaving the area cleared and entirely bare. When it rains runoff rushes downhill and generates quite a tremendous cutting power that detaches and carries a great deal of surface soil. Rills and sometimes gullies often result after one heavy rain.

SOIL EROSION SURVEY METHODS

The primary purpose of the soil erosion survey is to determine the degree of erosion in the different soils of the province, that is, the extent to which removal of the surface or subsoil has progressed as well as the amount of gullying with special reference to its effect on the cultivation of the land.

The present depths of the different soil types under cultivation in the province were compared to the depths of the virgin soils or soils with normal profiles. The depths of different soils under normal profiles were established after various determinations over a wide area by boring with the soil auger, studying road cuts, pits, open wells, and stream banks.

Variations in the depth of soil as caused by erosion together with the presence of gullies are considered in map-

Figure 27. *Kaingin* in no small measure contributes to the destruction of soil and forest cover of the province.

Figure 28. The loss of surface soil means also the loss of the soil's fertility. Many farms have declined in yield due to this cause.

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ping the different erosion classes. The depth and frequency of occurrence of gullies are noted as these affect the cultivation of the land. The classification of the different degrees of soil erosion used in this survey are as follows:

Erosion class	*Degree of erosion*	*Description*
0	No apparent erosion; no gullies	No apparent erosion; no gullies
1	Slight erosion	Less than ¼ of original surface soil eroded; occasional crossable gullies present.
2	Moderate erosion	From ¼ to ¾ of original surface soil eroded.
3	Severe erosion	From ¾ of original surface soil to ¼ of subsoil eroded.
4	Very severe erosion	All of the surface soil to ¾ of subsoil eroded.
5	Excessive erosion	All of the surface soil and over ¾ of subsoil eroded.
W	Normal erosion	Balance between soil erosion and soil formation is maintained.
Θ	Erosion, undifferentiated	Erosion conditions change as often as floods occur.

The extent as well as the degree of soil erosion will increase each year unless control measures are instituted and practiced.

SOIL EROSION IN THE DIFFERENT AREAS

A detailed investigation of soil erosion in the province is not within the scope of a reconnaissance survey. Hence, accurate statistics for each and every particular area affected by erosion could not be expected of this report. Instead the general distribution of soil erosion within the province is presented. All the different factors of erosion mentioned earlier herein together with actual field tests and measurements were all weighed and considered in the erosion classification of the soils of the province. As already pointed out, some soil types of varying physical characteristics but which are adjacent to each other on land of the same slope and more or less subjected to identical cultural treatments may all fall under one soil erosion class. On the other hand, one soil type in the same area but of a wide range of relief may

have various soil erosion classes depending upon the particular grade of slope. Furthermore, a soil type located in a region of evenly distributed rainfall can reasonably be expected to experience less erosion than that located in a place wherein intense and concentrated rainfall occurs for a certain season of the year only, that is, when all other factors of erosion are presumed equal. It can, therefore, readily be seen that erosion classification under the circumstances is generalized rather than localized. Table 17 presents the different erosion classes under which all the soil types found in the province belong.

The locale of the different soil types are briefly outlined and listed below to supplement table 17.

Umingan sandy loam (100).—This soil type is mostly found around the town of Libacao and stretches northward to Kalibo along the course of the Aklan River. It is a comparatively long and narrow strip. It is flanked by Alimodian and Sigcay series on the southwest and southeast, respectively, and the San Manuel series from Malinao to Kalibo.

San Manuel clay loam (236).—This soil type is found in the vicinity of Buruanga town in northwestern Capiz; in the municipalities of Nabas and Ibajay, along the courses of Alimbo, Ondoy, Ibajay, and Regidor Rivers; along the Aklan River within the municipalities of Numancia and Kalibo; around the town of Balete and the barrios of Calamcam and Ortega, municipality of Libacao; from the town of Jamindan, along both banks of the Mambusao River through the municipalities of Sigma, Dao, Panitan, and Panay; and around the town of Tapas along the Panay River to Dao.

San Manuel sandy clay loam (596).—The places where this soil type is found are along the road from the town of Nabas northwestward to barrio Gibon; from the town of Washington southeastward along the highway; from Batan town southeastward to barrio Mambuklao; and around the town of Capiz.

Soils of the San Manuel series are bounded by various soils, such as those of Alimodian, Sapian, Bauang, Bantog, Makato, Umingan, Sta. Rita, Sigcay, and Maligaya series, and miscellaneous land types; namely, hydrosol and beach sand.

Bauang clay (121).—Bauang clay exists between the towns of Makato and Ibajay. It is surrounded by soils of the Makato, Alimodian, and San Manuel series, as well as by hydrosols.

TABLE 17.—*Erosion Classification of the Soil Types of Capiz Province*

Erosion Class	Relief	Present Land Use	Soil Types
0—No apparent erosion	Flat	Row crops	100—Umingan sandy loam; 236—San Manuel clay loam; 596—San Manuel sandy clay loam; 121—Bauang clay; 126—Alimodian clay loam
1—Slight erosion	Relatively flat	Row crops	100—Umingan sandy loam; 236—San Manuel clay loam; 596—San Manuel sandy clay loam; 121—Bauang clay; 126—Alimodian clay loam; 120—Sta. Rita clay; 220—Maligaya clay; 221—Makato clay; 228—Bantog clay; 123—Sara sandy loam; 237—Sara clay loam
2—Moderate erosion	Rolling	Row crops; grass; fruit trees; secondary forest	121—Bauang clay; 126—Alimodian clay loam; 120—Sta. Rita clay; 220—Maligaya clay; 221—Makato clay; 228—Bantog clay; 123—Sara sandy loam; 237—Sara clay loam; 132—Faraon clay; 140—Luisiana clay; 222—Sigcay clay
3—Severe erosion	Hilly	Row crops; grass; fruit trees; secondary forest	121—Bauang clay; 126—Alimodian clay loam; 132—Faraon clay; 140—Luisiana clay; 222—Sigcay clay; 125—Alimodian-Barotac complex; 133—San Rafael loam; 223—Sapian clay
4—Very severe erosion	Steep	Row crops; grass; fruit trees; secondary forest	121—Bauang clay; 126—Alimodian clay loam; 125—Alimodian-Barotac complex; 132—Faraon clay; 140—Luisiana clay; 222—Sigcay clay; 133—San Rafael loam; 223—Sapian clay
5—Excessive erosion	Steep and rugged	Row crops; grass; fruit trees; secondary forest	121—Bauang clay; 126—Alimodian clay loam; 125—Alimodian-Barotac complex; 132—Faraon clay; 140—Luisiana clay; 222—Sigcay clay; 133—San Rafael loam; 223—Sapian clay; 45—Mountain soils undifferentiated
W—Normal erosion	Hilly to steep	Primary forest	45—Mountain soils undifferentiated
Φ—Erosion undifferentiated	Flat to steep	Row crops; fruit trees; grass; halophytic plants	100—Umingan sandy loam; 236—San Manuel clay loam; 596—San Manuel sandy clay loam; 118—Beach sand; 1—Hydrosol
Stream bank erosion	Flat to relatively flat	Row crops and fruit trees	100—Umingan sandy loam; 236—San Manuel clay loam; 596—San Manuel sandy clay loam; 228—Bantog clay; 220—Maligaya clay

Alimodian clay loam (126).—Alimodian clay loam is a very extensive soil type in Capiz covering the northwestern, central, and central-eastern parts of the province. In the central section of Capiz this soil type is bordered by hydrosol areas on its northern flank and to the south it extends as far as the Iloilo-Capiz provincial boundary.

Sta. Rita clay (120.—It is found south and southeast of Kalibo and in the vicinity of Sapian. San Manuel, Bantog, and Sapian soils adjoin this soil type. In addition, hydrosol and beach sand also border Sta. Rita clay.

Maligaya clay (220).—Maligaya clay is found around the barrios of Tumulalud and Caidquid of the municipality of Mambusao, and around the towns of Dumalag, Dumarao, and Dao. This lowland soil is adjacent to Alimodian, Sara, San Manuel, as well as Luisiana soils.

Makato clay (221).—This soil type is found around the towns of Makato and Numancia and bordered by soils of Bauang, Alimodian, and San Manuel series, and hydrosols.

Bantog clay (228).—Bantog clay is found in several scattered places; namely, in the barrios of Naili, Naligusan, San Jose, and Rizal, in the municipality of Ibajay; and around the towns of Banga, Altavas, Sigma, Ivisan, Pontevedra, Panay, and Capiz. It is found adjacent to soils of the San Manuel, Alimodian, Sapian, Luisiana, Sara, and Sta. Rita series, and also to hydrosols.

Sara sandy loam (123).—The sandy loam type of the Sara series is found on the eastern tip of the province along the Iloilo–Capiz provincial boundary. It is adjacent to soils of San Rafael and Alimodian series, as well as to the clay loam type of the Sara series.

Sara clay loam (237).—This soil type is found in the municipality of Banga; in the barrio of Sta. Cruz, Dumalag; around the town of Dumarao; and along the highway from the barrio of Hipona, Pontevedra to the barrio of Casanayan, Pilar in northeastern Capiz. Sara clay loam is adjoined by Sigcay clay, Bantog clay, Alimodian clay loam, Maligaya clay, San Manuel clay loam, Faraon clay, and hydrosols.

Faraon clay (132).—The clay type of the Faraon series is found around the municipalities of Dumalag and Dumarao; and south of the town of Pilar. This soil type adjoins soils of the Maligaya, Alimodian, and Sara series.

Luisiana clay loam (140).—Luisiana clay loam covers the area north of Dao and extends northward to the town of Capiz traversing through parts of the municipalities of Mambusao, Sapian, Panitan, and Ivisan. It is also found in the southern part of Pontevedra and in the southeastern part of the municipality of Dumarao. This soil type is bordered by the Alimodian-Barotac complex, Alimodian clay loam, Maligaya clay, Bantog clay, Sapian clay, and hydrosols.

Sigcay clay (222).—Sigcay clay extends along the highway from Libacao northward to Banga. It is bordered by soils of the San Manuel, Sara, Umingan, and Alimodian series.

San Rafael loam (133).—This upland soil is found in the southeastern part of Capiz along the Iloilo-Capiz provincial boundary. It is adjacent to Alimodian-Barotac complex, Alimodian clay loam and sandy loam.

Alimodian-Barotac complex (125).—This soil complex is found west of Dumarao town, and in the southeastern part of the municipality of Dao. It is bordered by Luisiana, Alimodian, and San Rafael series.

Sapian clay (223).—Sapian clay exists along the northwestern coast of Capiz from Buruanga to Nabas; and around the town of Batan in the northwest to Ivisan in the northeast. Soils of San Manuel, Alimodian, Bantog, Sta. Rita, and Luisiana series, as well as hydrosols border this soil type.

Mountain soils, undifferentiated (45).—This miscellaneous land type is found in the regions around Mounts Talipas, Guimbarogtog, Camaingin, Tinagtacan, Butong, and Tinayonga, all in northwestern Capiz; along the Antique–Capiz provincial boundary; and the region around Mt. Agnato in south-central Capiz. This miscellaneous land type is mostly bordered by soils of the Alimodian series.

EFFECTS OF SOIL EROSION

Soil erosion has great influence upon the economic stability of the people. Civilization flourishes or declines in consonance with the agricultural progress of the community.

PHYSICAL EFFECT

The first to suffer from erosion is the land. Through the action of water, destruction is brought on the land by one or all of the three types of erosion; namely, sheet erosion, rill erosion, and gully erosion. Loss of surface soil by sheet erosion

is hardly noticeable at first because the loss of the soil is almost uniform over a wide area. However, when the seemingly increment loss is repeated through a period of years, the result may be enormous. The first noticeable sign is the change in the color of the topsoil. Patches of lighter colored soils in a generally dark mass of land could be seen. The changing color pattern of the soil is due to the disappearance of the dark surface soil and the exposure of the lighter colored subsoil. This change in color is accompanied by decrease in yield.

Sheet and rill erosion usually occur simultaneously. After a heavy rain, a great deal of surface soil may be washed which may also cause shallow incisions to appear. These incisions compose rill erosion. Neglect, however, will cause these incisions to deepen and form gullies. Gullies may become deeper and wider unless given timely control measures. The formation of gullies changes the general appearance of the land and prevents the proper use of tillage implements.

Stream bank cutting is an agricultural hazard which a farmer has to cope with if his farm is beside a river or stream. The loss of soil is not in terms of a few centimeters depth of soil, but rather of strips or slices of land which may vary in length and width from fractions of a meter to several meters, and of depth that could include the whole soil profile. It may occur any season of the year because the toppling of a river bank through water action is rather instantaneous although the process might have started several weeks or months before the final fall. Depending upon the flow of river or stream current and the curvatures of the river course, as well as the soil material forming the face of the river bank, this type of soil erosion is the culmination of several forces acting through a period of time and effected by varied factors.

When soil erodes in one place, the soil materials detached may not all find their way to rivers or to the sea. Some soil materials are deposited on flood plains or deltas and also on ponds, reservoirs, and dams. In extreme cases a river may pile up enough materials on its banks and bed elevating its flow. It is reported that the Santiaguito River in Mexico flows fifteen feet above the adjacent broad flat plains of corn. Oftentimes sand and gravel are deposited on fields after a heavy flood. Erosion and deposition have lessened the capacities of reservoirs and dams. Siltation of harbors is also due to erosion.

Highways near and parallel to river courses are often subjected to damage from stream bank cutting. In the hilly and mountainous regions landslides cover and block roads especially during heavy rainfall.

ECONOMIC AND CULTURAL EFFECT

The adverse effects of accelerated or man-made soil erosion are much too obvious that they need not be over emphasized. Unfortunately, however, most people take the existence of soil for granted, in the manner that almost everyone always indifferently regards the existence of the air we breath. Whereas our supply of the latter has never been doubted, the certainty of our enjoying the bounty of the former cannot last forever unless we recognize the imminent dangers of soil erosion.

Soil conditions have much to do to shape the pattern of a nation's existence. While we begin by trying to analyze their effect from an agricultural point of view, we ultimately arrive to their economic and social effects as well. This is so because agricultural, economic, and social conditions are closely interrelated so much so that it is quite difficult to separate them too sharply. Erodibility being one of many soil conditions, should ever be borne in mind as much as fertility.

We know that food, shelter, and clothing, man's basic needs, all emanate from the soil. Soil lost to us if taken in terms of the economic value of production of these basic needs surely would amount to enormous figures. The high cost of living may then be partially understood.

We know that while soil loss mounts, there is no sign that population also declines. The tendency is when population increases, people tend to overwork the soil. Overworking the soil inevitably results in decline of productivity. Soil erosion then commences and if unchecked, the people simply abandon the affected area and move to other places. This may happen once or more than once within a generation. What has started as an agricultural problem also becomes an economic and social problem.

We know that industry, especially the manufacture of consumer goods, is dependent on the supply of various raw materials. By and large, these raw materials are produced from the soil. Industry, therefore, directly and indirectly, is affected by soil erosion. In turn, when factories shut down or curtail

operations, men lose their jobs and another social problem is added.

Soil erosion, therefore, is not the individual farmers' problem alone. While it affects his capacity to provide for his family's wants and meet his social obligations, erosion eventually becomes a community's, a province's, and finally a nation's agricultural, economic, and social concern.

METHODS OF EROSION CONTROL

There are two general ways of erosion control in croplands; namely, (1) vegetative measures, and (2) mechanical means. Vegetative measures are simpler and easier to apply, while mechanical means usually require engineering aids, tools, and machinery. The former is usually employed on land that are nearly level to gently rolling, while the latter is adapted to rolling and undulating land. Sometimes both means are employed simultaneously, or one in support of the other depending upon attendant circumstances.

VEGETATIVE MEASURES

Control of erosion by vegetative means deals with the use of plants following the normal farm operations and use of ordinary implements and machinery.

Cover cropping.—Vegetative cover is the first protection against runoff and erosion. Cover crops are usually planted after the harvest of row tilled or seasonal crops. There are also permanent cover crops which are mostly planted in orchards. When planting cover crops mulches of dead stems, leaves, or straw are necessary since cover crops offer protection only after they have attained considerable growth.

Strip cropping.—This vegetative method of erosion control is the alternate cultivation of clean tilled crops on one strip and dense close growing crops on the next strip. These alternate strips break up a relatively large sloping field into small narrow bands lying across the slope. They serve to check the momentum of runoff and to filter out the soil particles. The subsequent loss of the speed of runoff allows rain water to seep into the soil rather than readily flow down the slope. Soil and water are thus conserved.

Buffer strip cropping.—Buffer strips are established bands usually on the contour, two to three meters wide, planted to perennial grass or other erosion-resisting vegetation. They are arranged in regular alternation with relatively wider strips of row tilled crops. Buffer strips are adapted to land with slopes up to eight per cent. When the slope is long, a combination of vegetative and some mechanical means may be necessary. Grasses such as Guinea grass, Napier, Brown-top, Bermuda grass, and *Ipil-ipil* (periodically trimmed to about a foot high) are recommended.

Grassed waterways.—Waterways in soils work are either natural or man-made depressions on sloping areas which serve as passageways for water that goes through a farm from adjacent land or accumulating on it due to rain. They are important in any scheme of soil and water conservation. Naturally located depressions serve the purpose best. Man-made canals strategically laid are also necessary for more efficient discharge of runoff. The establishment of a dense vegetative cover over all waterway is imperative. Grasses readily adaptable to the area should be used, but whenever practicable those species which form a dense turf are preferable. Inasmuch as waterways are supposed to carry heavy flows during certain periods they should be designed to handle maximum runoff from the heaviest rainfall occurring in the locality once in about eight to ten years. Grassed waterways are essential wherever excess runoff accumulate such as in stripcropped fields.

MECHANICAL MEASURES

On the steep slopes vegetative measures offer inadequate protection for the soil. Mechanical means of erosion control are therefore essential in conjunction with the vegetative phase.

Contour tillage.—Contour tillage is plowing and planting on the contour. This is an erosion control measure which is most effective on two to eight per cent slopes and less than 100 meters long. Ridges formed by the tillage implements retard the downhill flow of water. These ridges serve adequately when rainfall is even and light but their effectiveness is reduced when rains are intense or heavy. Contouring is not enough protection especially when slopes are not uniform and above eight per cent, when the fields are already eroded, or when subsoils are clayey and compact. In these cases, excess runoff may break through the ridges, thus necessitating the adoption of other mechanical conservation measures like terracing.

Terracing.—Terraces are mechanical measures of soil conservation and are differentiated into three types; namely, (1) absorptive, (2) bench, and (3) drainage.

Absorptive terrace or ridge type is designed for moisture conservation. It is adapted to gentler slopes and absorptive soils.

Bench terrace is constructed on the contour. It has a steep drop and adapted to steeper slopes.

Drainage terrace or broad channel type is designed to conduct water from a field at low velocity.

As used in this text, terrace may denote a ridge type or a combination of ridge and channel type.

Terraces are built across a slope. They are either level or graded depending upon the purpose for which they are made. Graded terraces lead runoff from the field at nonerosive velocities. Level terraces impound most of the water giving it time to soak into the soil. Where the average annual rainfall is less than 30 inches, level terraces are recommended. Dimensions of terraces are also of utmost importance. They should be large enough to avoid overtopping. Usually the runoff which may be expected from the heaviest rain occurring on an average of once in 10 years is used as a basis. Their shape is generally based on the farming equipment used.

Terrace construction requires technical skill, financing, and special implements and machinery. Aside from these considerations, one must realize that all slopes and all soils cannot be successfully or economically terraced. Sandy, stony, and shallow soils, fields dotted by humps or mounds, or slopes that change planes and steepness every 30 meters are impractical to build terraces on.

Diversion ditches.—Diversion ditches or diversion terraces are built to intercept the runoff from drainage areas. They are usually larger than field terraces. They are designed to protect cultivated fields from hillside runoff by providing for a passageway of the water away from the fields to other nearby areas where it is spread or dispersed. Where adjacent slopes generate runoff towards a terraced area, diversion ditches carry the water away from the terrace system, or if towards a gully diverting the water assist in controlling its further enlargement.

Other Aspects of Erosion Control

Whereas erosion depletes the soil of its inherent fertility, low fertility also brings about soil erosion. Infertile soils invariably mean poor vegetation, thus more surface soil is exposed to direct rain and wind action. Therefore, soils of low fertility when tilled are highly erodible. In this case proper and adequate fertilization can minimize erosion.

The regular application of farm manures and the practice of green manuring increase the soil's organic matter content. Organic matter, aside from enhancing soil fertility, also improves tilth and maintain if not improve soil structure. Stable and favorable soil structure means higher porosity and better permeability. When soils are porous and permeable plant root penetration is improved. All of these favorable physical conditions when attained promote the soil's water absorbing and water holding capacities, or in other words surface runoff is minimized.

Crop rotation should essentially be a part of every farm program. A well planned scheme of crop rotation, aside from providing a practical means of utilizing green manures and fertilizers, counteracting possible development of toxic substances, and improving crop quality and increasing yields, also minimize or help control erosion. This farm practice keeps the soil in suitable physical condition, helps maintain the supply of organic matter and nitrogen in the soil, provides vegetative cover, and changes the location of the feeding ranges of roots.

The physical effects of liming such as the promotion of soil granulation of fine-textured soils and the modification and improvement of the structure of coarse-textured soils thus making them lighter to work subsequently contribute much to erosion control.

An efficient system of soil management in support to vegetative and mechanical measures is, indeed, necessary to combat soil erosion. The different practices followed or adopted should form a farm program that, as a unit, could fit the kind of soil or kinds of soils within a farm so that the end attained is the combined beneficial effects of the many interacting processes involved. Each farmer, therefore, should first appraise the erosion hazards of his farm, then plan a cropping system and supporting conservation practices to reduce or offset the erosion hazards.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN CAPIZ PROVINCE

Common Name	*Scientific Name*	*Family Name*
Abaca	*Musa textilis* Nee	Musaceae
Achuete	*Bixa orellana* Linn.	Bixaceae
Agingai	*Rottboellia exaltata* Linn.	Gramineae
Alibangbang	*Bauhinia malabarica* Roxb.	Leguminosae
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceae
Anonas	*Anona reticulata* Linn.	Anonaceae
Api-api	*Avicennia officinalis* Linn.	Verbenaceae
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceae
Arrowroot	*Maranta arundinacea* Linn.	Marantaceae
Atis	*Anona squamosa* Linn.	Anonaceae
Bakauan-babae	*Rhizophora mucronata* Lam.	Rhizophoraceae
Bakauan-lalake	*Rhizophora candelaria* DC.	Rhizophoraceae
Bamboo	*Bambusa spinosa* Roxb.	Gramineae
Banana	*Musa sapientum* Linn.	Musaceae
Bangkal	*Nauclea orientalis* Linn.	Rubiaceae
Batao	*Dolichos lablab* Linn.	Leguminosae
Bermuda grass	*Cynodon dactylon* (Linn.) Pers.	Gramineae
Binayoyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceae
Breadfruit	*Artocarpus communis* Forst.	Moraceae
Buri	*Corypha elata* Roxb.	Palmae
Cabbage	*Brassica oleracea* Linn.	Cruciferae
Cacao	*Theobroma cacao* Linn.	Sterculiaceae
Cadios	*Cajanus cajan* (Linn.) Millsp.	Leguminosae
Caimito	*Chrysophyllum cainito* Linn.	Sapotaceae
Cashew	*Anacardium occidentale* Linn.	Anacardiaceae
Cassava	*Manihot esculenta* Crantz.	Euphorbiaceae
Chico	*Achras zapota* Linn.	Sapotaceae
Coconut	*Cocos nucifera* Linn.	Palmae
Coffee	*Coffea sp.* Linn.	Rubiaceae
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineae
Corn	*Zea mays* Linn.	Gramineae
Cotton	*Gossypium hirsutum* Linn.	Malvaceae
Cowpea	*Vigna sinensis* (Linn.) Savi.	Leguminosae
Cucumber	*Cucumis sativus* Linn.	Cucurbitaceae
Derris	*Derris elliptica* (Roxb.) Benth.	Leguminosae
Duhat	*Eugenia cumini* (Linn.) Druce	Myrtaceae
Dungon-late	*Heritiera littoralis* Dryand	Sterculiaceae
Durian	*Durio zibethinus* Murr.	Bombacaceae
Eggplant	*Solanum melongena* Linn.	Solanaceae
Gabi	*Colocasia esculenta* (Linn.) Schott. and Endl.	Araceae
Garlic	*Allium sativum* Linn.	Liliaceae
Ginger	*Zingiber officinale* Rosc.	Zingiberaceae

Common Name	*Scientific Name*	*Family Name*
Ipil	*Intsia bijuga* (Colebr.) O. Kuntze	Leguminosae
Ipil-ipil	*Leucaena glauca* (Linn.) Benth.	Leguminosae
Kamachile	*Pithecolobium dulce* (Roxb.) Benth.	Leguminosae
Kapok	*Ceiba pentandra* (Linn.) Gaertn.	Bombacaceae
Kondol	*Benincasa hispida* (Thunb.) Cogn.	Cucurbitaceae
Lañgarai	*Bruguiera parviflora* (Roxb.) W. & A.	Rhizophoraceae
Lettuce	*Lactuca sativa* Linn.	Compositae
Lumbayau	*Tarrietia javanica* Blume. Bijdr.	Sterculiaceae
Maguey	*Agave cantala* Roxb.	Amaryllidaceae
Mandarin	*Citrus nobilis* Lour.	Rutaceae
Mango	*Mangifera indica* Linn.	Anacardiaceae
Molave	*Vitex parviflora* Juss.	Verbenaceae
Mungo	*Phaseolus aureus* Roxb.	Leguminosae
Nangka	*Artocarpus heterophyllus* Lam.	Moraceae
Nipa palm	*Nypa fruticans* Wurmb.	Palmae
Onion	*Allium cepa* Linn.	Liliaceae
Orange	*Citrus aurantium* Linn.	Rutaceae
Palosapis (lauan-puti)	*Anisoptera thurifera* (Blanco) Blume.	Dipterocarpaceae
Pandan	*Pandanus tectorius* Solander	Pandanaceae
Papaya	*Carica papaya* Linn.	Caricaceae
Patani	*Phaseolus lunatus* Linn.	Leguminosae
Patola	*Luffa acutangula* (Linn.) M. Roxb.	Cucurbitaceae
Patolang-bilog	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceae
Peanut	*Arachis hypogaea* Linn.	Leguminosae
Pechay	*Brassica chinensis* (Linn.)	Cruciferae
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceae
Potato	*Solanum tuberosum* Linn.	Solanaceae
Pummelo	*Citrus maxima* (Burm.) Merr.	Rutaceae
Radish	*Raphanus sativus* Linn.	Cruciferae
Rice	*Oryza sativa* Linn.	Gramineae
Santol	*Sandoricum koetjape* (Burm. f.) Merr.	Meliaceae
Sincamas	*Pachyrrhizus erosus* (Linn.) Urb.	Leguminosae
Siniguelas	*Spondias purpurea* Linn.	Anacardiaceae
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae
Soybean	*Glycine max* (Linn.) Merr.	Leguminosae
Squash	*Cucurbita maxima* Duchesne	Cucurbitaceae
Sugar cane	*Saccharum officinarum* Linn.	Gramineae
Sweet potato	*Ipomoea batatas* Linn.	Convolvulaceae
Talahib	*Saccharum spontaneum* Linn.	Gramineae
Tamarind	*Tamarindus indica* Linn.	Leguminosae
Tobacco	*Nicotiana tabacum* Linn.	Solanaceae
Tugui or yam	*Dioscorea esculenta* (Lour.) Burkill	Dioscoreaceae
Ubi	*Dioscorea alata* Linn.	Dioscoreaceae
Upo	*Lagenaria leucantha* (Duch.) Rusby.	Cucurbitaceae
Watermelon	*Citrullus vulgaris* Schrad.	Cucurbitaceae

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