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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
MANILA

Soil Report 18

SOIL SURVEY OF LEYTE PROVINCE PHILIPPINES

BY

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Published with MSA-PHILCUSA Aid

MANILA
BUREAU OF PRINTING
1954

3-3492

ILLUSTRATIONS

(All photographs by A. BARRERA)

PLATE 13

PLATE 14

HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide basic data for the formulation of land-use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part thereof. Ordinarily he will be able to obtain the information he needs without reading the whole report. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers under three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. An attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

Readers interested in the area as a whole include those concerned with general land-use planning—the placement and development of highways, power lines, urban sites, industries, community cooperatives, re-settlement projects, and areas for forest and wildlife management and for recreation. The following sections are intended for such users: (1) Description of the Area, in which physiography, relief, drainage, vegetation, climate, water supply, history, population, industries, transportation, markets, and cultural developments are discussed; (2) Agriculture, in which a brief history of farming is given with a description of the present agriculture; (3) Productivity Ratings, in which are discussed and presented the productivity of the different soils; (4) Land Use and Soil Management and Chemical Characteristics of the Soils, in which the present uses of the soils are described, their management requirements discussed and suggestions made for improvement; and (5) Water Control on the Land, in which problems pertaining to drainage and control of runoff are treated.

Readers interested chiefly in specific areas, such as a particular locality, farm, or field, include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers,

SUMMARY

The Province of Leyte is located on the southeastern part of the Visayan Group. Tacloban, the capital, is 353 statute miles southeast of Manila.

The geological structure of Leyte is chiefly pre-Tertiary basic igneous and metamorphic rocks. The central mountain range, the Biliran, and Maripipi Islands range in age from Miocene to Recent and with thick accumulation of andesitic volcanics. Uplifted coral reefs fringe the northwestern part of Leyte while alluvial plains are present both on the east and west sides of the island.

Water supply is abundant in Leyte. A number of springs are found both in the mainland and in Biliran and Maripipi Islands.

"Tandaya" was the former name of the province before the Spaniards arrived. The first mass to be offered in the Philippines was in Limasawa Island when Ferdinand Magellan landed in 1521. Civil government was established in 1901. Leyte has the distinction of being the first province in the Philippines to be liberated from the Japanese when the American forces landed on October 19, 1944.

The province has good land, sea, and air transportation. Farming is the principal industry. Lumbering and fishing also contribute much for the prosperity of the province.

The second type of rainfall prevails on the eastern part while the fourth type on the western side. On eastern Leyte the planting of lowland rice is from November to December while that of the western side is from May to June.

The leading and principal crops of Leyte are coconut, corn, rice, abaca, maguey, camote, cassava, sugar cane, and tobacco. Irrigation and drainage are must problems of Leyte.

There are 100,794 farms comprising 278;248 hectares in Leyte in 1938. About 58 per cent of the area is managed by the owners and the rest under tenants.

The soils of the province are classified into thirty soil types representing 22 per cent flat lowlands, 30 per cent rolling uplands and 45 per cent as mountain soils. A soil map showing the distribution of the soil types of the province is included in this report.

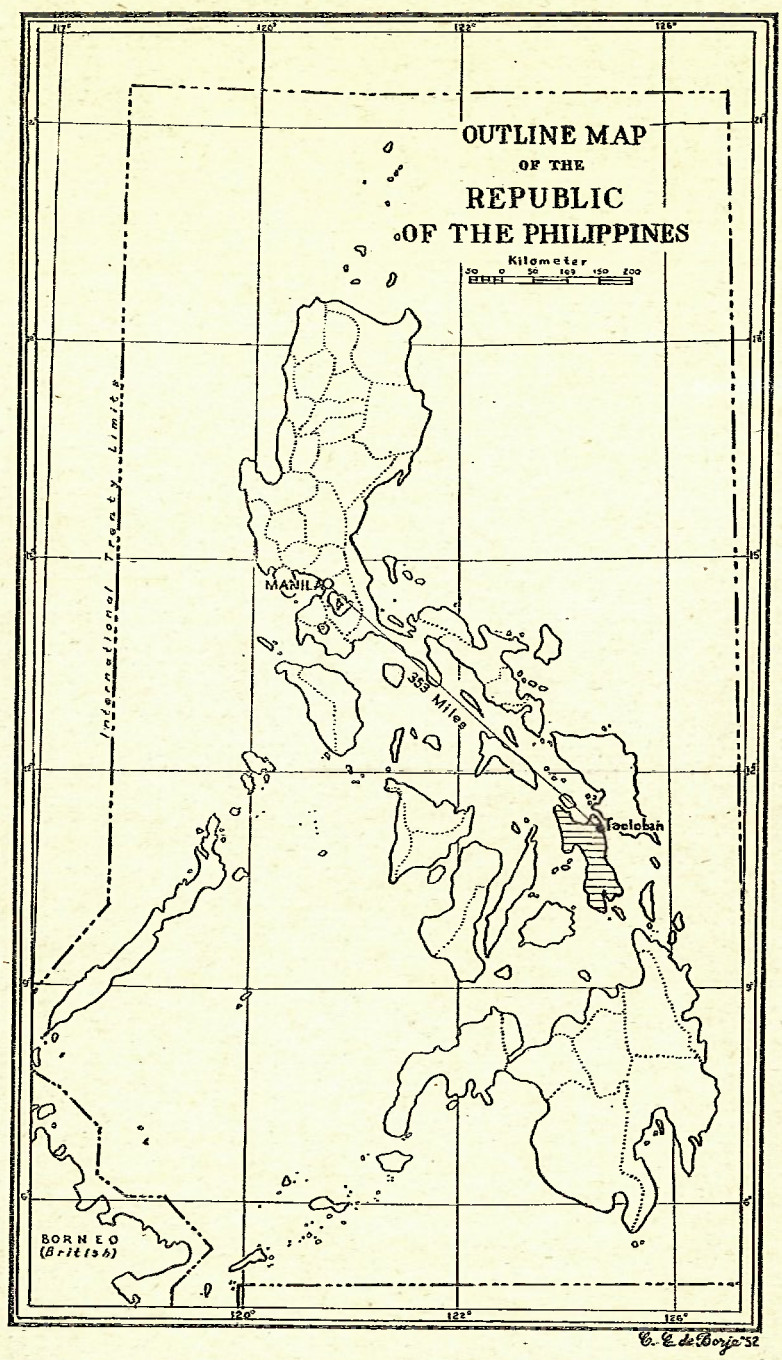

Fig. 1. Location of Leyte Province showing the distance of its capital, Tacloban, from Manila.

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[Area inspected by DOMINADOR Z. ROSELL, Chief, Division of Conservation Surveys, Bureau of Soil Conservation]

INTRODUCTION

Soil is one of our basic natural resources. It supports vegetation on which animal life depends. A progressive country is one that possesses large areas of soils suitable for the raising of large quantities of foodstuffs for man, materials for shelter, clothing, transportation, and industry. Because of this basic principle, it becomes the duty of everyone concerned in the production of these materials to see to it that soil be made to produce not only for the present generation but also for those to come.

Crop production has to be increased to meet the demand of the increasing population. To make an economical production, a better understanding of the properties and characteristics of the soil is of great importance. Tillage operation, kinds of crops, lime and fertilizer requirements, irrigation, drainage, soil erosion, etc. all depend upon these characteristics. It is for this reason that the soils of the province of Leyte were classified and studied.

The survey which was done by the Bureau of Soil Conservation was greatly facilitated by the financial help offered by the provincial government of Leyte for the maintenance of vehicle used during field operations from March to June, 1947.

DESCRIPTION OF THE AREA

Location and extent.—The province of Leyte is located on the southeastern part of the Visayan Group and lies approximately between 124° 17′ and 125° 18′ east longitude and between 9° 55′ and 11° 48′ north latitude. The mainland is long measuring 214 kilometers from the northwestern tip to the southeastern end and 72 kilometers wide between Tacloban and Palompon which is the widest portion across the island while the narrowest part is only 25 kilometers between Abuyog

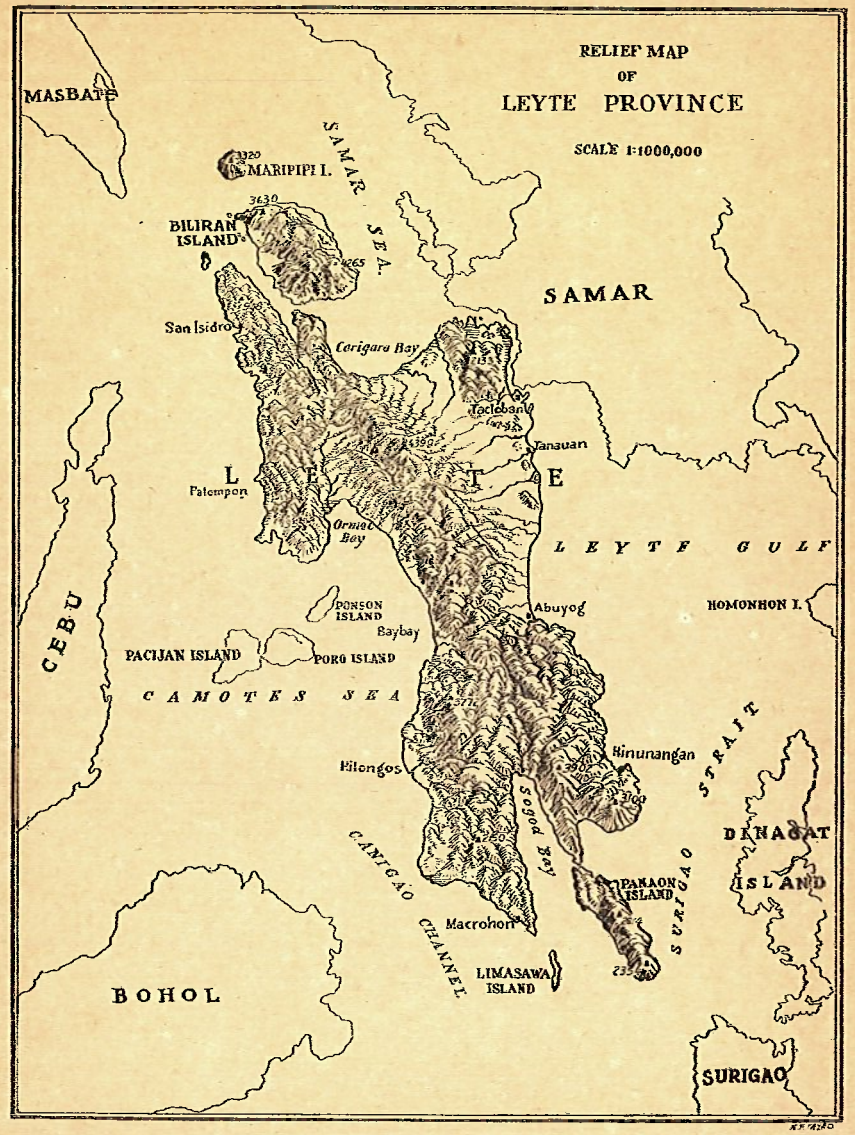

Fig. 2. Relief map of Leyte Province.

and with steeper slopes as the central portion of the range is reached. In these central areas, the hills are thickly covered by forest.

The area from the south of Palo to Abuyog (52 Kms.) and from Palo to Barugo (40 Kms.) is a long stretch of plain, the largest in the province. This plain which is bounded on the west by another mountain range has a width that ranges from

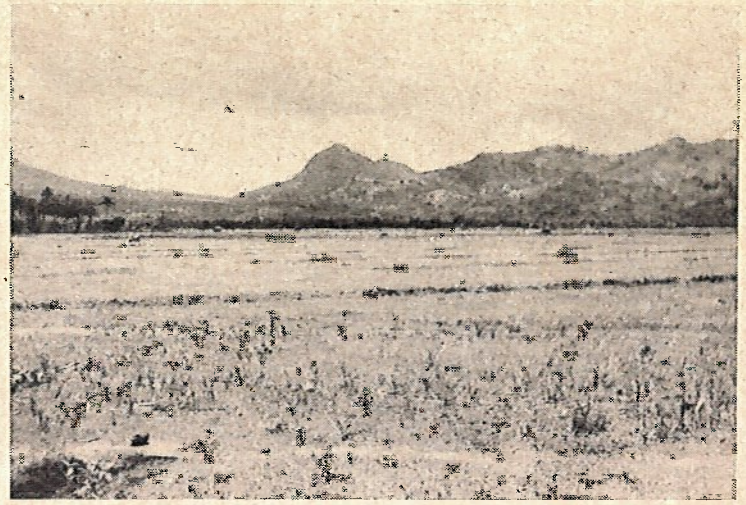

Fig. 1. A partial view of the eastern plain of Leyte Province and the central mountain range at the background.

Fig. 2. The island of Maripipi as viewed from Biliran.

PLATE 1.

higher than the range south of Baybay. In this range are some lofty peaks and extinct volcanoes such as Mount Janagdan, Alto Peak (1,333 meters), Mt. Tinagan (1,171 meters), Mt. Lunas (1,171 meters), Mt. Sacripante (1,150 m.), Mt. Capuloan (276 m.) near Sogod, and Mount Cabalian. Drainage on the northern half of the range is good. Too much runoff does not occur in spite of its steep slopes as this place is generally well covered by thick native vegetation. The areas on the south of the range, however, has from fair to excessive external drainage as some of the slopes are bared of vegetation.

The area from Merida on the south to San Isidro at the north is another range of hills. This range is not as broken or rugged as the central cordillera. The regions especially from Villaba to the end of San Isidro and those at Merida are dominantly hilly whose tops are rounded or smooth and extensively cultivated. The elevation in these areas ranges from 600 to 700 ft. Those areas on the central portion of the range on the other hand, are rugged with steep slopes and seldom cultivated. Their altitudes reach as high as 1,600 to 2,000 feet. Fringing from the western slopes of this range of hills are few small coastal plains that are fan-shaped. Drainage on the cultivated hills is rather excessive and the rivers in these places are short and intermittent in nature. The western side of the range drains towards the Visayan Sea while those on the eastern side find their ways into the Pagsangahan River which empties into Ormoc Bay.

In between the western range of the hills and the northern part of the Central Cordillera is a big valley known as the Pagsangahan Plain. This plain is wide and almost level having only from 5 to 8 degrees of slope. But in spite of such slope, drainage is not very good as there are many wide depressions on this plain that remain waterlogged throughout the year. The Pagsangahan River which flows southward through the middle part of the plain empties into Ormoc Bay. This river aside from draining the western hilly range also serves as the drainage way of some part of the northwestern side of the central Cordillera.

The plain east of Ormoc on the other hand has a better drainage condition than that of the Pagsangahan Plain as the slope in the former ranges from 10 to 15 degrees and the topography gradually becomes rolling and hilly as the side of the Cordillera is approached.

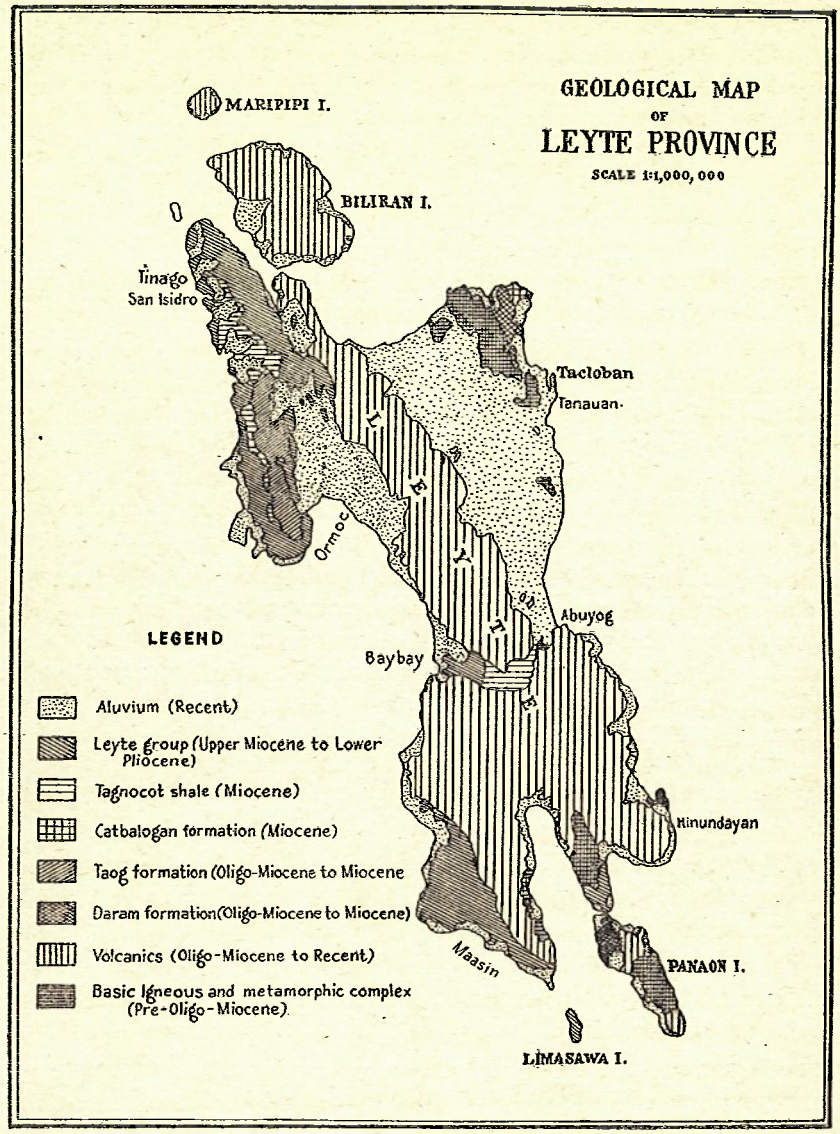

Fig. 3. Geological map of Leyte Province.

Uplifted coral reefs of Quaternary age fringes the northwestern part of Leyte. Wide alluvial plains are present both on the east and west sides of the island.

Volcanic activity has been intermittent during this entire period.

A geological map of Leyte (Fig. 3.) shows the distribution of the different formations.

Vegetation.—The native vegetation of Leyte Province shows a striking and intelligible expression of the physical conditions of structure, relief, and climate that prevails in the area. In general, vegetation of a place is used as a basis for classifying and judging the potentialities of environment. It also will tell the present climatic characteristics as well as the past changes that occurred in the place. Only a certain kind of plant or plant association grows under this set of conditions. The different factors that form this set of conditions are temperature, rainfall, wind, relative humidity and soil.

The Province of Leyte, by nature of its geographic location, has a fairly uniform temperature throughout the year. Differences in temperature are brought about only by differences in altitude. In such changes plant association also varies. According to Brown, types of vegetation change beyond 750 meters of altitude or from the dipterocarp type of forest or the big trees at sea level to the mossy type of dwarf trees at the higher altitudes.

Although Leyte Province has two types of climate, the differences in the distribution and amount of rainfall in each type do not vary much as to cause material changes in the character of the vegetation. The molave type of forest prefers more the relatively dry conditions than the dipterocarp types.

Although the amount of rainfall is uniform on the western part of Leyte, molave and dipterocarp types of forest exist. This shows that another factor more dominant than rainfall is responsible for the differences in vegetation.

Wind velocity and frequency of different wind directions are important climatic factors in connection with the dissemination of seeds. Where other factors are the same, frequency of wind in a certain direction will cause the propagation of that same kind of plant in that direction.

Humidity is the product of the interrelation of rainfall and temperature. Relative humidity as a factor in the development of vegetation is responsible for the germination of the seeds of plants tolerable only for those kinds of seeds. The ease with which plants transpire is also dependent upon the relative humidity. Plants living on the wet marshy areas of the plain of eastern Leyte are very different from those growing on the top of hills and mountains.

Soil condition is one of the most important determinants in kinds of vegetation. Dipterocarp forest develops only in areas of deep soils; molave trees on hard shallow soils, mangroves

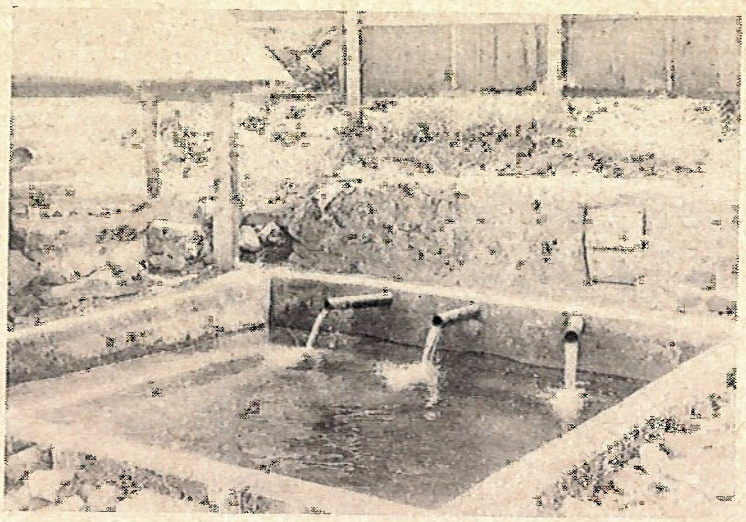

Fig. 1. One of the best springs in the islands is Biasong spring at Libagon on the southern part of Leyte.

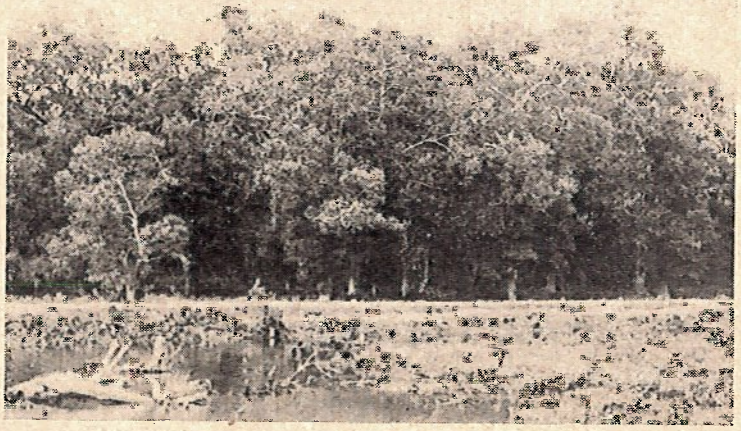

Fig. 2. The salty swamps along the Himagnol and Leyte Rivers are covered by several species of mangrove trees.

PLATE 2.

coastal or shoreline areas on the northwestern coast of Leyte are mangrove swamps covered by bakauan, api-api, pagatpat and nipa palms. The list of plants with their scientific and family names is contained in the glossary. On both sides of the banks near the mouth of the Nagasaan River is a wide area of mangrove swamp. Similarly, the shores in Carigara and Capoocan contain a mixture of mangrove and nipa palms. Both sides of the Himagnol and Leyte Rivers are wide areas of pure stand of mangrove principally the kinds of tabigi and bakauan (Plate 2, Fig. 2). Other wide areas of nipa palm are found in the southwestern coast from Ilongos to Matalom.

The leaves of the nipa palm are used for thatching materials in native houses. The manufacture of shingles is an important industry of the people living in the vicinity of nipa groves. Nipa swamps on public lands are under the jurisdiction of the Bureau of Forestry and such areas can be exploited either by sale or by lease. Owners or lessee of nipa groves in turn sub-lease the area to other persons for operation on the basis of one-third of the product or sale for the owner and two-thirds for the operator.

The long central Cordillera of Leyte is still well covered by virgin forest. Good stand of timber is found in this forested area. The principal trees found are yakal, molave and ipil on the western coast like Palompon and Albuera; guijo, guisok, tanguili, red lauan and apitong are found elsewhere. Babatngon is known for its big mancono trees which is reputed to be the hardest, most durable and rarest trees in the Philippines.

The primary forest in Leyte has a very thick undergrowth. Its upper canopy is likewise very dense that only scanty amount of sunlight can penetrate. The undergrowth, consisting of vines, herbs, and palms makes the understory almost impenetrable. Trees at the higher altitudes are almost covered by mosses, ferns and other kinds of aerial plants (Plate 3, Fig. 1.

The trunks of some trees reach up to about 2 meters in diameter. Many trees have large buttresses measuring from a few inches to one foot in thickness, from three to eight meters in height and extend from three to eight meters out from the trunk.

The hills on the northwestern part of the province (Merida to San Isidro) are mostly grasslands of cogon. This grassland is used for pasture. Most of the areas on the southern part of Leyte has also become grassland as a result of "kaingin" way of farming.

which was sacred to the diwatas. The rebellion spread to several neighboring towns, Bancao was an old friend of Legaspi who was converted to Catholicism in 1565. Later he changed his belief and went back to the practice of his former religion. Twenty-seven years after the revolt of Bancao, another uprising took place in Leyte. This uprising was the continuation of the Sumoroy rebellion in Samar. The center of the uprising was in Bacor where the rebels burned the church and the convent. This revolt was led by Sumoroy in Pilapag, Samar on June 1, 1649. The cause of the uprising was resentment against forced labor in connection with shipbuilding for the Spaniards. The rebels fled to the mountains and there they fortified themselves and from time to time harassed the Spanish forces sent to attack them.

In 1768, Samar was separated from Leyte. The capital of Leyte changed from time to time. From the first capital at Carigara it was moved to Palo, then to Tanauan and finally Tacloban where it stands to date.

With the reorganization of the provinces in Visayas in pursuance with the Royal Decree of July 31, 1880, a politico-military government was formed in Leyte. This form of government was in effect till the end of the Spanish rule in the Philippines.

The Philippine Revolution did not readily spread in Leyte until General Vicente Lukban took possession of both Leyte and Samar. Later on the people joined the revolutionists from Luzon and drove the Spaniards from the island. But much to the desire of the Filipinos to be free and independent, the Island fell into the hands of the United States in 1898. However, the new conquerors gave the Filipinos better dealings than the Spaniards and after a short period of military government, a civil government was established in Leyte on April 22, 1901.

Since then the people were enjoying many civil rights which were denied them before by the Spaniards. But still the Filipinos were not satisfied with the autonomy given—they asked for independence as prescribed in the Jones Law. In this request, America in November, 1935, gave the Commonwealth form of government as embodied in the Tydings-McDuffie Act wherein all internal legislations were passed and approved by Filipinos. This form of government was really a prelude to independence, for after ten years, America promised complete independence. But before that time came, the Japanese attacked Pearl Harbor and the Philippines (by reason of its

The South Road which also starts from Tacloban passes along the eastern coast through the towns of Palo, Tolosa, Dulag, and Abuyog,—the latter place being 63 kilometers from the capital. From Abuyog, the road goes to Baybay a town on the western side. A greater portion of this 24-kilometer cross-country road is winding while passing across the central Cordillera of Leyte. This same road continues to the south passing through the coastal towns of Inopacan, Hindan, Bato, Matalom, Maasin, Macrohon, Malitbog, Sogod, and Libagon. This road was recently extended farther south of Himayangan, a small barrio which is 290 kilometers from Tacloban. From this point in Himayangan, the road connects a 14-kilometer gap with another 42-kilometer road on the southeastern coast of Leyte which further connects the towns of Cabalian, Hinundayan, and Hinunangan.

The road to Ormoc is another part of the south road which branches at Palo. This road goes northwestward passing through the towns of Alangalang, Jaro, Carigara and Capoocan. From Capoocan, the road goes southwestward and crosses the northern end of the Central Cordillera to Ormoc. The distance from Tacloban to Ormoc is 108 kilometers. The road continues to Albuera, a coastal town 15 kilometers south of Ormoc. The American army during their operation in Leyte in 1945 put up a temporary road along the beach connecting Albuera with Baybay. However, another road is being constructed along this one but farther inland. Branching from the highway between Capoocan and Ormoc is another road that goes directly westward to Palompon. At Tanauan is another branch of the south road which crosses the plain westward to Dagami and Burauen and then out to Dulag covering a length of 41 kilometers.

There are several other roads in the mainland that were built by the United States Army during their short period of occupation but most of them were for their camps only and are no longer in use today. The road from Alang-alang to Barugo via San Miguel was passable before but was destroyed when heavy equipment of the U. S. Army passed through it. In general road condition in Leyte is poor because it is difficult to repair them immediately not only because of the frequent heavy rains but also because of the presence of many heavy motor vehicles in the highway. Then the frequent floods which occur, either wash away the bridges or make it impossible for vehicles

by both the Japanese and American armies but all of them were abandoned soon after the war. The Cataisan airfield is 363 statute miles from Manila and 100 miles from Cebu airfield.

Industries.—Farming is the principal industry of the people of Leyte. Of the 915,853 inhabitants of Leyte in 1939, 100,794 were farmers. When farming was considered a normal occupation in 1939, under no interruptions due to social disorders, the province was able to produce a total of 8,539,386 pesos worth of crops and 5,699,163 pesos worth of animals and animal products. The production in 1946, however, dropped considerably for both farm and animal products. This decrease in production may be attributed to the indiscriminate slaughtering of work animals during the period of enemy occupation. The decrease in farm produce may be due to a number of causes, some of which are: the abandonment of some farms by their owners because of the existence of too many lawless elements; the destruction of their crops, like coconut, as a result of the war; the destruction of their fields, such as those occupied by a number of airfields, army camps and depots; the partial destruction of the Ormoc Sugar Central; lack of seedlings and fertilizers; and to the depletion of the soil as a result of severe soil erosion and fertility exhaustion.

Aside from farming, the people of Leyte are engaged in many other enterprises. Following Manila, Iloilo, Cebu, and Davao in the amount of invested capital in commercial enterprises in 1938 was Leyte Province with an amount of 5,514,525 pesos.[a] In the same year, there were engaged a total of 59,821 persons in carrying out these different enterprises in which a total of 11,050,697 pesos worth of goods was transacted. Of this invested amount 1,762,112 pesos was used to capitalize the different manufacturing enterprises, such as those in bakeries, soap factories, rice mills, tailor shops, manufacture of hides, noodles, etc. Out from these investments, a total of 67,018 persons was employed to produce a total value of 2,734,382 pesos worth of products.

Fishing is another industry of the people living along the coasts of Leyte. The northern shores are the best fishing grounds in the province while the waters in the other parts of

[a] Data taken from Philippine Census of 1939.

TABLE 2.—*The location, capacity, and investment of different lumber mills in Leyte in 1947* [b]

Mills	Location	Capital invested	Total daily capacity (Bd. ft.)	Leased areas in hectares
1. Eureka	Tacloban	₱125,000	10,000	1,900
2. Leyte Saw Mill	Tacloban	65,000	10,000	5,000
3. Visayan Saw Mill	Tacloban	50,000	5,000	1,940
4. Caibiran Saw Mill	Caibiran	22,000	2,000	2,900
5 Larazabal Saw Mill	Ormoc	22,000	2,000	2,500
6. A.R P. Lumber Mill	Ormoc	25,000	1,000	3,000
7 Baybay Lumber Mill	Baybay	23,000	2,000	1,900
8 Abuyog Lumber	Abuyog	27,000	2,000	1,180
9. Rosario Lumber	Hinunangan	27,000	2,000	4,470
10. Sudmon Lumber	Hinunangan	70,000	4,000	3,500
11. Minoros Lumber	Capoocan	25,000	2,500	450
12. Capoocan Saw Mill	Capoocan	30,000	2,000	168
13. Serapica Saw Mill	Ormoc	10,000	2,500	2,500
14. Leyte Gulf		65,000	3,500	2,700
15. Philippine Lumber	Abuyog	(Not yet in	operation)	3,900
Total		586,000	49,500	38,008

[b] Data furnished by the Office of the District Forester, Tacloban, Leyte.

For this particular industry, the amount of 563,000 pesos is needed to produce a maximum of 48,500 cubic feet of lumber monthly. The important timber cut for commercial purposes are yakal, narra, guijo, tanguile, lauan, apitong, and molave. Aside from this timber, other forest products like rattan, balao, and resin are collected.

Minerals of various kinds are also found in Leyte but most of them are not exploited. Sulfur was reported by Abella to exist in Biliran and was reputed to be the best known sulfur deposit during the Spanish times. There is no plan of developing this mine due probably to less demand for this mineral.[a] Similarly, oil was reported to exist north of Villaba. There may be possibility of its existence there, as also reported in many areas in Cebu, because the geology north of Villaba is similar to those areas in Cebu where oil is reported to be present. Up to now, however, there is no concern in Leyte engaged in its exploitation, although the National Development Company has made geological surveys of this area. Coal is also reported to exist in two places in Leyte, namely, Calubian and Palompon. The presence of coal in the former place is not verified while those in the latter shows coal in the very young stage and the seams are very irregular and small that it does not warrant mining them.

[a] Smith cited Goodman of having reported the existence of about 3,000 tons of sulfur at the To-od and Pangujan solfataras south of Burauen. But because of the absence of good road, the mine cannot be exploited at a profit.

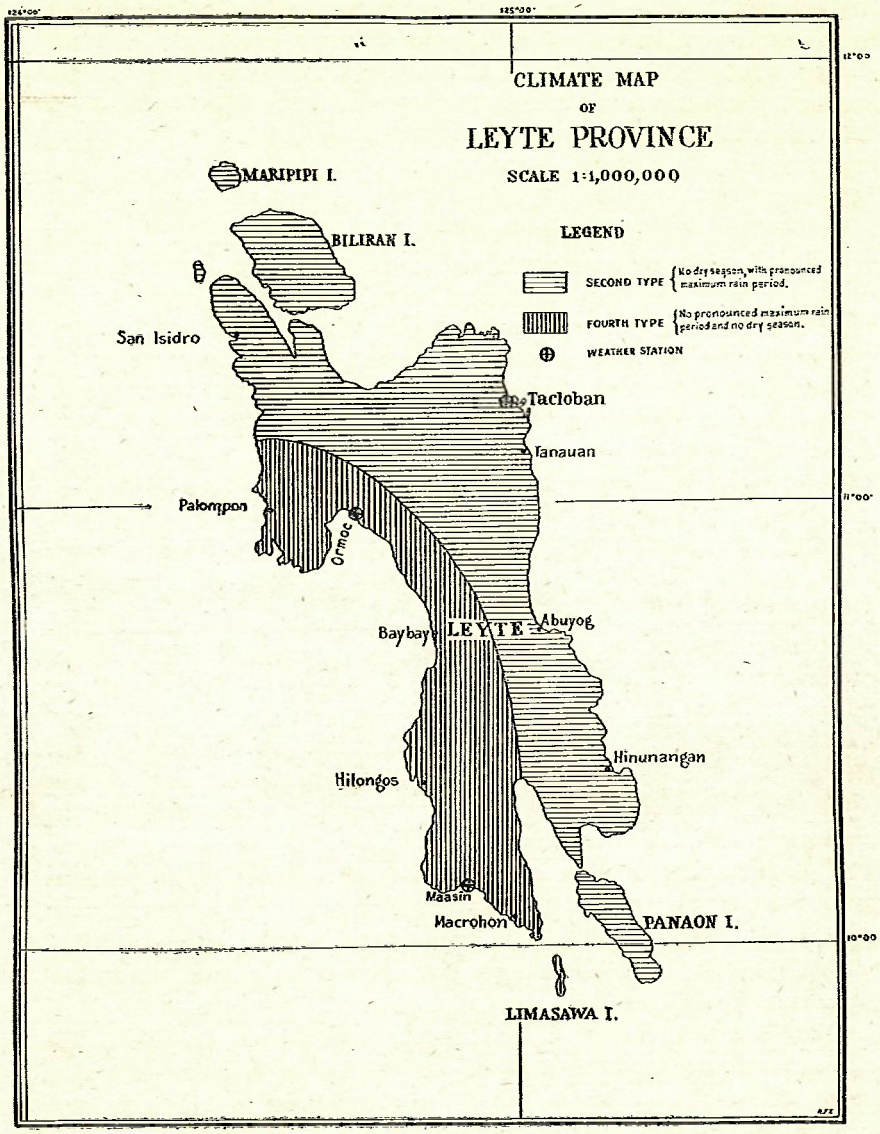

Fig. 5. Climate map of Leyte Province.

passing across the central mountain range is deflected to a certain extent so that there is not much rain on the western side. This side, which is classified under the fourth type of climate, has no very pronounced maximum rain period and no

and 27°C for Maasin. In the Province of Leyte as a whole, while the amount of rainfall on the east differs from that on the west, changes in temperature in these two places are practically insignificant. But the daily variation of temperature is very great for all stations, the difference usually averaging 15°C. As shown in Table 4, the mean annual maximum temperature of Tacloban is 33.8°C while the minimum is 20.1°C, or a difference of 13.7°C. This variation is usually greater in the tropics than in temperate areas, and the changes are usually greater during summer than in winter. The reason for the big difference in the tropics is that during day time, the sun heats the land to a great intensity but late in the night the land cools rapidly thus the difference in temperature.

Altitude also affects temperature in that the higher the place the lower is the temperature. Most of the coastal towns of Leyte are at sea level. Dolores is the only town that is quite

TABLE 4.—*Showing average of monthly maximum and minimum temperatures of three weather stations in Leyte Province from 1903–1918* [a]

Months	Tacloban		Ormoc		Maasin	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
	°C.	°C.	°C.	°C.	°C.	°C.
January	32.2	20.8	32.2	18.2	31.3	20.1
February	32.5	20.4	32.4	17.2	31.6	20.0
March	33.4	20.8	33.4	18.1	32.4	20.8
April	34.1	21.8	33.7	18.7	33.4	21.4
May	34.5	22.9	33.8	20.2	34.2	22.4
June	34.0	22.7	33.2	21.2	33.9	22.7
July	34.6	22.5	32.3	21.1	33.6	22.4
August	34.9	22.4	32.3	21.2	32.8	22.2
September	35.0	22.4	32.6	21.2	32.6	22.0
October	34.4	22.4	32.9	20.5	32.7	22.0
November	33.4	21.7	32.9	19.3	32.2	21.3
December	32.4	21.4	32.4	19.4	31.8	21.1
Mean annual	33.8	20.1	34.3	19.6	34.6	197.

[a] Corona, Jose, S. J. Climate and weather of the Philippines, 1903 to 1918.

above sea level and the air temperature there is naturally lower than that at sea level. The average decrease in temperature for every 300 feet of ascent is around 1°F. Dolores is about 800 feet above sea level, so it can be expected that the town is 2.66°F lower than the coastal towns of Leyte. Much greater variation in diurnal temperature occurs at higher altitude than at sea level. That is, temperature at Dolores may be 32°C at day time but may drop to 12°C, at night time.

Temperature influences every chemical and physical process connected with plants. Solubility of minerals, absorption of

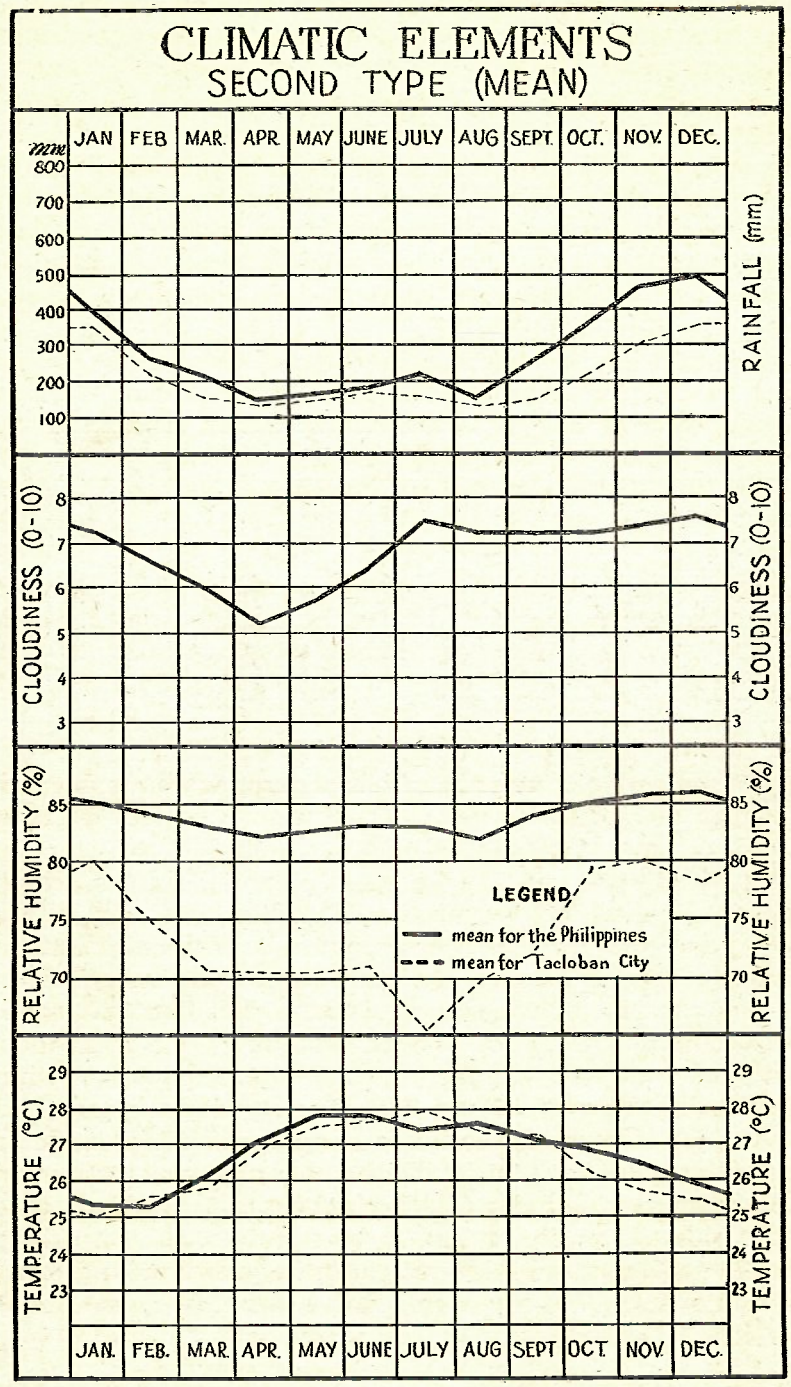

Fig. 6. Graph of the second type of climate in the Philippines and of Tacloban City.

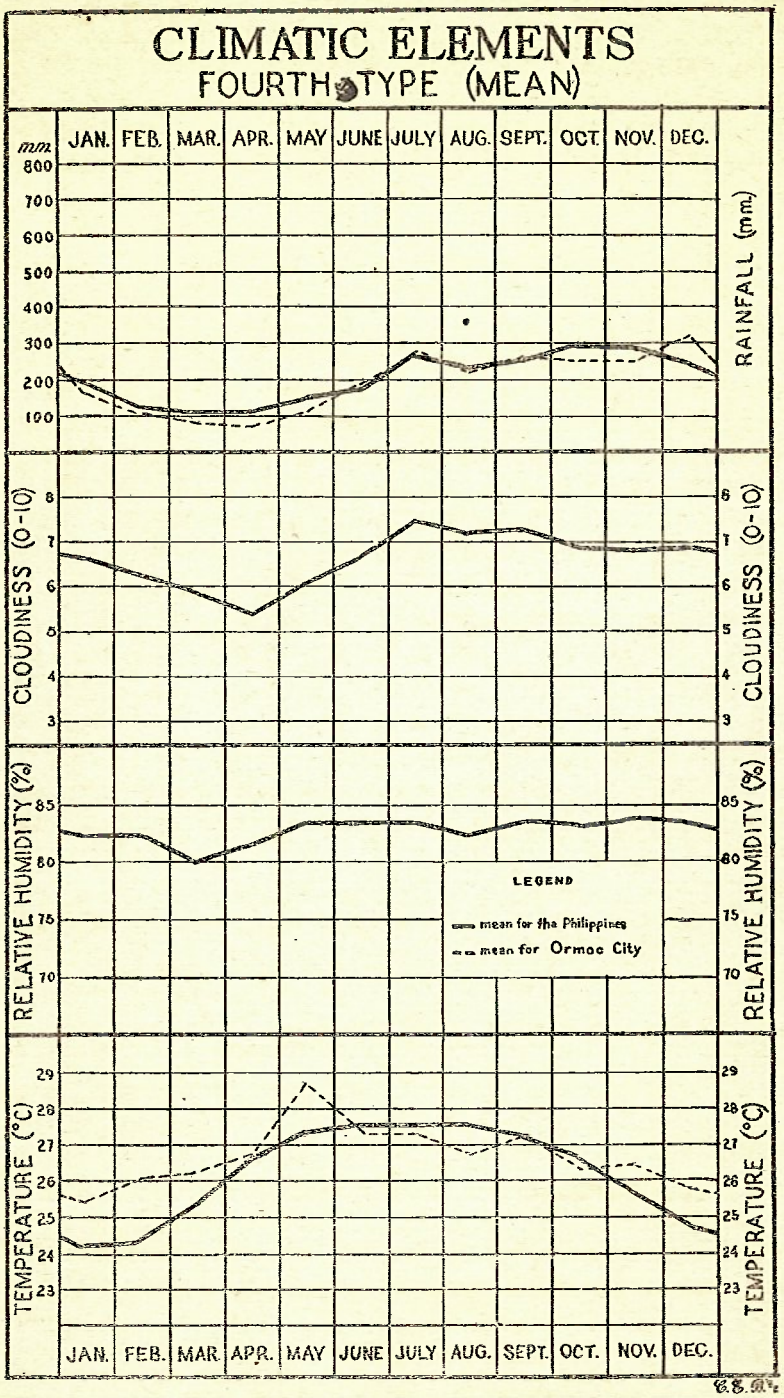

Fig. 7. Graph of the fourth type of climate in the Philippines and of Ormoc City.

The total value of crops produced from the 202,006.11 hectares in 1938 was 6,345,050 pesos.

The leading and principal crops of the province are coconut, corn, rice, abaca, maguey, camote, cassava, sugar cane, and tobacco. Table 6 shows the important crops grown in Leyte Province in 1948.

TABLE 6.—*Area and production of the eight leading crops of Leyte Province* [1]

Crops	Area (Hectares)	Production	Remarks
1. Coconut	71,009.95	[a] 167,461,453	
2. Corn	74,800.02	[b] 932,745	Total of first, second and third crops
3. Palay	60,651.14	[b] 1,252,352	Total of first, second and upland crops
4. Abaca	23,945.02	[c] 12,092,933	
5. Sweet potato	18,857.59	[c] 36,479,671	
6. Sugarcane	2,036.42	[c] 123,494.9	
7. Tobacco	1,065.33	[c] 456,404	
8. Cassava	2,841.83	[c] 6,847,515	

[1] Data from the Summary Report on the 1948 Census of Agriculture, Bureau of the Census and Statistics (1952).

Coconut.—This is the most important export crop and extensively grown on the southern section of the province. The total area planted to this crop was 71,009.95 hectares or 37.76 per cent of the cultivated area. There are 7,100,995 trees planted of which 5,267,588 are bearing trees which produced 187,461,453 nuts in 1948.

The growing of coconuts in this province is not as extensive as in other Visayan provinces. Coconut plantations are mostly confined along the coastal regions. The nuts produced from trees along the shores are believed to be better than those produced from the inland. The range of production per tree in the coastal areas is from 40 to 60 nuts as compared to the 12 to 35 nuts in the interior areas. The different islands and islets of Leyte also have extensive plantings of this crop.

The cultural management practiced by the farmers on this crop is nothing more than the cleaning of the plantation. In some old plantations, replanting is being done for its rejuvenation. Crops like camote, cassava, and gabi help increase the incomes of the plantations. Maguey and abaca have also been planted between the rows of coconuts.

Good market for copra increases the activities in copra making to the extent that sometimes immature nuts are harvested to the detriment of quality. Sun drying and "tapahan" are the usual methods of preparing copra. Thoroughly sun-dried copra

Lubang, Mudbud, Ricebrooke, Simurat, San Pedro, and San Pablo. These varieties are planted in July and harvested from October to December with yields from 15 to 35 cavans per hectare.

The medium-late maturing varieties on the eastern side like Bayambang and Putyocanon are planted in November or December and harvested either April or June. The yield ranges from 30 to 35 cavans per hectare.

The late-maturing variety like Elon-elon is planted in November to December and harvested in June or July. The average production is 40 cavans per hectare. These varieties are also grown only on the eastern side of Leyte.

Most of the lowland culture of palay are under cooperative irrigation systems, i. e. the farmers in a district group themselves for the purpose of constructing and maintaining an irrigation system. Through this system, a total of 10,048.13 hectares of riceland are under irrigation.

Rice fertilization is seldom practiced nor is there any system of crop rotation followed after lowland rice is harvested. In some well-drained areas, however, corn, tobacco, camote, and other money crops are planted. On poorly drained areas a second rice crop is followed.

The ten municipalities leading in the production of rice in the province are Ormoc, Palo, Dagami, Hinunangan, Abuyog, Baybay, Palompon, Alangalang, Tanauan, and Barugo.

Abaca and Maguey.—These are the most important export fiber crops of the province. The former is being the most extensively grown. A total of 23,945.02 hectares or 12.73 per cent of the cultivated area was planted to abaca producing 12,092,933 kilos of fiber. For maguey, in 1939 the area was 152.20 hectares or 0.07 per cent of the total area cultivated producing 71,547 kilos of fiber valued at 3,460 pesos. Most of these areas are located on the central-southern region of the province where the volcanic soil, relief, and other conditions are most favorable.

The activities being undertaken with these crops are replanting, cleaning and thinning of the abandoned plantations; cutting, stripping, drying and baling abaca fibers for export.

The municipalities that lead in the production of these fiber crops are Abuyog, Baybay, Maasin, Sogod, Burauen, La Paz, Malitbog, Cabalian, Ormoc, and Libagon.

Camote, Cassava, and other root crops.—Root crops are widely planted when the staple crops fail. Among this group of root crops, camote is the most extensively grown. Root

to 100 to 150 kilos per hectare. At the rate of 200 to 300 kilos per hectare of Leunaphos fertilizer, an average production of 84 piculs per hectare for P.O.J. 2878 cane, and 110 piculs per hectare of P.O.J. 2883 cane were realized. Without any fertilizer, the yield varies from 50 to 60 piculs per hectare.

The leading varieties of cane commercially planted are P.O.J. 2878 and P.O.J. 2883. The latter is being rated as first in sugar production.

The leading municipalities of the province which grow this crop are Ormoc, Barugo, Cabalian, Carigara, Albuera, Sogod, Hilongos, Naval, San Isidro and Maasin.

Tobacco.—Tobacco covers an area of 1,065.33 hectares or 0.56 per cent of the cultivated area producing 456,404 kilos of cured tobacco leaf.

This crop seems to have a wide range of soil adaptation ranging from alluvial sandy loam to clay but it is found to thrive best on fertile alluvial sandy loam soils having good external and internal drainage. The preparation of the land for planting is the same as that for corn. Usually the seeds, mixed 50–50 with wood ash, is sown evenly over the plot containing well pulverized and manured soil, pressed and watered and maintained at optimum moisture.

This crop is grown mostly on the central section of the province, in rotation with corn, camote, upland rice, and other annual crops.

The ten municipalities leading in the production of tobacco are Merida, Jaro, Leyte, Ormoc, La Paz, Macrohon, Hilongos, Dagami, Pastrana and Alangalang.

Other crops.—This covers all minor crops raised in the province such as vegetables, fruit trees, legume crops and other crops raised on small scale.

A certain degree of crop diversification may be noted in the undulating to rolling agricultural areas of the province.

Under the vegetable group, there seems to be no commercial planting of any kind or variety except eggplant. The local vegetables are not sufficient to meet the demand. The province sometimes have to import vegetables such as cabbages, lettuce, pechay and the like from Cebu. Native vegetables like alog-bati, eggplant, malungay, onions, upo, cowpeas and beans are raised on small scale.

Under the fruit trees group, banana is the most extensively raised throughout the province. The banana varieties like

Because of the necessity for water in the growth of plants especially lowland rice, many farmers organized themselves into associations for the construction and maintenance of irrigation systems in their respective districts. These communal irrigation systems had resulted in rendering 10,048.13 hectares of riceland productive. The dams built are not of the permanent structures but were constructed in such a way that it can be conveniently repaired once they are damaged by flood.

Another practice of equal importance with irrigation is drainage. The survey of the province reveals that thousands of hectares are waterlogged with the possibility of reclamation for lowland rice. This problem requires time, engineering ability and money. The conversion of these areas for rice production may bring about the much needed relief on food problems of the province. Some swamps which are lower than sea level can not be drained but will serve well for wildlife sanctuary.

Livestock.—According to the Census of 1948, the province has 11,075.48 hectares or 4.47 per cent of the total farmland area for pasture purposes. On this area, carabaos, cattle, horses, hogs, goats, sheep, and poultry are raised.

The livestock industry is an essential part of a good farming system in that by-products of the crops may be utilized by the animals. Most of these sources of animal feeds are being wasted during the preparation of the final product. Farming combined with livestock raising provides a well-balanced program for the maintenance of soil fertility. The kinds and number of animals before and after the war is shown in Table 8.

TABLE 8.—*Number and value of livestocks before and after the war in Leyte Province* [a]

Kind of livestocks	Number		Value in pesos
	Jan. 1, 1939	Jan. 1, 1945	
1. Carabao	163,398	72,200	3,474,216
2. Cattle	14,694	5,070	214,389
3. Horses	11,699	6,660	138,488
4. Hogs	342,251	134,220	1,488,210
5. Goats	10,186	5,130	20,253
6. Sheep	1,984	870	5,862
7. Chicken	1,300,755	528,470	----------
8. Ducks	2,754	2,040	----------
9. Geese	259	130	----------
10. Turkeys	173	70	----------

[a] Yearbook of Philippine Statistics, 1946

work on, (3) managers or farm operators who supervise the working of the farm for the landowner receiving wages or salaries or part of the crops for their service, and (4) tenants or farm operators who rent or lease from others all the land they work on. This class of farm operators are subdivided into three groups, namely, (*a*) share tenants or those who rent the land they work on and pay as rent a share of the crop or crops grown, (*b*) cash tenants or those who rent the land they cultivate and pay as rent a specified amount of money or a definite quantity of the crop or crops grown, and (*c*) share-cash tenants are those who rent all the land they work and pay as rent a share of the crops in addition to a specified amount of money.

In 1948, there were 97,626 farms of all sizes in Leyte. The distribution of farms according to size is as follows:

Farm groups	*Number of farms*	*Per cent*
0.02 to 0.99 Ha.	20,433	20.93
1.00 to 4.99 Ha.	68,581	70.25
5.00 to 9.99 Ha.	6,357	6.51
10.00 to 19.99 Ha.	1,559	1.60
20.00 to over Ta.	696	0.71
Total	97,626	100.00

The farms in the province are managed under different tenure systems usually based upon the crops grown, region, and productivity of the land. The distribution according to the number of farms is as follows:

Owners	50,025	143,753.26
Part owners	7,547	21,007.10
Share tenants	28,813	57,142.10
Share cash tenants	246	599.77
Cash tenants	91	248.23
Other tenants	10,885	2,617.87
Managers	19	21,822.82
Total	97,626	247,191.15

Landholding and farm tenure in Leyte in comparison with other eastern Visayan provinces are graphically shown in Fig. 8.

Tenancy systems.—The share of a tenant varies with the crop he grows and also in the place where he works with his landlord. The general principle being followed in most Visayan provinces is the one-third basis. In this system, the

landlord gets one-third of the produce, the tenant the other third, and the carabao owner gets the remaining third. The seed is deducted first from the total produce before sharing. Crops like rice, corn, tobacco, and coconuts are usually shared on this basis. Sometimes some owners prefer paying laborers for making their copra. In sugar cane, this crop is usually grown under the so-called administration basis wherein the owner or planter pays daily wages to the laborers.

In the case of upland rice in Biliran, a tenant with his carabao and seeds gets three-fourth of the harvest and only ¼ to the owner. This sharing is based on the presumption that yield on upland rice is usually low and thus gives the poor tenant bigger share of the harvest. Harvesters of grains get one-ninth of their harvest. For lowland rice, the ordinary one-third system is followed. On the southeastern part of Leyte, a landlord with carabao gets three-fifth while the tenant gets two-fifth. But if the tenant owns the carabao, the share is patterned after the fifty-fifty basis.

In San Isidro where most of the corn in Leyte is produced, the landlord gets one-fourth while the tenant gets three-fourth. This is in case the landlord gives nothing but his land. In Merida, when the landowner owns the carabao, and the tenant uses his own seed, the produce is equally divided.

Copra making is done either by share system or by paying daily wages to laborers. In Baybay, the owner of a coconut plantation gets one-half of the copra produced by his tenants. In this case, the owner of the plantation just shares from the produce. Otherwise a plantation owner spends from ₱2.50 to ₱3 per hundred nuts to make into copra. It usually takes 300 nuts to make a 100–kilo weight of copra. This rate was at the time when the price of copra was from 20 to 21 pesos per hundred kilos.

In the making of "tuba", a native drink from coconut, a different system is followed. Of the seven days of gatherings, the produce from the six days goes to the gatherer, while the produce of the seventh day goes to the owner of the coconut trees.

In 1947, the daily wages paid to laborers working in sugar cane fields as well as those working in the centrals ranged from ₱1.00 to ₱1.50. Laborers working in the sugar central receive in addition a ration of two gantas of rice every week. Sugar cane milled in the central is shared according to law

into consideration, and the relationship 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 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) complex. Areas of land that have no true soil, such as riverbeds, coastal beaches, and inaccessible mountains are classed (5) miscellaneous land types.

A series is a group of soils that have the same genetic horizons, similar important morphological characteristics, and similar parent material. It comprises soils having essentially the same general color, structure, consistency, range of relief, natural drainage condition, and other important 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 Tacloban series was first found and classified in the vicinity of Tacloban, Leyte.

A soil series has one or more soil types, defined according to the texture of the upper part of the soil, or the surface soil. The class name such as sand, loamy sand, sandy loam, silty clay loam, clay loam, or clay is added to the series name to give the complete name of the soil. For example, Tacloban clay is a soil type within the Tacloban 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 change in the kind of machinery to be used. The phase of a type with a slight degree of accelerated erosion may need fertilizer requirement and cultural management different from those of the real soil type. A phase of a type due mainly to degree of erosion, degree of slope and amount of gravel and stones on the surface is usually segregated on the map if the area can be delineated.

under certain systems of erosion control. The remaining 360,768.28 hectares, or 45.17 per cent, are the mountain soils which under no condition should be cultivated but be kept under permanent vegetative cover. Clearings made in forest concession areas should be replanted to forest trees.

The different soil types, phases, complexes and miscellaneous land types may be conveniently classified as follows:

A. Poorly drained flat lowland

1. Hydrosol—
2. Pawing fine sandy loam—191
3. Palo clay loam—193
4. San Manuel soils, undifferentiated—199

TABLE 10.—*Showing the area, the relative size, and present uses of the different soil types in Leyte*

Soil type number	Soil type	Area[1] in hectares	Per cent	Present uses
1	Hydrosol	9,584.28	1.20	Fishponds, sources of nipa and firewood
191	Pawing fine sandy loam	5,431.09	0.68	Lowland rice.
193	Palo clay loam	61,259.52	7.67	Lowland rice, corn, and coconut.
199	San Manuel soils, undifferentiated.	10,622.58	1.33	Corn, coconut, bananas, and for lowland rice.
82	San Manuel silt loam	45,924.68	5.75	Lowland rice, sweet potatoes and corn.
190	San Manuel loam	1,277.90	0.16	Lowland rice, corn, and coconut.
95	San Manuel fine sandy loam.	5,670.70	0.71	Coconut, sugarcane, peanut, vegetables and sweet potato.
240	Mandawe clay	8,945.33	1.12	Lowland rice, corn, sugarcane, coconut, and fruit trees.
16	Bantog clay loam	399.35	0.05	Lowland rice.
159	Medellin clay	2,555.81	0.32	Lowland rice, corn, and coconut.
168	Umingan clay loam	20,765.94	2.60	Corn, cassava, camote, and lowland rice.
122	Umingan fine sandy loam	479.21	0.06	Coconut, camote, peanut, cassava, corn, and fruit trees.
204	Dagami clay loam	1,757.12	0.22	Lowland rice, coconut, corn, cassava, and some fruit trees.
203	Obando fine sand	8,945.33	1.12	Coconut.
57	Taal fine sandy loam	4,472.66	0.56	Coconut, corn, bananas, and fruit trees
118	Beach sand	3,114.89	0.39	Coconut.
200	Guimaras sandy clay loam	1,038.30	0.13	Coconut, camote, corn, lowland rice and fruit trees.
194	Tacloban clay	23,561.36	2.95	Kaingins and pasture.
205	Guimbalaon clay	53,112.88	6.65	Sugarcane, coconut, lowland and upland rice and corn.
239	Luisiana clay	27,235.33	3.41	Kaingin, corn, upland and lowland rice and fruit trees.
195	Palompon clay	22,682.80	2.84	Kaingin, root crops and fruit trees.
196	Malitbog clay	11,660.87	1.46	Forested and part in kaingins.
197	Maasin clay	58,783.58	7.36	Upland rice, corn, coconut, and bananas.
198	Himayangan clay loam	6,299.78	0.78	Coconut, forest and part in kaingins.
171	Rough stony land	16,852.36	2.11	Forest.
202	Rough mountainous land	301,425.61	37.74	Forest and part in kaingins, upland rice and root crops.
156	Lugo clay	39,615.02	4.96	Corn, bananas, tobacco, coconut, upland rice and for pasture.
155	Faraon clay, steep phase	42,490.31	5.32	Kaingins, coconut, corn, bananas, and cassava.
153	Bolinao clay	2,236.33	0.28	Second growth forest, coconut, corn, tobacco, and root crops.
201	Faraon-Bolinao complex	559.08	0.07	Lowland rice, corn, cassava, and coconut.

[1] Areas were determined with the use of a planimeter. No deductions were made for areas covered by roads, rivers, and structures within the said type.

structureless mass whose depth often reaches to one meter from the subaqueous horizon.

Hydrosols are mostly found along the shores bordering the coasts of alluvial lands whose areas range from one-half to hundreds of hectares. The hydrosol areas at Babatngon, Carigara, Leyte, Ormoc, Inopacan, and Matalom are fine examples of extensive lands of this type.

The native vegetation on this land type is very distinct in that only very definite kinds of plants can grow on it. The common trees found growing are bakauan, langaray, api-api, pagatpat, and tabigi. These trees form the bulk of the vegetative cover of the hydrosol areas at Babatngon, Carigara, Leyte and Ormoc. With the exception of those trees found along the northeastern coast near Tacloban which were cut for fuel purposes, the trees of the other areas are not exploited. Of the palms, nipa is the most important growing on the hydrosols. Because of its usefulness for roofing material, nipa industry is an important means of livelihood of the people near nipa swamps. Carigara, Capoocan, Ormoc, Inopacan, Hilongos and Matalom are the principal nipa producing sections of Leyte.

The use of these areas for fishpond has not yet been implemented although there are several persons interested to develop them for *bañgos* culture. Big-sized crabs and shrimps find the swamps a suitable habitat where the fishermen catch them in large quantities. In many coastal provinces on western Luzon, the cleared-up swamps are made into salt beds. This scheme seems impractical in Leyte because there is continuous rain throughout the year. For this reason the people evaporate sea water by heating to produce salt.

Pawing Series

This series comprises soils of the low, level, alluvial plain on eastern Leyte south of Tacloban. This soil is of recent deposit as shown by the immature development of the soil profile and the short meanders of the rivers. Its elevation is just a few feet above sea level. The series, although level, has so wide depressions in many places that water collects in them thus establishing a condition of temporary swamps. The water table is very shallow ranging from 10 to 50 centimeters. Although the soil in the substratum is sandy, drainage is not facilitated because of the high water table.

Fig. 1. A view of vegetation in Pawing fine sandy loam. The soil is boggy and always wet. Plants called "Ticog" grow luxuriantly and are harvested for mat making.

Fig. 2. Landscape of San Manuel soils in Merida. Soil is used primarily for corn planting. Note the native plow used in cultivating corn.

Grass is the dominant form of plant association on this type. The grasses are evergreen and luxuriant (Plate 6, Fig. 1). Tambo, talahib, ticog, and balangot form the principal species. Bankal may be seen only close to the edges of this soil type. Lumbia, a certain species of palm, and several kinds of araceous plants like badiang, are growing in patches. Surrounding this plant association are grasses.

This soil type is seldom cultivated and, if at all, only those areas close to the boundaries of other soil types are tilled. It is impossible to cultivate this type because it is boggy and work animals sink. The soil is devoted to lowland rice, and planting is usually done during the relatively dry periods of the year. In growing lowland rice, the rice field is simply plowed and harrowed, and the seedlings transplanted. There are no dykes constructed. Inasmuch as the land can not be drained, the rice, upon maturity, is harvested even if there is water in the field. Being marshy and well covered by tall grass, the place is a sanctuary for games especially wild ducks.

Coconut trees are grown on the relatively better drained areas of this soil type. The trees, however, are not healthy and in some cases are chlorotic. This may be due to the poor drainage condition of the land. According to some farmers, the drainage was slightly better before the war than it is today. This condition was brought about by the damming of the drainage outlet of the coastal regions of eastern Leyte by the Army which occupied it. As a result, water in the interior lands could hardly be drained to the sea so that coconut not only becomes unhealthy and shy bearers, but some of the rice fields as well, could not be planted because the water in the field becomes deep.

Rice is the only crop grown on the low, wet areas. Farmers use standard varieties like Elon-elon and Apostol for first crop and Bayambang for the second crop. First crop planting is done in November and harvested in March or April. Elon-elon yields an average of 40 cavans to the hectare. Sometimes farmers plant on small scale a variety of aromatic rice they call "Inday mia" which also gives as much yield as the Bayambang; or 20 cavans to the hectare. Some farmers make a second planting of rice in June or July using the varieties Dumali and Bayambang. These varieties mature in three to four months giving an average yield of 20 cavans of clean rice to the hectare. There are no other crops of importance grown on this soil type.

100–150 Lower substratum. Gray, structureless sand; every friable and loose either when wet or dry. This noncalcalerous layers contains no stone or gravel. Roots of plants no longer reach this horizon. Mostly wet or waterlogged. This layer is separated from the layer immediately above it by a smooth abrupt boundary.

Palo clay loam (193).—This is the only soil type under this series. It is found around Palo and extends into the inner regions at the foot of the central Cordillera near Jaro and Dagami, Alangalang, and Barugo on the north and another area in Abuyog on the south. This soil type, although apparently level, has several depressed areas where runoff water easily collects and forms a condition of intermittent swamps. There are several rivers and creeks that traverse this soil type but because of the very low grade of slope flow of water is very sluggish and takes considerable time to drain. The sluggishness in drainage is attributed to the rather shallow water table, usually one meter from the surface.

The altitude of this type ranges from sea level, like those areas near the eastern coast, to 200 feet at Alangalang. This elevation, however, is not very high as to produce significant change in either the fauna or flora of the area from that at sea level. Native vegetation consists mostly of grasses like talahib, tambo and agingay. Entangled with these grasses are several species of vines that make them appear impenetrable. Such growths are common along riverbanks. Other species of plants which are mostly weeds that grow on fallowed lowland rice fields are various species of cyperaceous plants like biga-as, ogas, agor, and ticog. These plants are common not only on the rice paddies but also in all wet or swampy portions of this soil type. As in the case of the Pawing series, badiang and lumbia are found but in somewhat smaller quantities. Camias are also found growing wild along the drainage canals. Of the trees, several species of the *Ficus* family like balete, tibig, and is-is are found growing.

Palo clay loam is a brown to dark brown soil that ranges in depth from 25 to 30 centimeters. It is moderately friable with fine granular structure.

This layer is fairly rich in organic matter, it being constantly supplied by dead grass leaves, and straws of the rice crop. When this soil contains the right amount of moisture, plowing is very easy and pulverization is easily accomplished with the use of bamboo harrows. Since there are no boulders of any

Coconut is grown also on this soil type but only on very limited scale. Similar to corn, coconut is grown only on the well-drained areas of Palo clay loam. But as a result of the occupation-army operations there are many areas of this soil type which were fairly drained before that had become water-logged. As a consequence, many coconut trees on these affected areas became chlorotic and ceased to bear fruits. Generally, the coconut trees along the shores are much healthier than those grown in the interior region. On the average a tree on this soil type produces 25 nuts a season, or 75 nuts a year. On the basis of 1,000 nuts to every 300 kilograms of copra, a hectare of coconut will yield around 2,730 kilograms of copra.

San Manuel soils, undifferentiated (199).—Included in the group of poorly drained flat lowland is the San Manuel soils, undifferentiated. This soil is found north of Ormoc. It is similar to Palo series in topography and contains several wide depressions or pockets which become water-logged during heavy rains. The surface soil of this miscellaneous land type varies in texture from silty clay loam to silt loam. There are no stones or boulders either on the surface or in the substratum. The soil has been developed from alluvial deposits with fine sandy material substratum. Elevation along the road to Merida is 200 feet above sea level and must be naturally higher at the headwaters of the Pagsangahan River and its branches which serve as the only drainage outlet of the whole area.

The surface soil which ranges from 20 to 25 centimeters deep is dark brown to reddish brown. It is slightly friable when containing the optimum amount of moisture but becomes slightly hard when dried after plowing. It is fairly rich in organic-matter content, the supply of which comes mostly from straws of rice and corn that are left in the field after the harvest of such crops. No other attempts are made to augment the organic matter content of the soil. The high percentage of the clay fraction, as well as the relatively low organic matter content of this soil, contributes to the clodding. But in areas that are constantly under water, the soil is soft and the vegetation is grassy of which bungalon is the predominant species. Bamboo groves are seen all along the banks of some creeks and rivers in this land type. Aside from this, there is no other form of native vegetation found.

The subsoil reaches down to 40 centimeters from the surface and is brown to mottled brown silt loam or silty clay loam. Below this depth is a layer of grayish brown, structureless

add a dense cover to the thick growth of grasses. Second-growth trees like some species of *Ficus* and binunga may be seen at random but not in wide and continuous areas.

San Manuel soils have deep water table. Depending on the location, water in dug wells ranges in depth from 2 to 3 meters below the surface. Sometimes during the dry part of the year the water table sinks to even five meters or more. There are four soil types identified under this series.

San Manuel silt loam (82).—This soil type is the largest in area and the most important of them all agriculturally. Although some depressions or sinkholes are present in this type, water does not stay long on them but readily percolates. Drainage takes place readily because the whole deposit of alluvium from which this soil developed is loose and friable. The water table ranges in depth from 2 to 3 meters below the surface. This depth varies with the season of the year, it being high during the rainy days.

The surface soil of San Manuel silt loam ranges in depth from 30 to 35 centimeters. It is light brown to brown and is moderately loose to slightly friable in consistency. Its very fine granular structure makes this soil easy to work. The soils in cultivated areas are fairly rich in organic matter, but those under native vegetation have dark grayish soils indicating high content of organic residues. Inasmuch as the precipitation in the province is generally heavy, and that this soil is fairly well drained, it may be safely assumed that its reaction has a tendency towards acidity. Peanut, which requires almost neutral soil, is found growing well on this soil. The subsoil is fairly deep, reaching to 80 centimeters below the surface. This horizon, which is dark brown to light brown has a good fine granular structure. Basing from its color, this layer does not contain as much organic matter as the surface soil. Stones or boulders are absent and being very friable, roots of plants penetrate through this layer easily. The demarcation line between the surface and the subsoil is very gradual and regular.

San Manuel silt loam is mostly utilized for the culture of lowland rice wherever the supply of water can be controlled. This soil type on the southeastern part of the province grown to Budbud, Cabuagan, and Bayambang in October or November gives a yield as high as 50 cavans of palay to the hectare. This soil type at Cabalian, however, is planted to Kinarabao, Basaynon or Gabling varieties of rice which yield from 18 to 30

gray or grayish brown of the loam type. This variation in color may be due to the poor organic-matter content of the soil or to the anaerobic condition as brought about when irrigation water stands in the rice field. The consistence is likewise slightly harder than that of the silt loam type and the succeeding soil layers are somewhat compact. No stones or boulders of any kind may be seen either on the surface or in any layer in the profile. The subsoil which reaches down to 80 centimeters from the surface is silt loam, brown, slightly compact and with very fine good granular structure. The substratum is similar to that of the silt loam type. Soil boundaries for all layers are gradual and smooth.

San Manuel loam in Hilongos is used for lowland rice. Most of the rice fields do not have any dikes to hold irrigation water but some of them have. Generally, the first crop of lowland rice on the western part of Leyte is planted in June and July using the Apostol variety. A second crop may follow in January using the Lubang variety. Elon-elon is seldom used on western Leyte. The second crop of rice is usually a poor yielder.

Corn is oftentimes planted after the first crop of rice. Under favorable condition, corn gives as high as 20 cavans to the hectare. This soil is not as productive as the silt loam type. Coconut also grows on this soil type but is not considered an important crop. Nearly all the coconut trees are chlorotic, a possible indication of poor soil drainage. This condition is regarded by some farmers to be just a temporary malady considering the fact that unusual long and heavy rainfall has occurred during this survey.

San Miguel fine sandy loam (95).—This soil type is found along the Binakaan River at Tanauan and the Malaga River in Hinunangan. Although this soil type is frequently subjected to floods its drainage condition is good owing to the very loose consistency of the soil in all the horizons. In some portion along the sides of these rivers are deep deposits of coarse gray sand. Sometimes, as in case of the floods, the surface soils are washed off by the swift overflow and later replaced by deposits of coarse materials. Any of such cases entail the destruction of farmlands situated along the banks of these two rivers.

Tall talahib practically dominates other plant associations along the banks of the rivers. Pava, another species related to talahib characterized by hard and hollow internodes, is also

terials by rivers. This series is the common alluvial soil formation on western Leyte from Ormoc to Baybay. It is also found in Dulag on the eastern part and in most coastal plains on southern Leyte. Its drainage condition is slightly better than that of the San Manuel soils. Water table is deep ranging from 2 to 4 meters.

An important difference between this series and the San Manuel is the presence of stones in the lower profile layer of the former, a characteristic absent in the latter (Plate 7, Fig. 1). No stone is present on the surface soil. The vegetation is also similar to that of the San Manuel soil in that it consists also of several species of grasses like talahib, some cogon, and bamboo groves.

The dark brown surface soil of this series is moderately friable with good fine granular structure. The soil color varies though being very dark reddish brown between Albuera and Bagakay and dark brown elsewhere. The unusual dark tint may be due to stains from soils of the nearby upper areas which belong to the Luisiana series. Soils of the Umingan series are important because they are being extensively used for lowland rice.

Umingan clay loam (168).—This is an important soil type classified under Umingan series. A typical profile description of this type is as follows:

Depth of soil *cm.*	Characteristics
0–30	Surface soil. Brown to dark brown clay loam to loam. It is moderately friable when wet, but mellow to slightly loose when dry. It has good fine granular structure and fairly rich in organic matter. Roots can easily penetrate through this horizon. It is non-calcareous and in places where the surface soil is thin, gravels are present.
30–60	Subsoil. Dark brown to brown silt loam to very fine sandy loam. It is friable or loose, and roots of most trees easily penetrate this layer. It has a good coarse granular structure. Smooth-surface gravels and stones are found intermixed in this layer. This horizon is non-calcareous and poor in organic matter. Boundary between surface layer and subsoil is smooth and diffused.
60–150	Substratum. Light brown to yellowish brown fine sandy soil that is slightly compact and structureless. This horizon is characterized with abundance of stones. Non-calcareous and very poor in organic matter. Boundary between subsoil and substratum is smooth and diffused.

Umingan clay loam is found along the Daguitan and Marabang Rivers in Dulag and a small area in Abuyog, both of

Fig. 1. Profile of Umingan fine sandy loam. Topsoil and subsoil is brown, fine granular and mellow soil with riverwash gravels and stones as part of the substratum.

Fig. 2. Landscape of Umingan fine sandy loam at Ormoc. Land is used for corn and sugar cane.

of this soil series. The stones have smooth surface and edges showing that such materials were once transported by water before they were finally deposited to their present site. This layer varies in depth from 50 to 100 centimeters from the surface.

Umingan clay loam as found on eastern Leyte is extensively used for growing corn. The corn grows very well and a yield of from 20 to 30 cavans of shelled corn is usually obtained. Coconuts, too, are planted and the high production shows that the soil is well suited to the crop. When corn is not planted, cassava, sweet potatoes, and rice are grown instead.

On western Leyte, this soil is utilized more for lowland rice and sugar cane than for any other crop. Rice culture in this part of the province is slightly different from that on the eastern part in that the rice paddies are provided with dikes for holding water, a practice which is not done on eastern Leyte. Also, rice planting on this kind of soil on western Leyte occurs in June or July using the medium-late maturing varieties, whereas on the same soil on eastern Leyte, rice planting is in October or November using the late maturing varieties. Modbod and Apostol varieties on western Leyte yield an average of 30 cavans to the hectare.

In the areas between Ormoc and Albuera, sugar cane is an important crop. Affected by the last war, the milling of sugar cane was stopped, and consequently, lands formerly devoted to sugar cane were planted to corn and rice instead. Presently, sugar cane production has been resumed. Of the three different varieties of sugar cane planted, Java P. O. J. 2878 constitutes 80 per cent, Alunan cane, 15 per cent, and mixed or other varieties, 5 per cent. Badila cane, although a high yielder is not planted in this area because this variety is attacked by rats and therefore cannot be left long in the field. There is a claim by the sugar centrals that the bagasse of this cane does not make a good fuel for boilers because the material is powdery. The usual yield of cane in this area is from 50 to 60 piculs per hectare for unfertilized fields and from 80 to 110 piculs per hectare on the upland areas when fertilized with 300 kg. of Warnerphos or Leunaphos (15–15–0) fertilizer or the same amount of ammonium sulfate (20–0–0) for the lowland areas.

Another minor crop found growing on this soil type is banana, which seems to be suited to the soil.

Dagami clay loam has a surface soil which ranges in depth from 20 to 25 cm. and in color, from brown to dark brown. It has an excellent fine granular structure, friable when dry but slightly sticky when wet. The subsoil is from clay loam to clay with a brown to reddish brown color. Some gravels are present in this layer. The gravels do not occur in layer, and they have rough angular surface. The boundary line separating the surface and subsoil is smooth and gradual. The lower substratum has pronounced characteristics, it being clay loam with a brick red to red color with massive structure. It is hard when dry but plastic and sticky when moist. A smooth and abrupt boundary exists between the subsoil layer and the substratum.

The well-drained areas of this type are planted to coconut, corn, cassava, and some fruit trees. The poorly drained places are devoted to the culture of lowland rice. Rice fields in this type, unlike those in the Palo and Pawing soils, are provided with dikes to hold the water. Rice is planted in October to November and harvested by March or April. These rice fields are rainfed. The nearby rivers, if harnessed are sufficient to irrigate the whole of this soil type as well as other soil types adjoining it. The physical conditions of the substratum of this soil will make it good riceland provided the fertility of the surface soil is maintained.

Mandawe Series

Mandawe series, which was first identified in Cebu Province, also occurs in Leyte. It occupies the plain areas along the courses of the Hilongos and Bangerahan Rivers on southwestern Leyte. This soil was formed from alluvial deposits characterized by moderately developed profile underlain by unconsolidated materials. The land is not exactly level for there are also wide depressed areas which, during heavy rain, remain temporarily waterlogged. Although numerous creeks and rivers drain this area externally, yet drainage is slow because of the presence of a fairly dense subsoil and substratum which check percolation. This characteristic makes this soil different from San Manuel soils. The land surface is free from stones or boulders rendering mechanized system of farming feasible.

The surface soil of this series has a brown to light brown color and is fairly friable. Being good agricultural land, it is wholly cultivated to crops. Most of its native vegetation have been cleared. Bamboo groves along the banks of the rivers are allowed to grow, however, for the needs of the

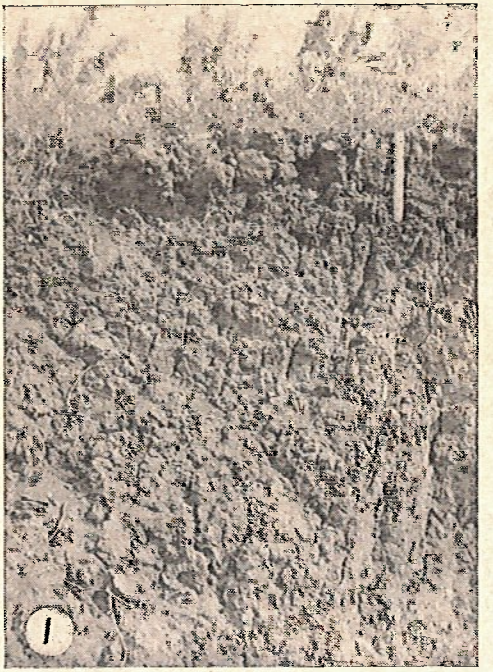

Fig. 1. Profile of Mandawe clay. Soil from this deposit originated from the surrounding upland whose soils are of the clay texture.

Fig. 2. Landscape of Mandawe clay. Land is almost flat with poor drainage. Soil is fairly rich with high calcium content.

tent. The subsoil is slightly dense or compact, to which is partly attributed the slow internal drainage. Even the substratum is also dense. The poor growth of some coconuts on this soil type may be partly attributed to the poor drainage condition of the soil. Lowland rice is well suited to this soil as the compact layer underneath will hold water for a long time. Irrigation system can easily be installed in this area to insure better production of lowland rice. Apostol variety of rice is planted in June or July, which is the beginning of the rainy season. After this crop another short season rice is planted depending upon the availability of water. For this second crop, a local variety called Lubang is planted in January.

The present yield of rice in this region can be greatly increased through á liberal application of fertilizer.

Inasmuch as corn, sugar cane, coconut, and fruit trees cannot withstand wet soils for a long time, these crops should be planted on the relatively well drained portions. Corn can be grown on the rice fields during the dry period of the year, usually after the rice crop.

Bantog Series

This soil is found in Villaba covering the low, level areas of the town. This soil, like those found in Bulacan and Iloilo has also poor drainage. The internal drainage is much impeded due to the heavy texture of the soil throughout the whole depth of the profile. Although outcrops of stones and boulders are absent, mechanized farming does not seem suitable, because the areas are very small.

Native vegetation in this area had altogether been removed. With the exception of the area covered by the town proper, the rest of the area is under cultivation. Lowland rice forms the principal crop. Corn is planted only as a second crop after rice.

Bantog soils are characterized with a profile as follows:

Depth of soil *cm.*	Characteristics
0–30	Surface soil. Brown to dark brown mottled with brownish red clay to clay loam. Has a good medium granular structure, soft and slightly plastic when wet. It is fairly rich in organic matter and non-calcareous. No coarse skeleton present. Roots of crops can easily penetrate this layer.
30–90	Subsoil. Yellowish, moderate, medium, granular structure, compact, slightly plastic and sticky when wet. Poor in organic

The native vegetation on this soil has all been removed and is now under cultivation. Lowland rice and corn are regularly planted on it in Cabalian but the same soil in Macrohon is entirely covered by coconuts.

Medellin clay (159).—Medellin clay is the only soil type under the Medellin series. The characteristic profile of this soil is as follows:

Depth of soil *cm.*	Characteristics
0–20	Surface soil. Black heavy clay, good coarse granular structure; strongly plastic when wet, slightly hard when dry; fairly rich in organic matter, and free from coarse skeleton. No rock outcrop.
20–70	Subsoil. Heavy clay, blackish brown; good coarse granular, strongly plastic when wet, slightly hard when dry, and no coarse skeleton. This layer is separated from the surface soil by a smooth gradual boundary.
80–140	Clay, grayish brown, medium coarse granular, strongly plastic when wet, slightly friable when dry, no coarse skeleton present and separated from the above layer by a smooth, diffused boundary.
140–150	Substratum. Grayish brown to dark gray; coarse gravelly limestone, structureless, slightly compact both when dry or wet. Gravels of limestone and weathered shale. This layer is separated from the above layer by a smooth and abrupt boundary.

Medellin clay is developed in place from calcareous material having a characteristic black surface soil that ranges in depth from 20 to 30 centimeters. The solum is fairly deep with no stones or boulders. Being level and moderately drained, it is a good agricultural land. It is very limited in area, however, being only 2,577.8 hectares, or about 0.33 per cent of the total area of the province. The same soil is found in Cebu and is considered one of the best sugar cane soils in that province. On the other hand, in Leyte, rice, corn, and coconut form the important crops on this soil.

The addition of organic matter to this soil will make it more granular and easy to work. Unlike that of the Bantog clay loam, this soil does not become hard when dry.

WELL DRAINED LOWLAND

The soils under this group have a flat to gently undulating topography. There are four soil series ranging in texture from sand to sandy loam. The external drainage is almost free to excessive. Being sandy, water percolation is fast. Of the different crops planted, coconut is the most common and produce healthy plants with good yield.

This soil is fitted not only to coconuts but also to a great variety of crops when adequately supplied with organic matter, carefully fertilized, and properly cultivated.

Umingan fine sandy loam (122).—The other soil types under this series as already described was included under the moderately drained flat lowland. The difference in drainage condition, however, is not so much as to warrant separation of the two soil types into different series. Umingan fine sandy loam has better drainage condition than the Umingan silt loam by virtue of the coarser texture of the former. Sandy soils, other things being equal, are better drained than silt or clay soils.

Umingan fine sandy loam is found only on the southern part of Leyte occupying the low level areas along the Amparo River. With the exception of the bamboo groves along the banks of the rivers, the rest of the area is cleared for cultivation.

The surface soil of Umingan fine sandy loam, which ranges in depth from 15 to 20 centimeters, is relatively shallow and its color varies from gray to grayish brown. The soil is very friable, loose and easy to work. It is relatively poor in organic matter but being loose, roots of most crops can easily penetrate through the subsoil which extends from 50 to 60 centimeters from the surface. Pebbles and cobblestones are found in a layer below the subsoil but are seldom encountered on the surface.

Umingan fine sandy loam is used generally for the growing of coconuts. The trees respond well to both the soil and the climate and yield fairly well. The yield ranges from 20 to 40 nuts a tree per season. This soil type is also used for general farming such as the planting of sweet potato, peanut, cassava, corn, and some fruit trees. Lowland rice is grown on this type to a very limited area. The Apostol rice variety is used. The planting season starts in June or July and harvested in November. An average yield of 25 cavans of palay per hectare is produced.

This soil type is subject to overflooding to which is partly attributed its high productivity. Flooding usually occurs during the rainy season, which is from October to December. Heavy rain also occurs in other months like July to September. Flooding also causes the destruction of this soil thru erosional process along the riverbanks. A program of soil conservation should therefore be adopted not only on the soil type itself but also on the headwaters of the rivers.

Taal fine sandy loam has a very friable, loose, surface soil that varies in depth from 15 to 35 centimeters. The presence of outcrops of rocks make plowing slightly difficult. Only small areas at a time can be cultivated. Some sections are covered with many big rocks and no efforts are made to clear them for cultivation. In these areas traces of the native trees can still be found.

Coconut is the main crop grown on this soil. An average of 30 nuts can be harvested from a tree in a season. The people depend upon this crop for their livelihood. Unlike in the other coconut regions in the province copra making is done by the "tapahan" method. Corn as a minor crop is planted in the inter-spaces in the coconut plantations. This cereal is used as staple food during scarcity of rice. Bananas also grow well on this type. In general, fruit trees will respond well on this soil.

Beach Sand

Beach sand (118).—Beach sand, a miscellaneous land type, in strict sense, is not a true soil for it has not been acted long enough by the forces of weathering as to develop a surface soil and subsoil due to the constant shifting it suffers by wave action. This soil is common on the western part of Leyte with an aggregate area of 3,123.7 hectares. Its occurrence is not extensive. It is usually found in caves where wave action is not strong thus causing its formation.

Beach sand, as a whole, is excessively drained. Its topography is flat and oftentimes suffers inundations due to high tide. The soil consists chiefly of sand with a mixture of a wide variety of fragments of marine shells. Organic matter content is practically nil. The soil is soft, loose, and structureless. Stones and boulders are sometimes found.

This soil is not used for agricultural purposes due to effect of the salty sea water except for coconuts which, in spite of their nearness to the sea, have excellent growth. Pandan, aroma, camachile, and creeping vines make up the native vegetation.

WELL DRAINED ROLLING UPLANDS

NONCALCEREOUS SOILS

This region includes the hilly and central mountain range in the mainland as well as those in Panaon and Biliran Islands. The mountain ranges in Panaon and Biliran are well covered by native vegetation with the exception of only small portions in

Depth of soil cm.	Characteristics
	penetrate this layer. This layer is separated from the surface soil by a gradual, smooth boundary.
60–80	Grayish brown, silt loam with a great mixture of weathered rocks. Hard and compact with no definite structure. Stones and some bedrocks are present. Boundary to above layer is gradual and smooth.

Guimaras sandy clay loam (200).—Guimaras sandy clay loam is found only on the eastern part of the province north of Tacloban. It occupies the foothills of the eastern slopes of the range running from Palo to Babatngon. This type is not extensively distributed as it covers only 1,042.6 hectares, or about 0.13 per cent of the total soil area. In general, the land is roughly rolling to hilly with good external drainage. The amount of runoff occurring on this soil is small as the greater part of the soil is still under cover of heavy vegetation. The internal drainage is good to slightly excessive.

The surface soil has a depth of from 15 to 25 centimeters and varies from silt loam, sandy clay loam to fine sandy loam. Since it is loose, friable and granular both under dry or wet condition, it can be plowed with ease both with animals or machines. Being fairly rich in organic matter the soil does not crack or harden upon drying. Gravels and pebbles are common but they do not in any way affect tillage operations.

The greater part of the cultivated area of this soil has just been recently cleared for cultivation and as yet no single major crop has shown prominence in production. Coconuts are grown more extensively than other crops, however, sweet potatoes, corn, upland rice, and fruit trees like bananas, jackfruits and breadfruits form the minor cultivated crops. The successful cultivation of bananas will depend upon the possibility of controlling winds. This element may cause considerable damage to the leaves and thus affect fruiting capacity.

Tacloban Series

The Tacloban series is found on the northeastern part of Leyte and consists of the low range of hills and mountains between Palo on the South and Babatngon on the North. The topography is hilly to mountainous with steep slopes. Some portions of the area have fairly suitable slopes for cultivation but the rest is too steep to be cultivated. The greater part of this series is still covered by thick primary forest of the dipterocarp type. Traces of grass spots indicate that some parts were used for kaingin. The forest under this particular soil series is famous for its big "mancono" trees reputed to be the hardest

Fig. 1. An excavation to show the profile of Tacloban clay. The soil shallow and the andesite rocks are mined for road ballast.

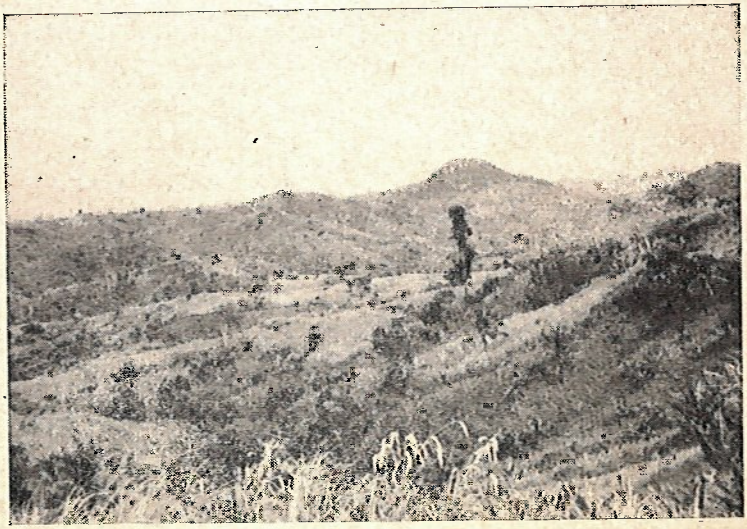

Fig. 2. A view of landscape of Tacloban clay. The clearings on this rolling land were made for kaingins.

In general the internal and external drainage is good. Rivers abound throughout the areas. There is a continuous supply of water throughout the year from springs and waterfalls. A great deal of control of the water supply in the rivers is influenced by the thick stand of the forest consisting of several species of trees, vines, shrubs, ferns, and grass.

The surface soil to a depth of from 20 to 30 cm. is reddish brown to brown clay loam. It is fairly friable and granular and can be easily worked. There are no stones or boulders to interfere in any tillage operation. However the absence of fairly wide arable areas remains a shortening of this type.

The scattered hills on the eastern part of Leyte are mostly cogonals and partly covered by second-growth trees. These hilly areas are oftentimes cultivated and planted to corn, coconut, cassava, sweet potato, and upland rice. Varieties of sweet potatoes like Caringket and Surigaonon usually yield as much as 100 sacks of tubers per hectare. Corn on this soil ordinarily gives only from 7 to 12 cavans. This soil type is not extensively cultivated to crops. To derive a maximum utilization of this type, the area, because of the existence of hilly and roughly rolling topography, should be reserved for forestry or wildlife.

Guimbalaon Series

The Guimbalaon series was first described by Pendleton in his survey of Silay–Saravia Area in Negros Occidental in 1925. The same soil series was identified on both sides of the central mountain range in Leyte Province like in Ormoc and between Capoocan and Dagami, and on the southern part between Anahawan and Hinundayan. It is also found in Naval, Cawayan, and Biliran in Biliran Island.

Guimbalaon series is an old plain having been formed from deposition mostly by volcanic action. Its topography ranges from rolling to hilly while the rough terrain is the result of geologic erosion. The elevation of Dolores is 900 feet above sea level; 900 feet along the highway between Ormoc and Capoocan, and 300 feet in Jaro.

The presence of big boulders of andesite and basaltic rock outcrops stands as a peculiar characteristic of this series, in addition to its dark brown to reddish brown deep soils. The transition of one layer into another in the profile is very gradual and hardly discernible. Rocks are also found in the various layers in the profile.

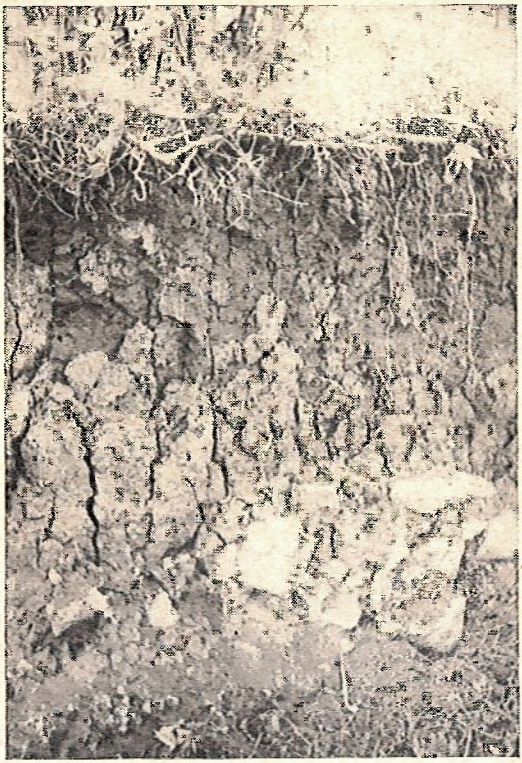

Fig. 1. Soil profile of Guimbalaon clay. Note the soil granulation and the depth of root development. Igneous rocks are found in the substratum.

Fig. 2. Outcrops of rocks make this characteristic landscape of Guimbalaon clay found in Biliran Island difficult for farming. Soil is widely used for sugar cane.

lowland rice and if ever practiced as done in Jaro, the consequent puddling of the surface soil somewhat impedes drainage.

This soil type has a distinct dark brown color. The soil color becomes darker when wet. The surface soil to a depth ranging from 30 to 50 centimeters is clay with a good medium granular structure. It is sticky when wet but becomes slightly hard and somewhat compact when dry. It has a fair amount of organic matter. This soil is generally acidic in reaction. This acidity which may be brought about by the decomposition of organic matter, by constant leaching of the bases or by the absorption of such bases by plants may be remedied by regular application of agricultural lime.

A distinguishing characteristic of this soil type is the presence of occasional quantities of rock outcrops. These rocks sometimes are impediments to tillage operation.

In Ormoc, this soil is widely used for sugar cane. The variety P. O. J. 2878 is more commonly used than the Badila. The former variety is reputed to be resistant to the attack of rats and its bagasse is better than that of the latter variety. The bagasse of Badila is powdery and does not make a good fuel for the boiler. Leunaphos or Warner-phos fertilizer is usually apllied at the maximum rate of 300 kilos per hectare. Fertilized fields normally give a yield range of from 80 to 110 piculs per hectare while the unfertilized fields yields only from 50 to 60 piculs to the hectare. Since liberation, only ammonium sulfate fertilizer is used as Leunaphos or Warner-phos demands high selling cost.

Around Jaro this soil type is utilized for coconut and lowland rice. The coconuts are fairly productive giving harvest from 20 to 30 nuts per tree every season. Lowland rice is an important crop in the lower areas of this soil type. Unlike the rice fields in eastern Leyte, the rice fields in Jaro are provided with dikes to hold irrigation water. Elon-elon and Bayambang are common rice varieties planted and give yields from 35 to 70 cavans of palay to the hectare. Rice is usually planted in December and harvested in May.

In Biliran, Guimbalaon clay is used for upland crops like rice and corn. The yields of both crops are quite low averaging 15 for rice and 7 cavans for corn.

In Anahawan, this soil type is devoted to coconut only. The yield, like those in Jaro, ranges from 20 to 30 nuts per tree every season.

Fig. 1. Luisiana clay as shown in this profile is a deep and highly weathered soil having dark reddish brown surface and subsoil and yellowish gray with reddish splotches in the substratum.

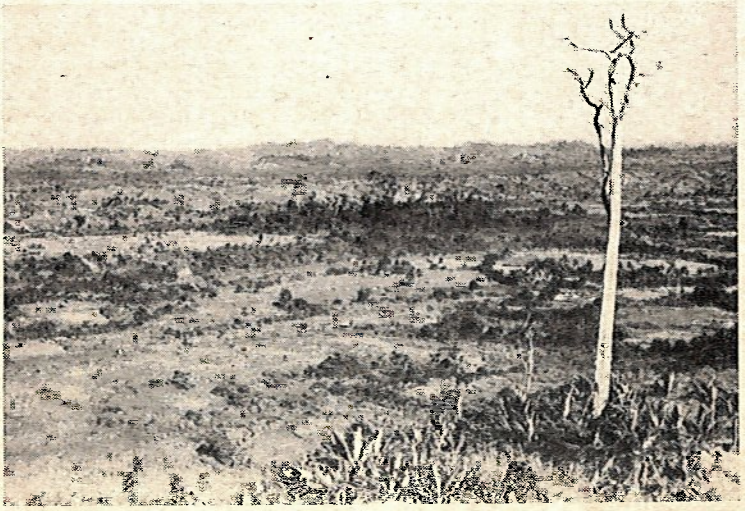

Fig. 2. A view of landscape of Luisiana clay on the southern part of the town of Leyte. The well drained rolling land is used for abaca, corn and upland rice.

PLATE 11.

to the Guimbalaon soils. Those in Biliran and Ormoc have altitudes from 600 to 900 feet above sea level while the rest are from 100 to 300 feet.

The soil is well drained. The runoff in cultivated areas is excessive and oftentimes produces gullies. In between slopes of hills the drainage condition is poor. Since water collects in these areas such areas are usually converted into lowland rice paddies.

This soil is dark reddish brown to purplish red. The color becomes darker when wet. The surface soil to a depth of from 20 to 35 centimeters is usually clay with a fine granular structure. It is friable when just moist, but is slightly hard when dry and slightly sticky to plastic when moist. The soil is slightly acidic. It is alleged that corn does not grow well on this soil as found in Biliran but that rice can produce a fair yield. This may be attributed to the acidity of the soil.

This soil type has a total area of 27,235.2 hectares. In Biliran this soil type is mostly under cultivation, whereas in Ormoc and Hinunangan only a small portion is cultivated, the rest being grassland consisting mainly of cogon and some talahib. Those in Barugo and San Miguel are partly cultivated and partly under second growth forest.

Corn and rice, both upland and lowland, as well as coconut, are the principal crops planted on this soil. In general, the soil is poor. Other crops grown are bananas and sugar cane. The yield for corn seldom reaches 7 cavans to the hectare. Upland rice usually gives from 10 to 15 cavans per hectare. The water requirement for lowland rice is solely dependent upon rain.

Accelerated soil erosion on this soil type is a menace especially on slopes ranging from 10 to 15 per cent. To minimize its occurrence and to avoid the consequent destruction, some conservation measures such as contour farming, strip cropping and terracing should be adopted. Lands under this type with steep slopes should be planted to permanent crops like fruit trees, coffee and cacao, rather than grow them to seasonal crops.

Palompon Series

The low range of hills between Villaba and Palompon on the northwestern part of the province is classified under the Palompon series. These hills have steep slopes and their altitudes are often over 1000 feet above sea level. Some portions of these hills are kaingined while the rest are still under cover of dipterocarp forest. This series is well drained externally that excessive runoff very often occurs on the cleared areas.

vated. This soil is very sparsely settled. Dipterocarp forest covers a greater part of this soil while the abandoned kaingins are either grasslands or second-growth forest. The area of the clearings is increasing every year.

Palompon clay has a brown to light brown surface soil ranging in depth from 15 to 25 cm. The soil color is darker when it is rich in organic matter as in the case of soils under forest. The color changes to black when it is under cover of grasses. Generally this soil is friable with only very slight tendency towards stickness when wet. It remains friable when dry. This friability may be attributed partly to the fine granular structure of the soil and partly to the organic-matter content. In spite of the favorable soil conditions, the greater part of the area can not be used for agricultural purposes because of its topography. Some sections, however, are cultivated to upland rice, sweet potatoes, cassava, corn, coconut and fruit trees like bananas, jackfruit, and citrus.

This area may be planted to permanent crops like fruit trees but cultivation of annual crops should; as much as possible, be restricted only to slopes of not more than 15 per cent. On the sloping areas erosion control measures should be adopted.

Malitbog Series

The rugged land on the southwestern part of the province belongs to the Malitbog series. The hills and mountains have steep slopes. External drainage on the open lands is very excessive. Some portions of these mountain ranges are still covered by thick growth of dipterocarp forest.

The dark grayish brown clay soil of this series was developed from andestite and basaltic rocks. Some of these rocks are exposed on the surface as outcrops. Soil development extends from one to two meters deep with a characteristic gray surface soil, brown subsoil, and yellowish brown substratum underlain by igneous rocks. Conglomerates are also present in the lower layers. The soils in all the layers of the profile are compact clay which are very sticky when wet.

Coconut constitutes the important crop on this soil but most of the trees are stunted in growth, chlorotic and unproductive. The forest areas are located quite in the interior and partly inaccessible. Numerous patches of open lands exist in which cogon grass predominates.

sive external drainage and poor internal drainage. Like the Lugo series Maasin soils are severely eroded. Sheet and gully erosion are common with more of the former kind in occurrence. The soil is of heavy clay, very sticky when wet and slightly friable when dry. It was developed from shale.

Maasin clay, the only soil type under the series has profile characteristics as follows:

Maasin Clay

Depth of soil *cm.*	Characteristics
0–20	Surface layer. Deep brown to reddish brown red clay to clay loam, good coarse granular structure and sticy to moderately plastic when wet but slightly friable to compact when dry. Poor in organic matter and no rock outcrop or coarse skeleton in this layer.
20–55	Subsoil. Light brown, good coarse granular clay to clay loam, sticky to moderately plastic when wet, but slightly friable to compact when dry. This layer is separated from the upper layer by a wavy gradual boundary. Roots of grasses plenty in this layer. No coarse skeleton found.
55–90	Light yellowish brown with streaks of dark red, massive clay, moderately sticky when wet and hard to compact when dry. This layer is separated from the above layer by a wavy gradual boundary. In some areas, limestone rocks may be found.
90–150	Substratum. Grayish brown with streaks of red, massive highly weathered shale developing into clay loam or silty clay. Very hard and highly compact either wet or dry. Boundary to above layer is wavy and clear.

Maasin clay (197).—Maasin clay is found on the southern part of Leyte covering the interior regions from Inopacan to Malitbog. The land is rolling to hilly with excessive external drainage. The heavy soil makes internal drainage very slow. The dark brown to reddish brown surface soil which ranges in depth from 10 to 25 cm. is heavy clay. It is poor in organic matter and very susceptible to erosion. Most of the areas of this soil are severely eroded with surface and subsoil layers gone and the lighter colored substratum already exposed.

Upland rice, corn, coconut, and bananas are the common crops grown. Upland rice have been proven to be more adaptable than corn on this soil. The variety *Lubang Pula* when planted in June and harvested in October yields from 20 to 25 cavans per hectare. Corn, on the average, yields 5 cavans per hectare. The surface soil is very acidic ranging from pH 4.0 to 5.5, which acidity is certainly too high for corn. Most of the coconuts grown are partly chlorotic with the older leaves more yellow than the younger leaves.

Fig. 1. Soil profile of Himayangan clay loam taken on southern part of Libagon. Note the soft and porous sandy shale in the substratum.

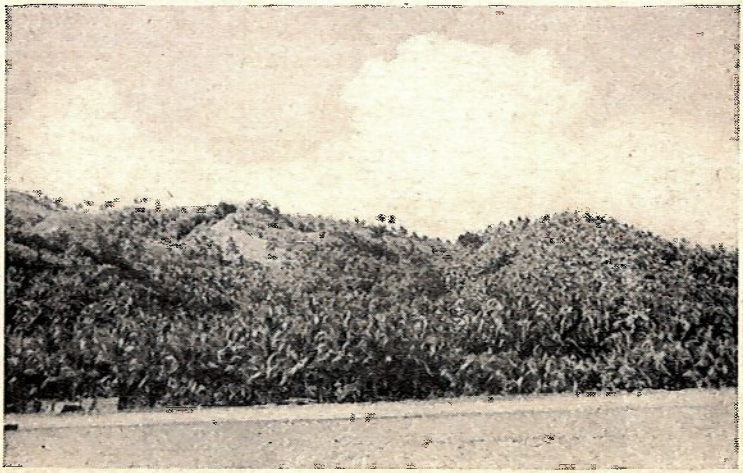

Fig. 2. Landscape of Himayangan soil on the southern part of Libagon. Hillsides are cleared and planted to coconut.

PLATE 12.

Babatngon. The topography is rolling and, with the exception of some valleys, this soil is not suitable for clean-culture crops. The surface soil which varies in depth from 15 to 20 cm. is sandy clay loam to clay loam. Under native vegetation, it is very friable and loose but under grassland, the soil becomes hard and somewhat compact. In general the soil is gray especially those in the open grassland, but becomes light brown in the case of forest soils. There are no stones or boulders on the surface.

Himayangan clay loam is rated as a poor soil. The principal crop grown is coconut. It grows well when planted along the seacoast but those found inland are chlorotic, stunted and do not bear any fruit. Upland rice, corn, cassava, and camote are also planted in kaingins but these crops produce good yields only in the first year of planting.

Rough stony land (171).—Rough stony land is under the miscellaneous land type, which includes land having steep relief with many outcrops of solid rocks and large boulders. The land is too steep and therefore unsuitable for either cropping or grazing. This type is located in Panaon Island covering about 16,899.43 hectares. The whole Panaon Island is very rugged with the exception of a few and small coastal alluvial plains. Aside from having such steep slopes, the land is covered by rock outcrops thus making their use for cropping impossible. Under these conditions it is advisable to keep this area under a permanent forest cover. The considerable quantity of large boulders greatly affect even the timber stand. It was further noted that in a certain plane called Pinamughaan exists a big waterfall which can be utilized for power.

Rough mountainous land (202).—Rough mountainous land refers to very rough lands dominantly stony in character but it includes small areas of land suitable for cropping and considerable land suitable for grazing. This mapping unit is essentially a complex of rough stony land with small areas of soils. This is the most extensive type found in Leyte Province which comprises 301,425.61 hectares. It occupies the mountain range from the northern to the southern end of the province. This range has not only very steep slopes along the central portion but is also very much elevated. The extreme ends are not as rugged as the central part and for this reason plenty of clearings have been made. With the exception of these spot clearings, the other portions of this land type are covered by

year. Obviously, the water supply of the farmers during the summer months becomes an important problem.

In areas where the soils are severely eroded, gravels of calcareous shale appear as concretions on the surface. These are not true concretions. They are only calcareous rocks which have resisted weathering. The calcareous shale which forms the bedrock of this series extends to several meters in depth. This rock is soft and plant roots easily penetrate into it. Ipil-ipil roots not only penetrate to over a meter and half but also go through much harder rocks.

Lugo clay has a profile with the following characteristics:

Lugo Clay

Depth of soil *cm.*	Characteristics
0–15	Surface soil. Clay, black to dark gray; medium to fine granular structure. When wet, it is sticky and strongly plastic but slightly friable when almost dry. There are no stones or outcrops of rocks. Fairly rich in organic matter.
15–30	Subsoil. Dark brown to yellowish brown clay, with a good coarse granular structure and slightly friable when dry but strongly plastic when wet. Boundary separating from the surface layer is smooth and diffused. There are no stones or rock outcrops in this layer.
30–150	Substratum. Silty, clay brownish gray with a weak coarse granular structure and with a consistency that is strongly gritty both when dry or wet. Boundary separating this layer from the above is abrupt and smooth. This layer consists of the consolidated limy shale rock.

Lugo clay (156).—This soil type is found on the northwestern part of Leyte in the municipalities of San Isidro, Calubian, and part of Villaba.

Lugo clay has a black surface soil that ranges in depth from 5 to 30 centimeters. This wide range in depth is attributed to the severe erosion taking place. As a matter of fact large areas were noted to have no more surface soil. The surface soil is very sticky and plastic when wet rather crumbly to friable when dry. The subsoil is also clayey but rather thin. The substratum which consists of partially weathered calcareous shale is gray to brownish gray which appears in laminated layers.

This soil type is widely used for corn growing. Bananas, upland rice, coconut, and tobacco are some of the minor crops. The creeks and deep gullies in this type are sometimes lined with bamboo groves. Ipil-ipil and katuray are also abundant

Fig. 1. Soil profile of Faraon clay. The black granular clay is laid over the gray coralline limestone.

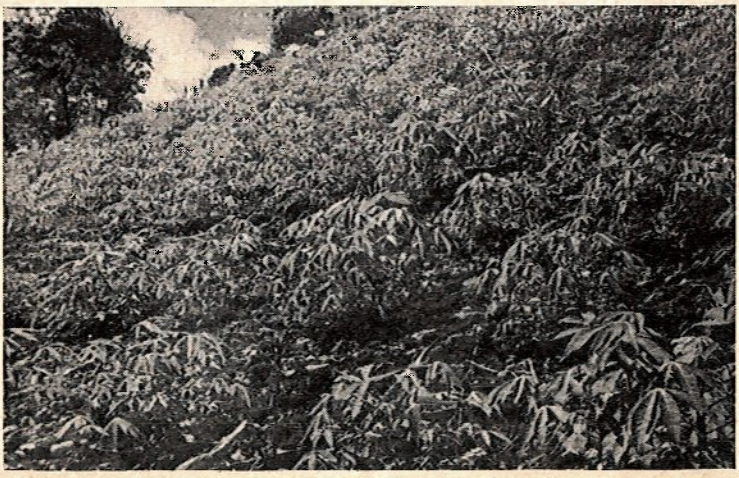

Fig. 2. Landscape of Faraon clay, steep phase. Slopes of hills are cleared and planted to corn or cassava. This soil is severely eroded.

PLATE 14.

Faraon clay, steep phase (155).—Faraon clay, steep phase, occurs on the southern end of Leyte. The slopes are too steep to justify any cultivation to annual crops. Permanent crops like coconut and fruits trees do best since by planting such crops there will be a minimum disturbance of the soil thus preventing or minimizing erosion.

The surface soil, which ranges in depth from 10 to 20 centimeters, is a fairly granular clay that becomes sticky when wet and hard upon drying. At normal moisture content this soil has a fairly friable consistency. Most part of this soil type are abandoned kaingins which developed into second growth forest. The cultivated areas are devoted mostly to coconut, some corn, and banana, and to a very minor extent, sweet potatoes. The first three crops mentioned are well adapted to this soil.

Bolinao Series

Soils of the Bolinao series had developed from limestone. Unlike the Faraon soils, Bolinao soils are red. Generally the bedrock of Bolinao is white, hard, and compact limestone while that of the Faraon is gray, porous, and relatively soft limestone. All other external characteristics of these two series are the same.

Bolinao soils are fairly productive and are especially suitable for corn, coconut, bananas, and maguey.

Bolinao clay. (153).—Bolinao clay is found on the southern part of Leyte covering nearly 2,236 hectares. The soil is well drained with undulating slopes. It is of heavy clay, reddish brown to dark brown and ranges in depth from 10 to 15 centimeters. When wet, this soil is very sticky and plastic but upon drying it becomes granular and fairly friable. Out crops of limestone are very numerous and are obstacles in tillage operations. Erosion pavements are likewise present on the surface. The subsoil is sometimes absent in which case the surface soil rests immediately on top of the bedrock.

In Leyte this soil is partly covered by second-growth forest as is found in Macrohon. The cultivated crops are mostly coconut, corn, some tobacco, and a few patches of sweet potatoes. This soil is fairly productive provided the nitrogen content of the soil is maintained.

Faraon-Bolinao complex (201).—This soil complex is a mixture of Faraon and Bolinao clay existing in small areas and in-

clay loam, clay loam, or silty clay loam. Soils containing less than 20 per cent clay may be either loamy sand, sandy loam, loam, silt loam or silt.

Knowledge of the textural class of soils is important in predicting the physical properties and, to a certain extent, the chemical properties of soils. The different soil samples collected in Leyte were analyzed using the modified Bouyoucos method.

During the survey, the texture of the soils was determined in the field by the feel-method. Later, after the analysis of soil samples in the laboratory, the textural classes were changed to conform with the analysis if any discrepancy existed between the two methods. The textural classes of some soil types which in the opinion of the authors should not be changed in spite of the anaylsis, are maintained.

TABLE 11.—*Showing the mechanical composition of the different soil types in Leyte Provnice* [a]

Soil type No.	Soil type	Sand 2.0–0.05 mm.	Silt 0.05–0.002 mm.	Clay 0.002 mm.
		Per cent	*Per cent*	*Per cent*
191	Pawing fine sandy loam	67.6	14.8	17.6
193	Palo clay loam	30.8	34.8	34.6
82	San Manuel silt loam	44.6	27.8	27.6
190	San Manuel loam	28.8	36.2	35.0
240	Mandawe clay	27.0	26.0	47.0
16	Bantog clay loam			
159	Medellin clay	16.6	24.8	58.6
95	San Manuel fine sandy loam	42.0	32.3	25.1
168	Umingan clay loam	34.8	35.0	30.2
204	Dagani clay loam	40.8	24.0	35.2
203	Obando fine sand	74.6	12.5	12.9
122	Umingan fine sandy loam	68.4	12.8	18.8
57	Taal fine sandy loam	60.4	17.6	22.0
200	Guimaras sandy clay loam	56.8	16.0	27.2
194	Tacloban clay	28.1	24.6	47.3
205	Guimbalaon clay	24.8	21.5	53.7
239	Luisiana clay	26.4	18.4	55.2
195	Palompon clay	25.4	26.4	48.2
196	Malitbog clay	28.2	32.6	39.2
197	Maasin clay	38.6	16.2	45.2
198	Himayangan clay loam	46.4	20.4	33.2
156	Lugo clay	8.4	26.8	68.8
155	Faraon clay, steep phase	22.8	16.8	60.4
153	Bolinao clay	28.8	14.8	56.4
201	Faraon–Bolinao complex	26.4	18.4	55.2

[a] Data for surface soil only. Soils analyzed by Edmundo K. Villegas.

The classification of Leyte soils by texture shows that 66.1 per cent of the area of the province is clay; 18.4 per cent, clay loam; 0.3 per cent loam; 9.3 per cent, silt loam; and 5.9 per cent is of the sandy loam class. The sandy loam as grouped in here is a composite of the fine sandy loam and sandy clay loams.

igneous rocks. Seams of coal which are too soft for practical use and widely scattered for economical exploitation are found.

The transported soils such as those found on the eastern and western plains of Leyte had developed from alluvium or unconsolidated materials.

The primary soils in Leyte are the following:

1. Tacloban
2. Guimbaloan
3. Luisiana
4. Palompon
5. Malitbog
6. Maasin
7. Guimaras
8. Himayangan
9. Lugo
10. Faraon
11. Bolinao
12. Mountain Soils

The secondary soils are:

1. Pawing
2. San Manuel
3. Bantog
4. Dagami
5. Taal
6. Palo
7. Mandawe
8. Medellin
9. Umingan
10. Obando

From the standpoint of profile development, the secondary soils are generally very young and of very recent formation. The land formation on the eastern as well as on the western side was very recent as evidenced from the comparatively less degree of meandering of the rivers. The edge of the plain meeting the slope of the hills is so clear that a definite boundary can be laid to separate the two land forms. With the exception of Bantog, Mandawe, and the Medellin series, the rest of the secondary soils have sandy substratum. The Bantog, Mandawe, and Medellin soils, although of clay substratum, are also young and that the original materials came from pre-existing soils of clay formation such as the Palompon clay, Faraon and Lugo clay, and Faraon clay, respectively.

The morphology and genesis of Faraon and Lugo soils may be found in the Cebu soil report.

Climate.—The climate of Leyte is generally humid. Rainfall on the eastern side is a little more and well distributed throughout the year as compared to that on the western side. In spite of the heavy rainfall, leaching, on the plains is not rapid since the downward movement of water is very much impeded by the shallow water table. Heavy rainfall on the rolling lands, hills, and mountains does affect profile development. Warm weather and moist condition favor rapid formation of soils

Manuel, and Umingan series are of this kind. Soil material on steep slopes is replaced through rock weathering as the soil mantle is removed by geologic erosion and very little opportunity is present for the formation of a mature profile. The upland soils as well as the mountain soils classified in Leyte belong to this group. These two broad classes constitute the young and very young soils of Leyte. A matured soil is formed only when a condition of equilibrum exists between soil formation and external enviroment.

PRODUCTIVITY RATINGS OF LEYTE SOILS

The actual performance of any kind of soil is shown by its production or the so-called productivity rating. This rating simply indicates how productive a soil is for a certain kind of crop compared to a standard for that crop. In determining the productivity rating of the soil, the yields of crops are based upon common farming practices. The yields of crops are obtained mostly on interviews with farmers, provincial agriculturist and municipal agriculturists. The estimates for some crops not usually grown on the soil type are obtained by deduction through judgment of the soil conditions. These estimates are presented only as average production over a period of years according to common farming practices. They are not to apply directly to specific tract of land or farm for any particular year.

Except for sugar cane on the western part of Leyte, fertilization is seldom practiced. But with the recent introduction of fertilizer, many farmers began to fertilize their crops obtaining good results especially with rice. Rice production on the eastern part is not as high as it should be because of the unsuitable climatic condition, and lack of thorough land preparation. On sugar cane, the common practice is to apply ammonium sulfate on the alluvial soils, and ammophos on the the upland soils. The average yield of sugar cane for the province is fairly above the standard yield of 80 piculs per hectare.

The following are the average yield of crops per hectare, without the use of fertilizers and other amendments, that have been established as standards of 100, arranged according to importance in Leyte Province:

Sugar cane	80 piculs
Corn	17 cavans
Lowland rice	60 cavans
Coconut	3,750 nuts

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN LEYTE PROVINCE

Common name	Scientific name	Family name
Abaca	*Musa textilis* Nee	Musaceae
Achuete	*Bixa orellana* Linn.	Bixaceae
Agiñgai	*Rottboellia exaltata* Linn.	Gramineae
Agor	*Fimbristylis miliaceae* (Linn.) Vahl	Cyperaceae
Alogbate	*Basella rubia* Linn.	Basellaceae
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceae
Anonas	*Anona reticulata* Linn.	Anonaceae
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceae
Aroma	*Acacia farnesiana* (Linn.) Wild	Leguminosae
Arrowroot	*Maranta arundinacea* (Linn.	Marantaceae
Atis	*Anona squamosa* Linn.	Anonaceae
Avocado	*Persea americana* Mill.	Lauraceae
Badiang	*Alocasia macrorrhiza* (Linn.) Shott	Araceae
Bakauan	*Rhizophora mucronata* Linn.	Rhizophoraceae
Balanggot	*Typha capensis* Rohrb.	Typhoceae
Bamboo	*Bambusa spinosa* Roxb.	Gramineae
Banana	*Musa sapientum* Linn.	Musaceae
Bangkal	*Nauclea orientalis* Linn.	Rubiaceae
Batao	*Dolichos lablab* Linn.	Leguminosae
Batad	*Andropogon sorghum* (Linn.) Brot.	Gramineae
Biga	*Alocasia macrorrhiza* (Linn.) Schott	Araceae
Binayoyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceae
Breadfruit	*Artocarpus communis* Forst.	Moraceae
Buñgalon	*Panicum stagninum* Retz.	Gramineae
Buri	*Corypha elata* Roxb.	Palmae
Cabbage	*Brassica oleracea* Linn. var. *capitata* L.	Cruciferae
Cacao	*Theobroma cacao* Linn.	Sterculiaceae
Cadios	*Cajanus cajan* (Linn.) Milsp.	Leguminosae
Caimito	*Chrysophyllum cainito* Linn.	Sapotacea
Cassava	*Manihot esculenta* Crantz	Euphorbiaceae
Cashew	*Anacardium occidentale* Linn.	Anacardiaceae
Chico	*Achras sapota* Linn.	Sapotaceae
Coconut	*Cocos nucifera* Linn.	Palmae
Coffee	*Coffea arabica* Linn.	Rubiaceae
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineae
Corn	*Zea mays* Linn.	Gramineae
Cotton	*Gossypium hirsutum* Linn.	Malvaceae
Cowpea	*Vigna sinensis* (Linn.) Savi.	Leguminosae
Dayap	*Citrus aurantifolia* (Christm) Swingle	Rutaceae

Santol	*Sandoricum koetjape* (Burm. F.) Merr.	Meliaceae
Sincamas	*Pachyrrhizus erosus* (Linn.) Urb.	Leguminosae
Sineguelas	*Spondias purpurea* Linn.	Anacardiaceae
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae
Squash	*Cucurbita maxima* Duch.	Cucurbitaceae
Sugar cane	*Saccharum officinarum* Linn.	Graminea
Sweet potato	*Ipomoea batatas* (Linn.) Poir.	Convolvulaceae
Talahib	*Saccharum spontaneum* (Linn.)	Gramineae
Tambo	*Phragmites vulgaris* (Lam.) Trim.	Gramineae
Tamarind	*Tamarindus indica* Lam.	Leguminosae
Tangile	*Shorea polysperma* (Blanco) Merr.	Dipterocarpacea
Tanglad	*Andropogon citratus* DC.	Gramineae
Tibig	*Xylocarpus granatum* Koenig	Meliaceae
Ticog	*Fimbristylis globulosa* (Retz.) Kunth	Cyperaceae
Tindalo	*Pahudia rhomboidea* (Blanco) Prain	Leguminosae
Tobacco	*Nicotiana tabacum* Linn.	Solanaceae
Tomatoes	*Lycopersicum esculentum* Mill.	Solanaceae
Tugui	*Dioscorea esculenta* (Lorur.) Burkill.	Dioscoreaceae
Ubi	*Dioscorea alata* Linn.	Dioscoreaceae
Upo	*Lagenaria leucanthia* (Duch.)	Cucurbitaceae
Watermelon	*Citrulus vulgaris* Schrad.	Cucurbitaceae
Yakal	*Hopea plagata* (Blanco) Vidal	Dipterocarpaceae

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