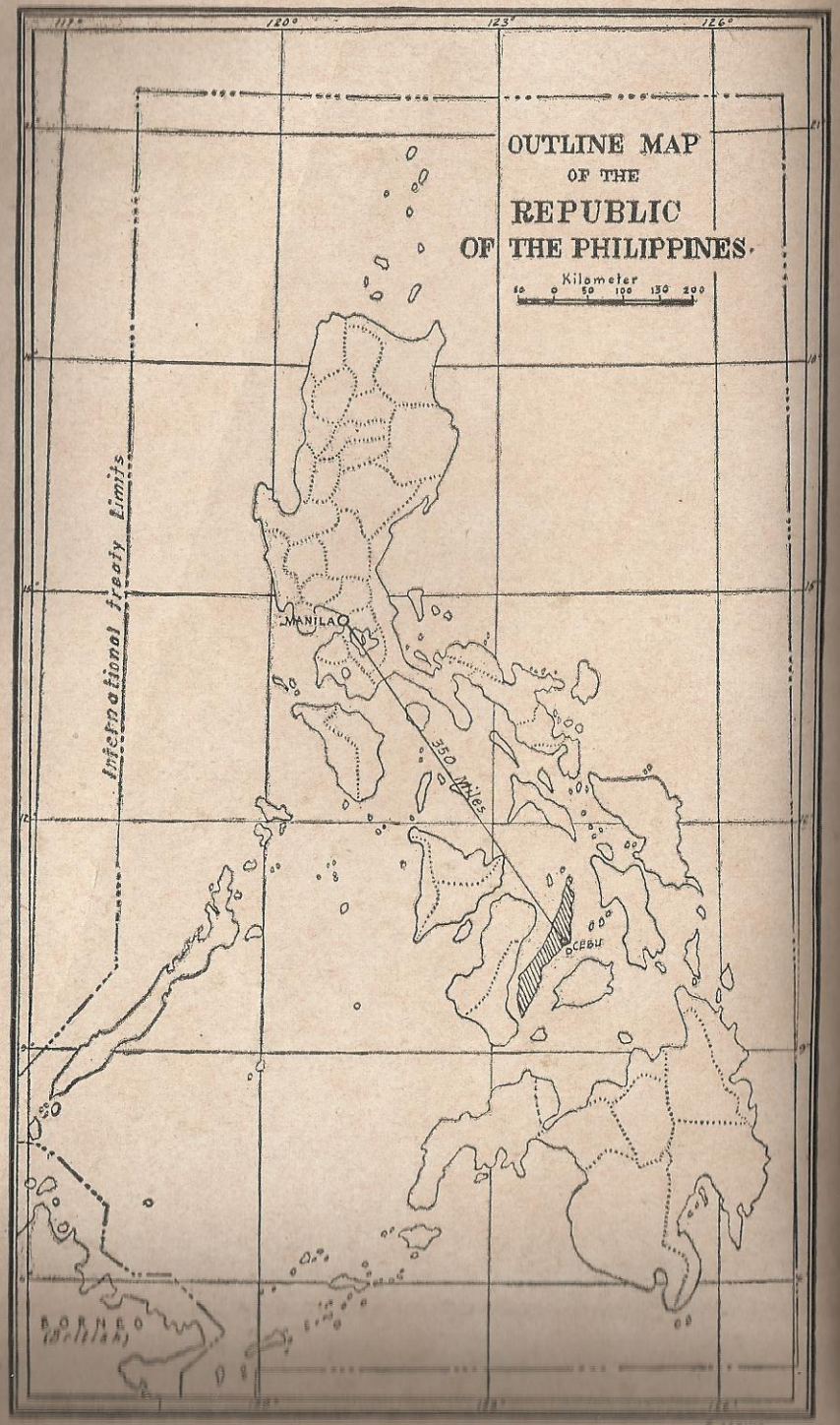

Outline map of the Philippines showing location and distance of Cebu

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
MANILA

Soil Report No. 17

SOIL SURVEY OF CEBU PROVINCE PHILIPPINES

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Published with MSA-PHILCUSA Aid

MANILA
BUREAU OF PRINTING
1954

59709

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, resettlement 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 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, prospective purchasers and tenants, and farm-loan agencies. These readers should (1) locate on the map the tract concerned; (2) identify the soils on the tract by referring to the le-

gend on the margin of the map and seeing the symbols and colors that represent them; and (3) locate in the table of contents under the section on Soils the page where each type is described in detail, giving information on its suitability for use and its relations to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Ratings, Land Use and Soil Management, Chemical Characteristics of the Soils, and Water Control on the Land.

Students and teachers of soil science and allied subjects, including crop production, animal husbandry, economics, rural sociology, geography, and geology, will find interesting the section on Morphology and Genesis of Soils and Mechanical Analysis. They will also find useful information in the section on Soils and Agriculture, in which are presented the general scheme of classification of the soils of the province and a detailed discussion of each type. For those not familiar with the classification and mapping of soils, these subjects are discussed under Soil Survey Methods and Definitions and Mechanical Analysis. Teachers of other subjects will find the sections on Description of the Area, Agriculture, Productivity Ratings and the first part of the section on Soils of particular value in determining the relation between their special subjects and the soils of the area.

—Adapted from the U.S.D.A.

ILLUSTRATIONS

[All photographs by A. BARRERA]

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SOIL SURVEY OF CEBU PROVINCE PHILIPPINES

RECONNAISSANCE SOIL SURVEY

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SOIL EROSION SURVEY

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

SUMMARY

The Province of Cebu which lies on the central part of the Visayan Islands, has a total land area of 486,850 hectares. Cebu City, which is the capital of the province, is 345.5 miles southeast of Manila. In 1938, the population of the province was 1,068,078.

The island of Cebu is predominantly hilly to mountainous with a few small coastal plains. The drainage condition in general being excellent is conducive for the good health of the people. Water supplies from different sources are abundant.

The geological structure of this island has been thoroughly studied. Cebu is well known for its coal mines and potential oil deposits. Of the native vegetations, cogon grass covers a large portion of the island but some virgin forests and second-growth trees exist. Mangroves and swamps are sparsely distributed.

Cebu was discovered by Ferdinand Magellan on April 7, 1521. The Spanish explorer was killed in the battle of Mactan in his attempt to subdue Lapu-lapu. Spain continued to send forces to colonize Cebu and the rest of the islands in the Philippines. The many abuses of the Spaniards led the Filipinos to revolt against them. After the Spanish-American War in 1898, the Philippines was ceded to the United States. Not long after the Pacific War in 1945, Philippine Independence was finally granted on July 4, 1946.

All kinds of transportation are available in Cebu, which facilitate the movement of people and agricultural products. The Province of Cebu has the largest total number of kilometers of roads in the Philippines. The port of Cebu is open to foreign vessels.

The most important industries of the province are farming, cement manufacturing, coal mining, fishing, and blacksmithing.

Two types of climate prevail in the province, namely, the fourth type under which the northern part of the island belongs and the third type which covers the southern part of the mainland.

Corn farming is the principal occupation of the people. The other crops grown are coconut, tobacco, rice, sugar cane, vegetables, and fruits. Poultry and hogs are raised in commercial quantities.

Farm land subdivision in Cebu is generally small. Ninety-seven per cent of the total number of farms ranges from .2 to 4.99 hectares. Majority of the farms are held and operated by the owners themselves.

The different soil types of Cebu were classified on the basis of their morphological characteristics. Faraon is the largest soil series in the province followed by Lugo series. These are the two most important agricultural soils of the province. The Baguio soils rank third in extent but are not important agriculturally as they represent the mountainous regions on the central part of Cebu. These soils should be reforested.

The productivity ratings for each soil type were determined in order to show the relative capacity of each soil type to produce different kinds of crops.

Attempts were made to show the genesis and morphology of the two important soils in the province. However, conclusions drawn therefrom were based largely upon the physical characteristics of the soils owing to the limited chemical analysis conducted.

Accelerated erosion began in Cebu when man started to clear and cultivate the land in order to satisfy his wants.

The present condition of soil erosion in Cebu is extremely serious as shown by the recent reconnaissance erosion survey. Of the total area of the province, more than 9/10 (439,065 hectares) or 91.7 per cent are affected by erosion of varying degrees. About 3/5 or 62.7 per cent of the area had lost 3/4 or more of their original surface; slightly less than 1/6 or 18.5 per cent of the area had lost 1/4 to less than 3/4 of their top soil; and approximately 1/5 or 18.7 per cent of the area has slight to no apparent erosion only. Gully erosion has affected 16,036 hectares or 3.3 per cent of the land area. A hectare of soil with a depth of 17 centimeters weighs aproximately 2,000 tons. On this basis, 699 million tons of surface soil must have been washed away from the 396,571 hectares of land area affected by erosion from moderate to severe type.

The Mandawe, Medellin, beach sand and hydrosol soils have, in general, slight to no apparent erosion. The slope of the land varies from 0 to 5 per cent. All the lowland soils, with the exception of the Medellin series have good to excellent permeability, which prevents the concentration of runoff. Deposition of soil materials washed from the uplands add certain fertility to the bottomland soils to some extent; but where the deposition is made up of cherts and infertile subsoils, the agricultural value of the land is lost.

The Faraon, Bolinao, Lugo, Baguio and Mantalongon soils have erosion ranging generally from moderate to serious and severe types. The slope of the land ranges from 25 to 90 per cent. Soil erosion is attributed to several factors, namely, slope, vegetative cover, climate, and character of the soil, but slope of the land has decidedly exerted the greatest influence in the present deplorable condition of soil erosion in Cebu.

Heavy downpour produces more runoff than gentle rains. The power of water to scour the land depends on its velocity and volume. Velocity is directly proportional to the slope of the land. The texture, structure, and organic matter content of the soil are factors affecting soil permeability. The kind and density of the vegetative cover determine the severity of soil erosion on a given piece of land. Intensive cropping on steep slopes is the major cause of the serious to severe soil erosion in Cebu Province.

Soil erosion in Cebu Province resulting to various adverse effects deserves serious consideration:

1. The loss of the soil and soil fertility.
2. The cause of floods on the lowland which destroy crops, bridges, roads, houses, lives, and properties.
3. The cause of silting on waterways, channels, reservoirs, and harbors.
4. The cause of drought which tremendously lowers the yield of crops.

The following soil-erosion-control measures are practiced in Cebu:

(1) Terracing of steep slopes and hillsides.
(2) Planting ipil-ipil in rotation with corn and tobacco.
(3) The reforestation program of the Bureau of Forestry.

The adoption of sound program of soil conservation farming is primarily needed in the island of Cebu. Cebu, as a matter of fact, is a critical problem area in the Philippines in so far as soil erosion is involved. It is believed that the greatest single factor which may ultimately pave the way towards solving the menace of soil erosion is to change the attitude of the farmers in their methods of present farming. Such change could only be brought about by educating the farmers anew in the modern system of agriculture. Practices like better system of soil and crop management, crop rotation with legumes, contour tillage, contour strip-cropping, cover cropping, terracing, green manuring, and the application of the farm manures and fertilizers must be done. Finally, all lands should be utilized for crop production according to their inherent capabilities.

I. RECONNAISSANCE SOIL SURVEY

INTRODUCTION

The Province of Cebu is one of the most densely populated areas in the Philippines. To sustain such a great number of inhabitants, extensive cultivation of the land for the production of foodstuffs has to be done. The people, being primarily corn-consumers, clear every available spot of their land to plant this cereal crop, whether the land is suitable or not for such cultivation. Since Cebu is typically a hilly province, the planting of any clean-cultured-crop, like corn, would inevitably accelerate soil erosion. This is the evil that besets the present agriculture of Cebu Province. Low production and crop fail-

ures are certainly the aftermath of soil erosion which may mean individual poverty and finally low government revenue.

To evaluate the soil resource of this province, a soil survey was conducted in October, 1946, by the Division of Soil Survey and Conservation (now Bureau of Soil Conservation). It is the aim of this report to show the existing soil conditions of this province in order that sound program for the proper care and management of the soil can be formulated.

Also included in this report is the erosion survey of the province, which shows the extent of soil erosion taking place on the croplands. Soil-erosion causes and their control measures are well pointed out in the hope that they might help the farmers of this province conserve their soil and soil fertility for a permanent agriculture.

DESCRIPTION OF THE AREA

Location and extent.—The Province of Cebu lies centrally in the Visayan Islands and is approximately between 9° 25′ and 11° 21′ north latitude and between 123° 18′ and 124° 40′ east longitude. The mainland of Cebu is a long and narrow island measuring nearly 220 kilometers long and 36 kilometers wide measured at its widest portion (Asturias–Danao). The total land area is 486,850 hectares representing the different soil cover as shown in Table 1.

TABLE 1.—*Land area showing the actual soil cover of Cebu Province* *

Type of cover	Hectares	Per cent
Commercial forest	40,200	8.26
Non-commercial forest	27,990	5.75
Swamps	3,790	0.78
Open and cultivated land	414,870	85.21
Total	486,850	100.00

* Yearbook of Philippine Statistics, 1946

The adjacent islands of Cebu are small, the most important ones being Mactan Island which lies about 3.2 kilometers east of Cebu City; Camotes Islands located about 52 kilometers northeast of the City; and Bantayan Island situated on the northwestern part or about 14.4 kilometers west of Medellin. Cebu City, the present seat of the capital, is 345.5 statute miles southeast of Manila (frontispiece).

Physiography, relief, and drainage.—The mainland of Cebu is long and narrow with a continuous range of hills and moun-

tains. There are very few narrow coastal plains. The mountain range rises gradually from the southern end, but more abruptly on both the southeastern and southwestern coasts. The range runs on the northerly direction, attaining a maximum height of 1,000 meters above sea level on the central portion of the province where it gradually descends until it disappears as rolling hills and plains on the northern end (Fig. 1). The central cordillera which is most elevated and rugged is dissected by deep V-shaped canyons.

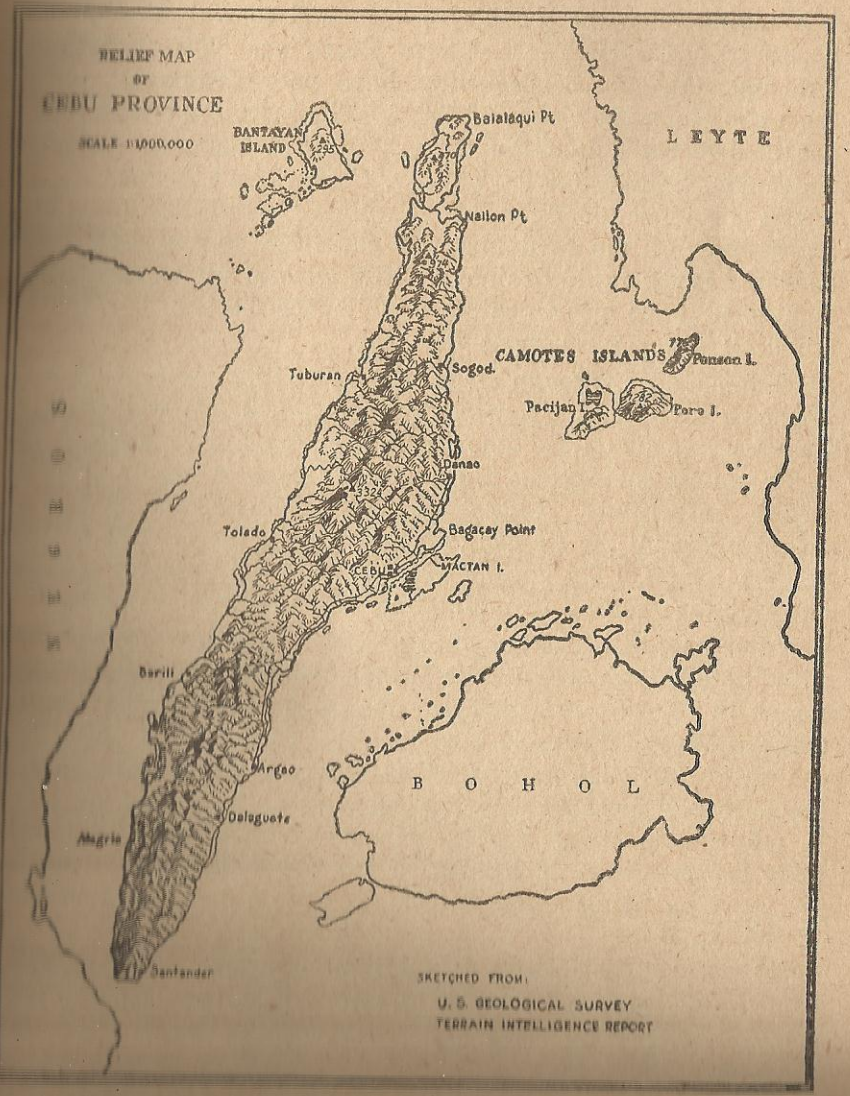


Fig. 1. Relief map of Cebu Province

There are no volcanoes in the island, but some hot springs exist near Barili, Oslob, and Alegria. These hot springs may be due to the water passing through the uncooled lava in the interior portion of the earth. There are numerous other springs along the hillsides, some of them are big and are tapped as water supply for the towns. The rivers of Cebu are few and small originating from the interior central regions and flow swiftly towards the coast. These rivers are not navigable, for they become dry during summer.

Fringing from the cordilleras are small coastal alluvial flood plains and alluvial pans. These plains are characteristically low and flat, and consequently have poor drainage. All of them are along the rivers of Cebu. The most important plains are those located in Cebu City, Mandawe, Carmen, Asturias, Balamban, Toledo, Barili, Talisay, Carcar, and Argao.

The Province of Cebu as a whole is well drained. The topography of the land and the naturally porous underlying bedrocks favor rapid drainage. The alluvial plains as already mentioned have poor drainage while the bottom lands keep standing water throughout the year.

Mactan and Bantayan Islands have rolling lands with very low hills and short rivers to the coast, and are well-drained. Camotes Islands on the other hand are very hilly. Each of the three islands comprising the Camotes Group is highly elevated on the central part. Limestone hills and mountains of igneous origin make up the rugged, steep slopes on the central portion of Poro Island. The coastal areas around the Camotes Islands, however, are rolling to undulating and are well populated.

Water supply.—The province of Cebu is adequately supplied with potable water. Public water-distribution systems are found in thirty municipalities the biggest of which is the Osmeña Water Works located in Cebu City with a daily discharge of 1,915,200 gallons. The different waterworks in the province are operated either by gravity or by pumps or both. In addition to these sources of water supply, many artesian wells are conveniently located in the different places. Perennial springs along the hillsides are found in many sections of the province.

The chief characteristic of the water of Cebu is its hardness. This is true because Cebu is largely a limestone country and the carbonates which are easily dissolved in water cause the hardness.

Table 2 shows the municipalities equipped with public water distribution system with its corresponding capacity, type, and population served.

TABLE 2.—*Public water distribution system in Cebu Province*

Municipality	Type	Capacity (Gallons per day)	Population served
Cebu City	Gravity and pump	1,915.200	79,500
Mactan Island	Pump	144,000	2,700
Catmon	do	38.000	1,650
Carcar	Gravity	94.600	2,200
Argao	Pump	345,600	7,000
Bantayan	(Rain storage)		600
Bantayan Island	Pump		4,000
Medellin	do	21,600	300
Asturias	Gravity	121,000	3,900
Balamban	do	72,200	4,800
Toledo	Pump	172,800	4,500
Barili	Gravity	61,200	2,100
Talisay	Pump	187,200	1,500
Minglanilla	Gravity		1,900
Naga	do	54,720	5,108
Naga	do	194,400	4,350
Naga	do	100,800	5,300
Malabuyoc	do	104,500	1,500
Santander	do	43,200	2,700
Samboan	do	78,000	3,541
Santander	do	72,600	2,000
Oslob	do	108,000	5,000
Dalaguete	Gravity and pump	146,600	5,100
Argao	Gravity	29,000	4,500
Dumanjug	do	63,360	2,660
Carcar	do	216,000	4,500
San Fernando	do	108,000	3,000
Naga	do	79,200	3,250
Minglanilla	do	36,000	1,500
Talisay	do	576,000	65,000

Geology.—Cebu is one of the few provinces in the Philippines where a thorough study of its geology has been relatively made. The presence of several coal deposits and reports of the existence of mineral oil led geologists to investigate more of the geologic structure of the island.

The geologic formations in Cebu according to Smith are as follows:

Recent	Alluvial deposits and coral reefs.
Pliocene	Malumbang coral limestone and marls.
Unconformity	Andesitic flows and agglomerates.
Middle and upper Miocene	Vigo shales.
Pre-Tertiary, probably Mesozoic	Schist and slate-like rocks Serpentine intrusions.
Pre-Tertiary	Basal complex, chiefly diorite.

Smith added that there had been an intense dynamism as proved by the presence of schist and hematites. The certiary sediments, including the coral beds were folded and faulted. The terraces in many parts of the coast signify recent elevation

of the island. Smith cites Becker in 1901 of the continuous growth of the limestone from the fringing reef along the coast to the coral limestone cap on the crest of the Cordillera.

From the geological survey of Cebu conducted by the National Development Company, eleven different formations of rocks have been classified. The distribution of these different formations is shown in Fig. 2 and table 3, respectively.

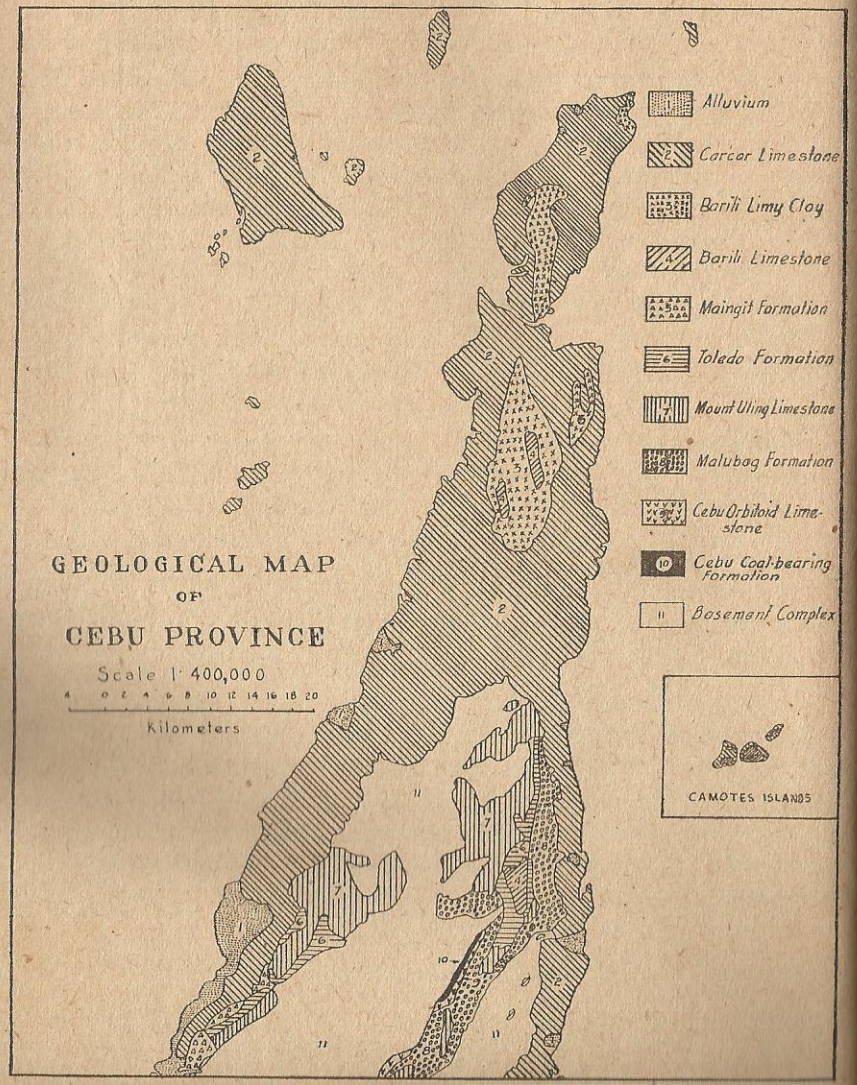


Fig. 2A. Geological map of Cebu Province (northern portion).

Vegetation.—The native vegetation of Cebu Province consists of mangrove swamps, grasslands, virgin and second-growth forests (Fig. 4).

The mangrove swamps are scarcely found along the coastal areas. Majority of them are at the mouths of most rivers. The marshes extend from the shoreline up to the limits of the brackish

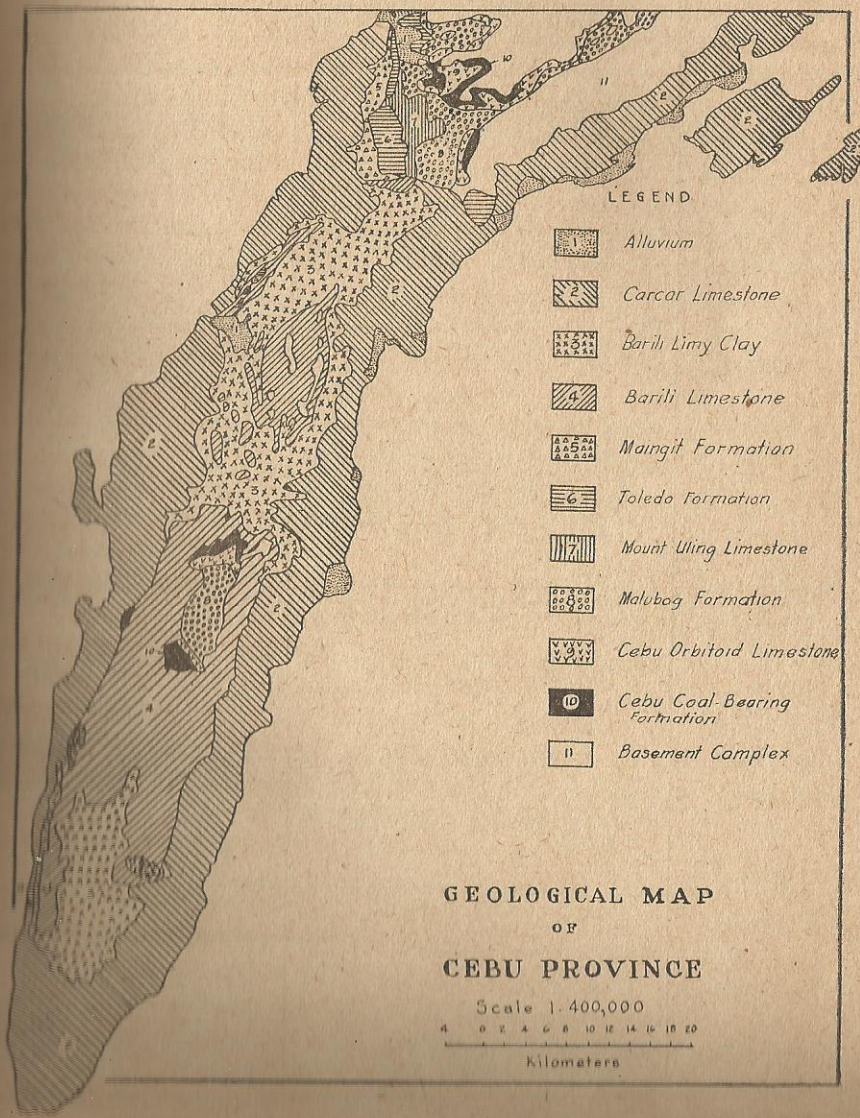


Fig. 2. B. Geological map of Cebu Province (southern portion).

TABLE 3.—*The different geologic formation of Cebu*

Geologic formations		
Map unit and geologic age	Lithology	Topographic expressions
Alluvium 1 Recent	Silt and clay, sand and gravel under coastal plain. Narrow alluvium in borders of most interior streams. Beach deposits of sand and coral reefs and some detritus of igneous rocks.	Coastal plains and river flood plains
Carcar limestone 2 Pliocene to Recent	Porous coralline limestone poorly bedded cavernous. Some well bedded commonly soft. Contains bed of limy clay. At sea grades into living coral reefs. Average thickness about 1,000 ft.	Younger limestone of coastal plains has rough surface. Older rocks at high altitude has gentle to steep slopes. Much of drainage is underground. Surface drainage concentrated in few large streams.
Barili limy clay 3 Miocene-Pliocene	Brown sandy clay with high lime content. Base of formation is calcareous shale. Thickness from 450 to 1,200 ft.	Broad ridges, or open V-shaped valleys with smooth surface and gentle to moderate slopes, surface drainage.
Barili limestone 4 Upper Miocene	White porous limestone, sometimes hard or clayey Ranges from 650 to 1,300 feet thick.	Somewhat similar to Carcar limestone; isolated cliffs common in some areas. Drainage underground.
Maingit formation 5 Upper middle Miocene	Lower member white coral limestone about 160 ft. thick. Middle member poorly sorted and poorly consolidated sands and conglomerate of limestone and old volcanics and pre-Miocene rocks, Upper member is carbonaceous poorly consolidated shale and sandstone. Thickness from 650 to 3,800 feet.	Low rugged hills but higher than Toledo formation. Cliffs absent and slopes moderately steep.
Toledo formation 6 Lower middle Miocene	White bentonitic shales underlain by brown carbonaceous shales locally coal bearing; all with limestone lenses.	Low rolling hills and gentle swales, broad V-shaped valleys.
Mount Uling Limestone 7 Lower middle Miocene	Compact thin massive white limestone of about 700 feet thick.	Precipitous mountains, with steep-sided gorges probably underground drainage.
Malubog formation 8 Lower Miocene	Predominantly fine to coarse clastics. In layers of shale and mudstone below; sandstone and conglomerate at middle and carbonaceous shale and coal lenses on top. Thickness ranges from 1,500 to 3,500 feet.	Broad depressions and low smooth, rolling hills.
Cebu Orbitoid limestone 9 Lower Miocene	Hard, impervious, white pure limestone. Thickness from 250 to 325 feet	Ridges and steep cliffs little underground drainage.
Cebu coal bearing 10 Lower Miocene	Sandstone and shale lenses of conglomerate. Lower part with 7 feet coal seams. Thickness from 150 to 400 feet.	Steep slopes and valley bottoms in Central Cebu to high rugged hills in southern part.
Basement complex 11 Pre-Miocene	Igneous and metamorphic rocks of unknown age. Diorite, quartz diorite, andesitic flows tuffaceous rocks. Some metamorphosed into greenstones slate conglomerates, and hard limestone, in part probably cretaceous.	Bold, rugged mountains separated by deep V-shaped gorges.

tide water, but the well-developed ones are in most river mouths. The native vegetation of this type, when grown along the margins of flood plains, serves as a good protection to the shores against the scouring effect of the sea waves.

Mangrove swamps are extensive along the eastern coast of the province between Liloan and Carmen, and on the western coast from Aloguinsan to Toledo. The coastal areas between the Pacificans and Poro Islands of the Camotes Group are likewise wide mangrove swamps. The southern coast of Mactan Island is covered by this kind of vegetation.

Bakauan (*Rhizophora mucronata* Lam. and R. *candelaria D.C.*), api-api, piagao, tabigi, pagatpat, langarai, and nipa palms are the common plants in the swamps. These trees are useful for fuel purposes while the nipa palms are used for thatching materials of houses.

Hydrosol areas when cleared offer good sites for either *bañgos* fishponds or salt beds.

The greater part of the central portion of the island are grassland areas. These grasslands were formerly cultivated areas which were later abandoned and thus covered with cogon grass. Most of the steep mountain ranges on the central part of the province are grass lands. Some of the cultivated fields like those planted to coconuts are also covered by cogon. Except on the northern portion of the province, the cogon plants (*Imperata cylindrica*) in general have a very thin growth with narrow and short leaves. These characteristics of the cogon grass may be attributed to the poor and thin soil on which they grow.

The second-growth forest also occupies a large portion of the soil cover of the Island. Trees in this forest have no commercial value except for firewood. In easily accessible places, the trees are frequently cut before reaching a fairly large size. Such areas are common in the interior regions between Consolacion and Carmen. When the place, however, is hardly accessible, the trees have the chance to reach fairly large size with dense under cover. Second growth molave trees are found in the limestone regions throughout the island but seems to be relatively abundant on the northern part of the province. Although the people clear the area for cultivation, they spare the young molave trees. Low-growing shrubs called *Coronitas* are very common in the open areas of the limestone region on the northern part of the island. Ipil-ipil to a very limited extent are also found growing on many steep slopes of the hills and mountains throughout the island.

The virgin or the primary forest covers only 8.26 per cent of the soil cover of the island. This kind of forest is found only in the inaccessible areas of the south-central part, the central and interior regions between Carmen and Asturias. It is also found in small patches on top of high cliffs and rough mountain lands of the central part of the province. The distribution of the different types of native vegetation is shown in Fig. 3.

Sketched from: ATLAS OF PHILIPPINE CENSUS, 1960

Fig. 3. Vegetation map of Cebu Province.

Some of the common plant association in the primary forest are makaasin, malugao, nato, and white lauan in Odlol; and dunga, sili, ugia, and kahumay-humayan, all in Danao. Tindalo, ipil and narra are mostly found in the interior regions of Toledo. Dita, bagilumbang and kalantas are common in the forest of Dumanjug. Dita is a forest tree commonly used for wooden shoe making in Talisay and in the City of Cebu. Such woods as marig, anubing, apitong, amugis, balete, banuyo, sakat, anislag and yakal, which have commercial value, are found on the central region of Cebu Province.

Although maguey is a cultivated plant, it is oftentimes found growing wild in many areas like those in Bantayan Islands, Camotes Group, Mactan Island and on the northern portion of Cebu and, therefore, seldom cultivated. It is very rare on the southern part. It is often found growing in the rocky areas where the soil is thin.

Organization(4) *and population of the area.*—Long before the discovery of the Philippines by Magellan, the town of Sugbu, now called Cebu, existed as a prosperous native settlement. History shows evidences that the people of Cebu have had contact with and were influenced by the Hindunized Malays from Sumatra, Java, and China.

Inspired by the need of a new trade route to the East, Ferdinand Magellan, in a fleet of five ships sailed on September 20, 1519 from San Lucar, Spain via the Pacific Ocean. On March 16, 1521, Magellan landed on the island of Homonhon where the Spaniards first saw the Filipinos. In their desire to get more food, the explorers further sailed inward and reached the island of Sugbu on April 7, 1521. Rajah Humabon, then Chief of Cebu, welcomed the Spaniards. After the blood compact between Humabon and Magellan was signed, the former and his wife, and many others totaling 800 were baptized by the latter. A large cross was set up in the middle of the square to commemorate the first mass in Cebu where it stands today (Plate 1, Fig. 1).

Opposite Cebu on the eastern side is the Island of Mactan, ruled by a powerful chieftain by the name of Lapulapu, who refused to yield to the Spanish influence. To subdue Lapulapu and all his men, Magellan sent a force on April 26, 1521, to the town of Opon. The invaders armed with lances and body armor fought Lapulapu and his men who were only armed with bamboo spears and cross-bows. In the battle, the Spaniards were repelled and Magellan was killed.

Soon after Magellan's death, the Spaniards sailed back to Spain on September 16, 1522, in a ship (Victoria) commanded by Juan Sebastian Elcano.

Forty-four years after Magellan initiated Christianity in the island, Spain sent another expedition to the Philippines which also met failures. On November 21, 1564, an expedition led by Miguel Lopez de Legaspi with the aid of Andres de Urdaneta sailed for the Philippines and arrived in Cebu on April 27, 1565. There was a change of event when Tupas, the greatest chief of Cebu, acceded to the friendship of Legaspi, between whom a blood compact was signed pledging loyalty, protection, help, and equal shares in the spoils of war between the two leaders. Thus began the colonization of the Philippines by Spain.

The discovery of the Philippines by Spain elicited her rival country, Portugal, to send a series of expeditions to Cebu in the years 1566, 1568, and 1570, to drive away the Spaniards by blockading them; but she never prospered.

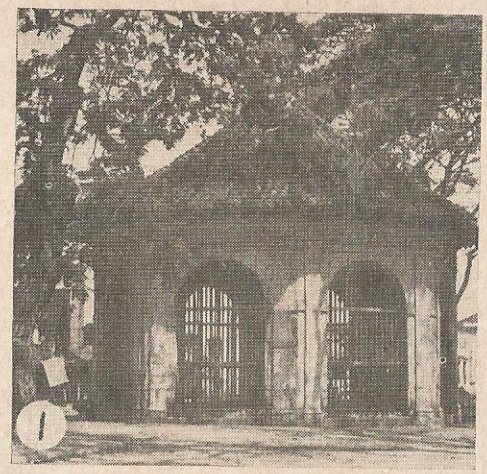
The people of Cebu did not suffer much from the blockade as they did from the frequent attacks of the Moro pirates on most coastal towns, which lasted up to the end of the seventeenth century. This impelled the people to build several watch towers along the southern coastal shores to warn the inhabitants of the approach of the Moros. Some of these towers still stand today.

The beginning of the 17th century was characterized by frequent revolts of the natives. The abuses of the friars; the excessive tribute imposed; depriving the people of the access to the wealth of the natural resources; and the fraudulent way of subdividing the land among the natives enraged the Filipinos to revolt against the Spaniards.

The defeat of the Spaniards by the British in the battle of Manila on October 4, 1762, gave the irate Filipinos renewed effort to revolt against the Spaniards. The people of Cebu participated in this revolt, but were later suppressed by substantial Spanish government forces.

The victory of the Americans in the Spanish-American War in 1898, ended the Spanish sovereignty in the Philippines.

In the Second World War, the Philippines fell under the Japanese Army. The island of Cebu, just as any other province, was placed under the Japanese Occupation Forces from April, 1942 to April, 1945, after which the Americans returned to liberate the Philippines.



This structure in Cebu City houses the cross planted by Ferdinand Magellan upon his arrival in the Islands on April 7, 1521. The original cross which was already partly destroyed by the elements was cased-in by another wooden material.

This is Magellan's monument in Mactan Island, marking the place of his battle with Lapu-Lapu that took place on April 27, 1521 where Lapu-Lapu came out victorious. The incident marked the first Filipino uprising against European aggression.

There was a tremendous increase in the population of Cebu during the 19th century. In 1799 the population of the province was 100,000 and in 1850 it was 389,073. According to the Census of the Philippines, there were 653,727 inhabitants in 1903, 855,065 in 1918 and 1,068,078 in 1938. This dense population coupled with the poor and eroded soils of the province conspired the Cebuanos to migrate to sparsely populated provinces like Cotabato and Davao. Cebu is the most thickly populated province in the archipelago today. In spite of its rugged topography, and eroded and depleted soils, the people

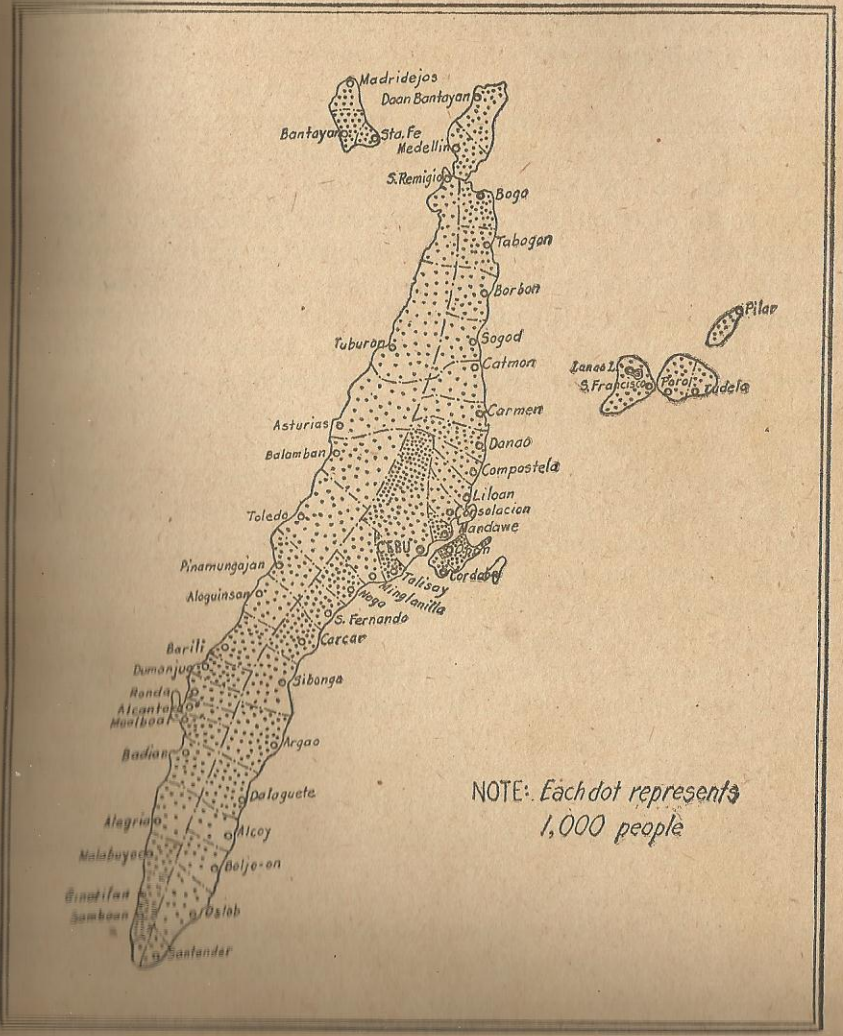


Fig. 4. Map of Cebu Province showing distribution of population in 1938.

in general are happy and prosperous because of the geographical location of the province which favors the field of commerce and transportation.

Transportation and market.—Cebu is one of the provinces in the Philippines that has a well-developed system of land transportation. Roads not only virtually surround the coast of the island but also cross the country. The country being predominantly a limestone area makes road construction and maintenance less expensive. In 1946, a total of 1,130.4 kilometers of road was in use in the province, of which, 832.9 kilometers were first class roads, 160.7 kilometers, second class and 136.8 kilometers, third class. (42)

From Cebu City, Santander, the farthest town on the south, can be reached either through a 133-kilometer road along the eastern coast or through another 154-kilometer road along the western coast via the Carcar-Barili way. Other cross-country roads south of Cebu City are the Argao–Moalboal road, Carcar–Aloguinsan, Talisay–Toledo and Sibonga–Dumanjug roads. Similarly, the northern coastal area is traversed by good roads. Tuburan, a town on the northwestern coast is accessible through a 96-kilometer road via Toledo way or through 100-kilometer road by way of Lugo. With the exception of a few short roads from the coast to the inlands, there are no cross-country roads in any place between Cebu City and Tuburan.

The road north of Lugo continues up to Bogo (km. 101) and farther north to Daanbantayan, the northernmost town of Cebu. The towns of Borbon, Tabogon, San Remigio, and Medellin are each connected by roads from the main highway.

The islands of Bantayan, Camotes, and Mactan also have good system of land communication. Transportation to Bantayan is by launches plying between a 12-kilometer strait from the port of Hagnaya in San Remigio to Santa Fe. Motored sailboats are used between the port at Mandawe to Poro in the Camotes Group. Launches, bound for Opon in Mactan Island are available at any time at the wharves in Cebu City.

At present there is no railroad in operation in the province but before World War II, the Philippine Railway maintained a line from Argao to Danao with Cebu City as the central station. Cebu City is also the center of airways in the South. The Far Eastern Air Transport, Inc.,[1] the Philippine Air Lines, and the Commercial Air Lines[1] operate airway travel to Manila and a

[1] Later absorbed by the Philippine Air Lines.

number of them have connections with Bacolod, Iloilo, Tacloban Malaybalay, Cagayan (Misamis), Dipolog, Zamboanga, Davao, and Cotabato. The airfield is located at Lahug, about four kilometers from the heart of the City. The United States Armed Forces has its own airfield in Mactan Island.

The Port of Cebu City is the second largest in the Philippines. There are three piers and one long berthing space along the waterfront. These piers were badly damaged during the battle of liberation of the island in 1945. Aside from the above-mentioned wharves, other small wharves are also in existence at Naga, Dalaguete, Santander, Dumanjug, and Toledo. These wharves are used only for small ships and launches plying to the neighboring provinces.

The Port of Cebu has been a busy trading center even before the arrival of Magellan. China, Japan, Borneo, and other neighboring countries had made tradings with the Cebuanos principally on such articles as porcelain, iron vases for perfumes, glasses, pearls, iron needles, silk fabrics, fish nets, and umbrellas, and in exchange, the natives exported *kapok, sinamay* (a light fabric made from either maguey or abaca), yellow wax, coconuts, camotes, mats, shells, and betel nuts (4).

The geographical location of Cebu makes her the biggest trading center in the Visayan Islands. Ships from all ports of the Philippines call at Cebu to trade. The port of Cebu was opened to foreign trade as early as 1863. Imported articles are first sent to Cebu before they are distributed to the different islands in the Visayas as well as in northern Mindanao. Likewise, products for export to foreign countries are sent first to Cebu where they are either immediately loaded in big transport ships or kept in big warehouses pending shipment.

According to the records of the Bureau of Commerce in Cebu City, custom collection for 1946 amounted to ₱2,161,428.60. The same source reports the large amount of exports and imports from the port of Cebu. For example, in January, 1946, the export was ₱8,657,923.17, while the import was ₱1,063,199.02. In July of the same year, the export was ₱4,360,602.68, while the import was ₱1,669,008.66.

Cultural development and improvement.—Cebu is a first class province having fifty-three regular municipalities with the town of Cebu as the capital. In June, 1938, the capital was made a chartered city of the Philippines. It is a progressive city with many big commercial houses and banking facilities. Almost all big commercial firms in Manila have branches in this City. Her

progress, however, was impaired because of the Second World War.

Soon after the World conflict, the province began to reestablish itself little by little and with the present trends of commerce, it will not be long for Cebu to make up for her war losses.

The education of the youth in this island is undertaken by both public and private institutions. Aside from the public elementary and intermediate schools found in every town, there are also private schools established by private corporations and Catholic institutions. There are four public high schools outside the city limit each located in Tuburan, Argao, Carcar, and Dumanjug. Privately-owned institutions offering both secondary and collegiate courses are found in the City. Some of these institutions have branches in the outskirts of Cebu. Among the well-known institutions are the San Carlos College, Southern College, Southwestern College, Visayan Institute, and Cebu Institute.

Industries.—Farming is the major industry of the people of Cebu. The aggregate value of agricultural products in 1938 was 12,325,165 pesos. [2]

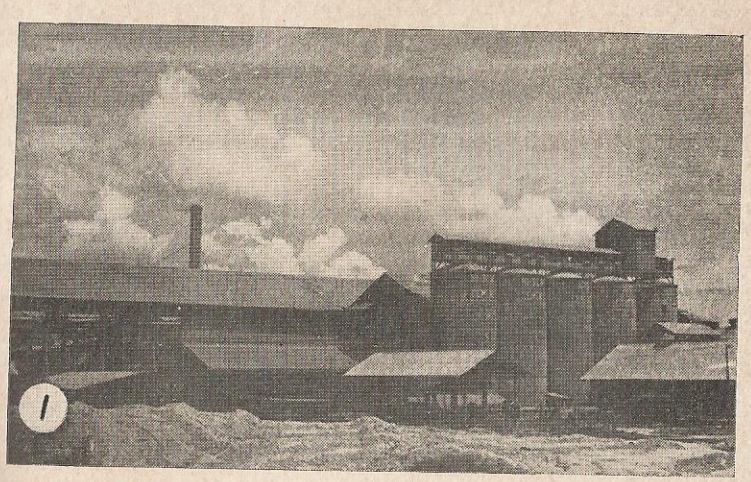
Aside from farming, there are other industries that make Cebu progressive. Among them are the cement manufacturing, coal mining, pot making, blacksmithing, and fishing.

The Cebu Portland Cement is a government factory which is located at Naga, on the southeastern coast of the province, 21 kilometers from the city (Plate 2, Fig. 1). This factory was built in 1923. With the increasing demand for cement, additional units were installed in 1939. The estimated output of the plant is 6,000 barrels a day. Before the war, the factory produced two kinds of cement, namely, the portland cement and a high-silica cement. The raw materials of the cement are obtained behind the factory. Part of the coal used by the plant was imported and the rest was obtained from the Uling Coal Mine, 13 kilometers west of the factory.

It is fortunate that this cement factory escaped the ravage of the Second World War. During the early period of liberation, the factory was operated by the U. S. Army. Later it was turned over to the Philippine Government.

There is at present a great demand for cement and to meet this demand, the factory operates on a full 24-hour basis. In addition to the imported coal and oil, the factory uses for fuel

[2] Census of the Philippines, 1938.



This is the Cebu Portland Cement Factory in Naga. Cheap cement is produced here as Cebu has the necessary raw material, fuel, and labor for the manufacture of good cement.

Cebu ranks second in the production of coal in the Philippines. The coal produced is not of the best kind but it is sufficient to meet local demands, especially for the manufacture of cement.

all the coal obtainable from the different coal mines in the province. In 1940, the Cebu Portland Cement burned 96,071.64 tons of coal, 34,808.9 tons of which were imported and the rest was supplied by the local mines. Only local coal was used in the amount of 20,859.52 tons in 1946. Speaking of output in 1940, the factory produced 861,481 barrels of APO cement and 255,300 barrels of Hi-silik (a barrel contains four bags at 43 kg. a bag). From February of 1946 to February of 1947, the factory produced a total of 1,735,406 bags of cement valued at 6,073,921 pesos.

Cebu is one of the few places in the Philippines that has coal deposits and ranks second in the production of this mineral. Coal was first discovered in Cebu in 1827. There are several coal deposits in Cebu. Only a few were mined owing to the complicated structure of most deposits; the quality deficiencies including spontaneous combustion; the relatively poor accessibility, and the low price of coal at the time which did not warrant mining.

Coal production before 1942 was rather low because of competition from foreign markets. But importation was curtailed as a result of the war. This reduction of import and the excessive demand of the cement plant for coal, sparked a big encouragement in the coal mining business. In 1946, there were eight coal districts in Cebu Province which embraced a total of sixty-three coal mining enterprises. These districts were (1) Cahumayhumayan in Carmen, (2) Northeastern Camansi in Danao, (3) Camansi Proper also in Danao, (4) Mount Licos in Compostela, (5) Toledo, (6) Uling in Naga, (7) Mantalongon in Dalaguete, and (8) Guila-guila, west of Cebu City. The total production of these mines in 1946 was 48,427(28) tons valued at 1,089,607.50 pesos. The average price of the local coal in 1946 was 22.50 pesos a ton.

According to Smith, the principal characteristics of Cebu coal are as follows: Rather soft, crumbling into fine particles upon exposure to air; highly inflammable producing too much gases upon burning; and unless proper care be given on the crate, too much loss in heat and in the amount of unburned coal may be expected. Fair coking coals are found in Guila-guila, Mount Uling, and Toledo.

Blacksmithing or manufacturing of iron implements is one of the industries of the people of Consolacion, Compostela, Bogo, Talisay, Cebu City, and Naga. The principal articles produced

are bolos, knives, plowshares, chairs, and many other iron-wares.

Potmaking from earthen clays is done in Naga, Carcar, Argao, Bogo, Danao, Daanbantayan, and Liloan.

The coastal waters of Cebu teem with marine products. The northern waters of the province, especially around Bantayan Island and the western side of Daanbantayan are the best fishing grounds of Cebu. This area, which is rich in herring, salmon, sardines, and anchovies, is closed to fishing from November 15 to March 15. The sea around Mactan Island is especially rich in crustaceans. The southeastern and western waters, however, cannot favorably compare with the northern portion in terms of fishes, fishing being merely for sustenance purposes and consequently is opened throughout the year.

The artificial culture of fish like bangos is not very extensive. Although fishponds are found in almost all hydrosol areas along the coast, only those at Mandawe, Sibonga, Opon-Cordova, and Pinamungajan are of commercial importance. Bangos fries are obtainable as early as February along the shores of Mactan Island, Dalaguete, and Argao. As the fry requirement of this province is easily met, a large quantity of these fries is sent to Manila. The district Office of the Bureau of Fisheries in Cebu reports the total catch of various kinds of fishes for the year 1946 as follows:

Kind of fish	Kilos	Value in pesos
Toloy (Herrings)	1,242,340	459,665.80
Tabagac (Herrings)	461,865	170,890.05
Haul-haul (Herrings)	5,470	2,023.09
Bolinao (Anchovies)	33,318	12,327.66
Malatindoc (Round Scod)	41,019	15,177.03
Aguma-a (Mackerels)	2,150	795.50
Tamban (Herrings)	560	207.20
Total	1,786,722	661,086.23

Some of the fishes and the fish products are consumed in the province; some are exported to the nearby provinces including Northern Mindanao, but the greater bulk is sent to Manila.

Iron was once produced in a smelter plant in the City before 1942. Iron ores were taken from the mines located on the mountains back of the town, but its operation was never resumed.

Mineral oils, which attracted foreign prospectors, were also reported to be abundant in many parts of the province. Drilling for this oil was interrupted by the war, but the operation was resumed in places of Medellin and Barili. Oils were also reported to exist in San Remigio and Alegria. As a matter of fact, people in these places make use of the oil seeping from some springs for lighting purposes.

CLIMATE

The condition of the atmosphere at any time or place is expressed by a combination of several elements, primarily; (1) temperature, (2) precipitation, (3) humidity, (4) winds, and

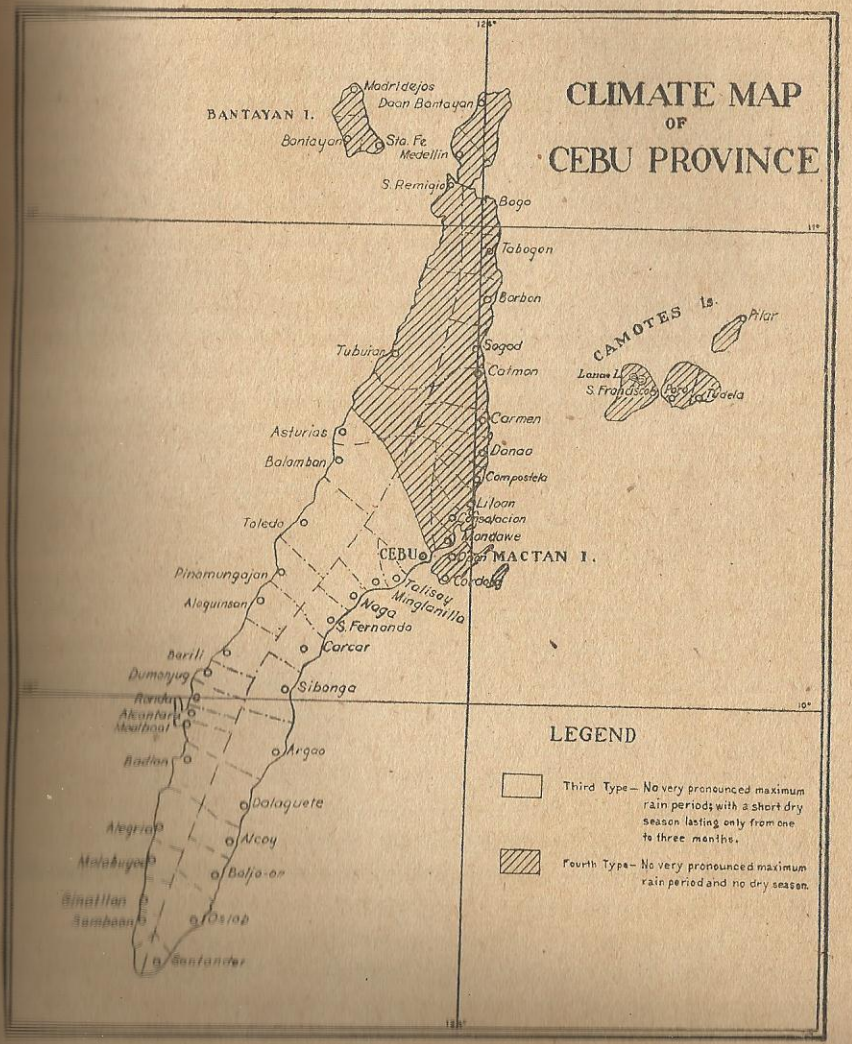


Fig. 5. Climate map of Cebu Province.

(5) air pressure. These elements of weather and climate make up the ingredients out of which various weather and climate types are composed. Weather varies from day to day, and climate differs from place to place because of variations in the amount, intensity, and aerial distribution of the several elements, more particularly temperature and precipitation. The cause for the variation of these elements from place to place and from season to season on the surface of the earth is attributed to climatic controls such as (1) latitude, (2) distribution of land and water, (3) winds, (4) altitude, (5) mountain barriers, (6) ocean currents, (7) storms of various kinds, etc.

Cebu is a long and narrow island extending on a north-south position between the north latitudes of 9° 25′ and 11° 17′. This position places Cebu under the tropical rainforest type of world climate. Under this type, there is a uniform high temperature and heavy precipitation distributed throughout the year, so that there is no marked dry season.

The climatic map of Cebu Province as shown in Fig. 5 indicates two types of rainfall conditions, namely, the third and fourth types. The northern portion of the island of Cebu, including Mactan, Camotes, and Bantayan Islands belongs to the fourth type. This type is characterized by no very pronounced maximum rain period and no dry season. The month of November receives the heaviest rainfall while April receives the least. On the other hand the southern part of Cebu Province falls under the third type, and is characterized by no very pronounced maximum rain period; but with short dry season lasting from one to three months. The distribution of rainfall for the third type, exemplified by the records of Cebu City and that of Mantalongon (Table 4) shows that March to April is the relative short dry season and that the heaviest rains fall in October. The heavy rainfall in October is attributed to depressions, typhoons, and the start of the northeasterly winds. However, rainfalls from June to September also continue up to October since these months are within the typhoon season. Rainfall in August is slightly less than in any other months as the general path of the typhoon is along the highest north. Although the distributions of rainfall in all the weather stations are similar, there are more rain and rainy days recorded at Mantalongon than in any other station in the island. This is so because generally more rain can be expected in regions of higher altitudes than those at lower ones, Mantalongon being about 1,000 meters above sea level.

TABLE 4.—*Showing the average monthly rainfall of four weather stations of Cebu Province (9)*

Months	Third type of climate				Fourth type of climate			
	Mantalongon 1931–1933		Cebu City 1902–1933		Tuburan 1902–1932		Bogo 1919–1932	
	mm.	*days*	*mm.*	*days*	*mm.*	*days*	*mm.*	*days*
January	260.5	26.5	110.9	13.8	155.2	15.1	124.4	16.1
February	142.6	21.0	74.1	10.7	82.5	9.5	68.0	11.9
March	75.2	16.3	49.5	9.4	61.3	9.4	66.7	10.5
April	31.5	12.3	40.1	7.2	34.0	5.0	52.3	6.7
May	115.1	16.5	111.1	10.4	102.3	8.6	118.0	11.0
June	268.8	22.5	167.0	16.1	131.8	13.6	174.5	16.4
July	301.2	19.5	182.0	17.1	146.9	14.0	173.0	16.5
August	130.2	22.0	137.4	15.0	83.6	10.3	141.9	13.7
September	288.0	23.5	175.6	16.1	154.9	13.0	195.2	16.0
October	347.3	24.0	204.8	17.8	210.0	16.0	195.7	17.0
November	211.8	23.7	168.5	15.3	225.2	15.1	224.4	14.9
December	181.3	25.3	131.9	16.0	153.5	16.1	161.0	16.0
Annual	2353.5	253.5	1552.9	164.9	1541.3	146.5	1695.1	166.7

In general, there is almost a uniform distribution of rainfall for any one time in the whole island of Cebu. An exceptional case, however, was the rainfall recorded on November 12 to 13, 1946, wherein for a period of 24 hours, 97.9 millimeters was recorded. This rain which fell on the central part of the province caused heavy destruction to crops, soil, roads, bridges, houses, and lives.

Record of temperature and humidity for Cebu City is shown in table 5. Cebu Province being near the equator consequently lies within the belt of maximum insolation and, thus the temperature will be uniformly high.

Since the sun's noon rays are not far from the vertical position, and the lengths of the days and nights do not vary much from one period of the year to another, it is natural for the annual temperature to be high subject to little variations, so that the differences in temperature for the hottest and coldest parts of the year do not exceed 3 degrees centigrade. May, with a record temperature of 28.1 degrees centigrade is the hottest month while January with a temperature of 26.0 degrees centigrade is the coolest month. The average temperature for the year is 27.1 degrees centigrade.

The daily or diurnal differences in the range of temperature, that is, between the maximum and minimum for the day, are usually 5 degrees centigrade, fairly greater than that of the annual temperature range. The difference of the monthly average of the maximum and minimum temperature for Cebu is 10.4 degrees centigrade. The absolute minimum temperature

recorded in 16 years was 18.3 degrees centigrade in 1905 and the absolute maximum temperature recorded in the same period of years was 35.0 degrees centigrade in 1915.

TABLE 5.—*Showing the average monthly temperature and relative humidity of Cebu City (9)*

Months	Maximum	Normal	Minimum	Relative Humidity
	(°C)	(°C)	(°C)	*Per cent*
January	31.0	26.0	20.9	76.5
February	31.0	26.0	20.9	75.3
March	31.6	26.8	21.3	73.3
April	32.5	27.7	22.6	72.6
May	33.7	28.1	22.9	74.7
June	33.2	27.8	22.6	76.5
July	32.7	27.4	22.6	76.8
August	32.9	27.5	22.5	75.6
September	32.7	27.3	22.4	77.0
October	32.8	27.1	22.4	77.7
November	32.0	26.8	22.0	77.9
December	31.5	26.5	21.9	77.9
Mean annual	32.6	27.1	22.2	76.0

In general, the temperature range of the province is fairly uniform, the slight variation in temperature being influenced by the differences in altitude. The higher the elevation of a place the cooler is the temperature. This usual positive correlation registers a variance of 2 degrees centigrade for every 300 meters rise or fall in altitude. Mantalongon, Camp 7 and some valleys west of Cebu City are typical examples of regions having semi-temperate climate. Semitemperate crops like cabbage, coffee, everlasting, and others thrive well on these places.

The interaction between precipitation and temperature, which is referred to as humidity, produces certain influence upon plant and animal development. The amount of water that transpires from the bodies of animals or plants is dependent upon the relative humidity.

Storms may occur in any month of the year in Cebu, but it is more prevalent from October to November. One or two typhoons may also be expected annually. Typhoons pass more frequently and with greater intensity on the northern part of Cebu than on the southern sections. Although Cebu is below the typhoon belt, typhoons that pass outside the Island are also felt in the province.

The graphical fluctuations of some climatic elements as compared to the climate of the Philippines for the province of Cebu are shown in Figs. 6 and 7.

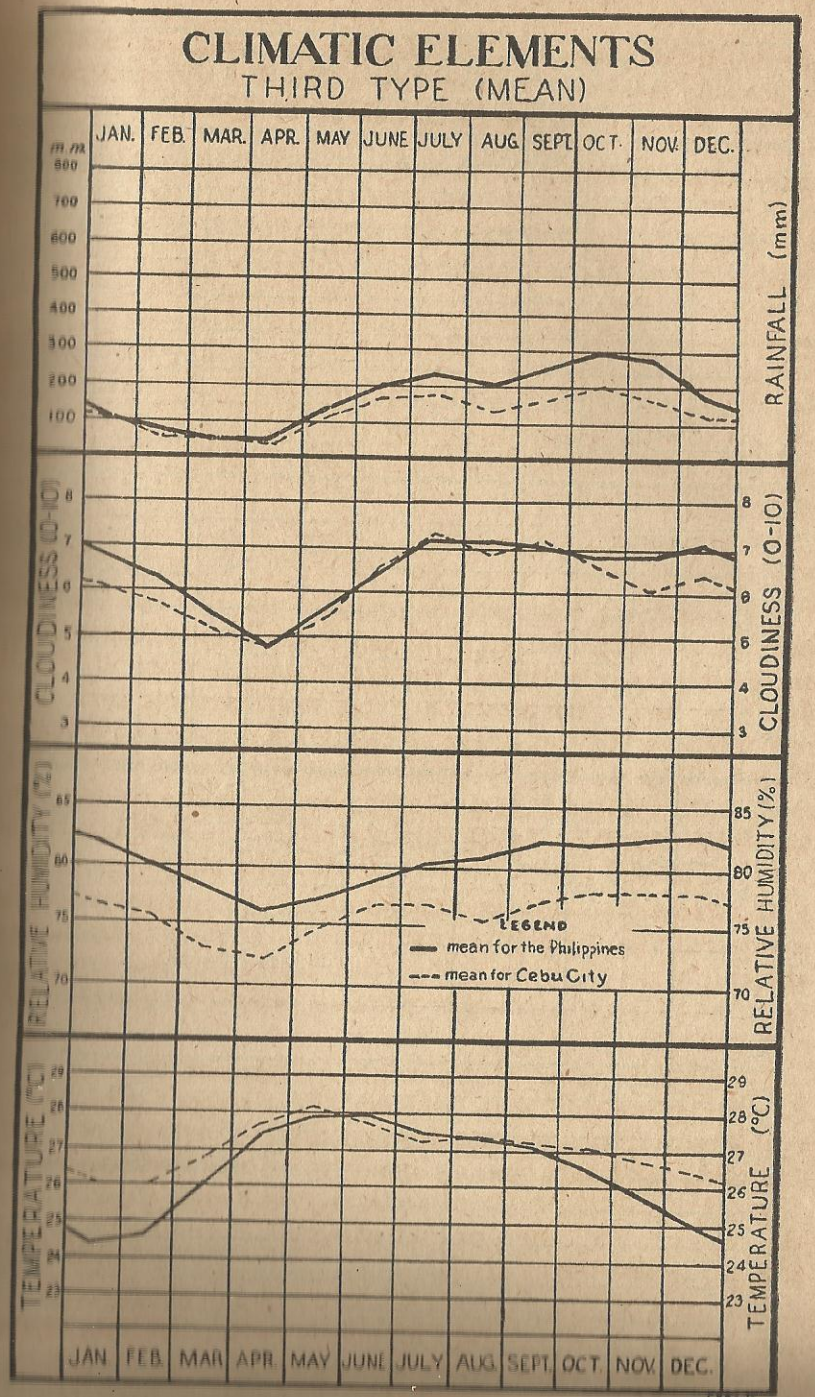


Fig. 6. Graph of the third type of climate of the Philippines and of Cebu City.

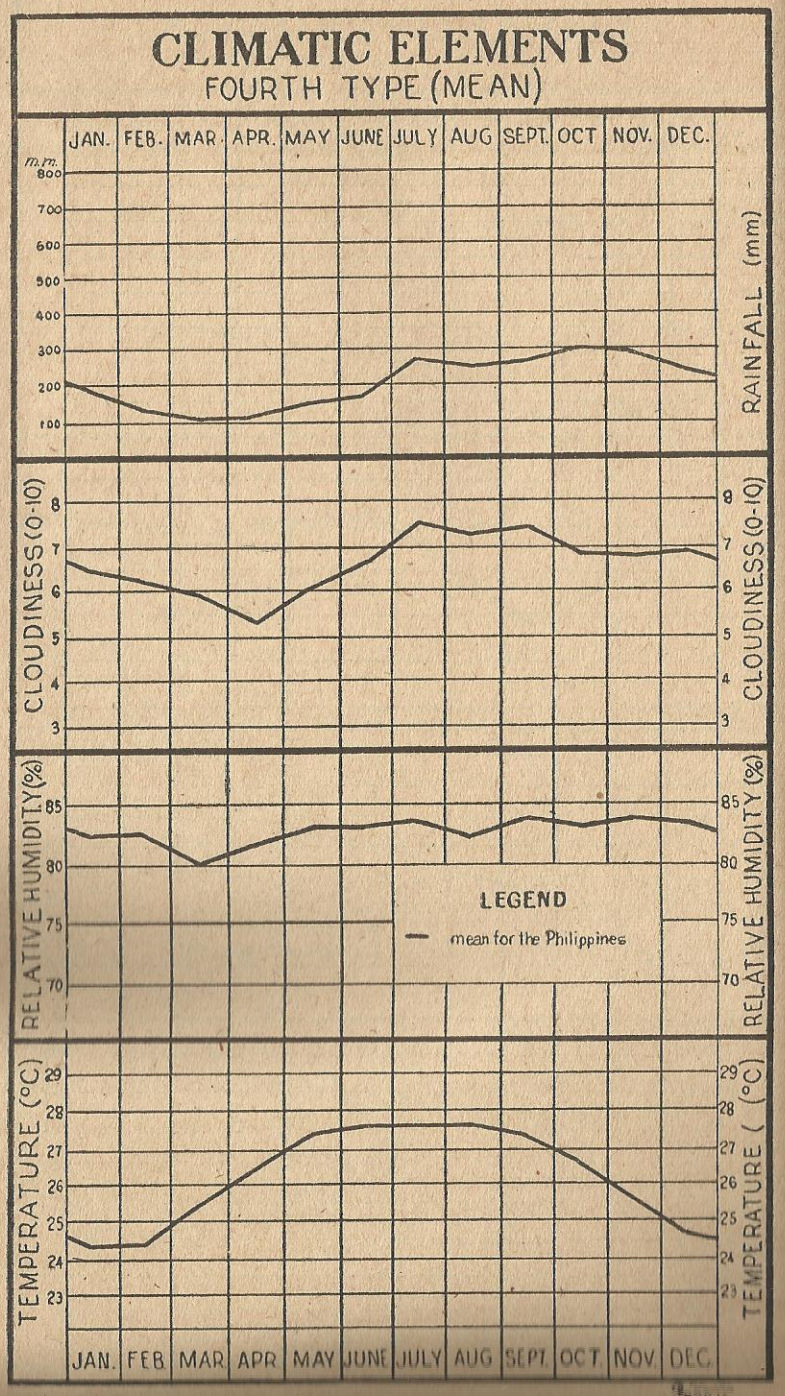


Fig. 7. Graph of the fourth type of climate of the Philippines.

AGRICULTURE

Long before the discovery of the Island of Cebu by Ferdinand Magellan, the cultivation of the staple crops had already been started by the natives and commerce had been flourishing with some Asiatic countries. Bartering was the system of trading employed. The pre-Spanish Cebuanos cultivated rice, sugar cane, coconuts, lemons, garlic, bananas, hemp, millet, panicum, sorgo, ginger, oranges, coconuts, nangcas, and gourds. As trade progressed, other crops like tobacco, corn, cacao, cotton, pineapple, maguey, arrowroot, peanuts, cassava, indigo, and many other crops were introduced into the island from other countries. Thus, from the Spanish to the American regime passed the era of agricultural development in Cebu. This progress in agriculture in some way was influenced by domestic needs and foreign demands for export crops. Shortly after the First World War, there began a great demand for copra and coconut oil abroad, thereby encouraging the planting of more coconut trees. On the other hand, the free entry of sugar into the United States considerably encouraged the rapid growth of the sugar industry in Cebu. Derris, which at one time was in great demand in the United States, was also cultivated extensively. But such demands were short-lived, for not long after the first World War, prices of coconut oil dropped so low that subsequent decrease in export greatly caused the abandonment of some coconut plantations which were ultimately changed to growing of other crops. This was also true of sugar cane plantations. The imposition of oil excise tax and the Sugar Limitation Act further aggravated the development of these two agricultural industries. Cebu, one of the leading coconut and sugar producers as well as the center in the Visayas in the export of these products, was greatly affected by these changes. With the development of better synthetic insecticides in the United States, the demand for derris roots gradually ceased to a point where this crop was altogether forgotten.

The ever-increasing population of Cebu also created attention to increase the production of more food crops. Cebuanos are corn-eating people and naturally, they have a great need for this grain. But due to the limited lands suitable for corn, Cebu has to get supplemental grains from other provinces. It is because of this great demand for corn that unsuitable lands were planted thereby accelerating soil erosion and fertility depletion.

During the Japanese occupation, the growing of food crops in the province became more intensified for obvious reasons and

the cultivation of such crops as maguey, fruit trees, derris and others were stopped.

When the province was liberated in the middle part of 1945, the agricultural set-up of the country was rather unstable. Agricultural problems presented certain difficulties such as the need of seeds and other planting materials, lack of farm implements, and work animals, etc. Agriculture, like any other industries, requires a good program of rehabilitation and readjustment.

CROPS [3]

Cebu is one of the provinces in the Philippines where agriculture is extensively practiced. But despite the collective efforts to increase the production of food crops, the province still imports corn from other provinces to supplement the cereal need of the growing population.

The total cultivated area of the province in 1939 was 139,161.10 hectares or 28.58 per cent of the total area of the province. A great portion of the province is under grassland and only a little portion is occupied by second-growth forest. But as previously mentioned elsewhere, some of these cogonal and second-growth forest areas were placed under cultivation during the enemy occupation and even after the liberation of the Island. At present the cogonal areas are on the roughly rolling and hilly areas of the province.

The ten principal crops of the province are corn, coconut, sugar cane, rice, maguey, tobacco, sweet potato, cassava, abaca, and derris. Other crops like gabi, mongo, ubi, peanut, eggplant, cabbage, fruit trees, and flowers are also grown on commercial scale.

Corn.—Corn is the most important cereal crop of the people of Cebu. In 1938, a total of 81,196.67 hectares representing 57.57 per cent of the cultivated area of the province was planted to this crop. In the same year the total production amounted to 919,365 cavans of shelled corn and 10,306,107 ears of green corn. The total value of this production was 2,655,822 pesos. The 1918 corn production was greater than the 1938 production by 4,458,162 cavans. This decline in corn production in 1938 may be attributed to the decreasing fertility of the land as a result of continuous cropping or to soil water erosion.

[3] Data on the area planted, production, and value of the crops raised were taken from the Census of Philippine Statistics, 1939.

Continuous and intensive cropping of corn on the same area will eventually exhaust its soil fertility. And if planting is done on steep slopes as is common in many parts of the province, soil erosion hazard will be increased. Corn may be grown on a wide range of soil types and climatic conditions. Best results can be obtained on flat, alluvial, undulating to sloping areas having fertile, deep, fine sandy loam to clay loam soils with good drainage. With good soil and favorable climatic conditions, together with sound crop management, a maximum yield of 20 cavans per hectare may be realized. Fertility on corn lands as does in other crop lands can be maintained by fertilization and good cropping system, usually alternating a legume crop as a soil rejuvenator. Otherwise, continuous cropping of corn will seriously drain the soil of its plant food nutrients.

There are two methods of culture used by the Cebuano farmers in the growing of corn, depending on soil conditions. On areas having deep and stone-free soils, the land is plowed and harrowed two or three times during the latter part of January and is planted in the latter part of March or early May. Hand weeding and cultivation of the corn field are done when plants are about one to one-and-a-half months old. Irrigation and fertilization are seldom practiced. The crop matures three to four months after seeding, depending upon the variety of corn planted. After harvesting, the same field is prepared again for the second crop of corn. Although the general practice elsewhere in the Philippines is to plant corn at the start of the rainy season, many farmers in Cebu plant corn anytime they can prepare their fields.

On rolling and eroded upland areas where soils are stony and rocky, the land is "kaiñgined" or thoroughly cleared of weeds and other plant debris with the use of square-pointed bolo locally called "gona". On the early part of April or after the first rain, corn is planted with the use of pointed stick. On severely eroded and rocky areas, corn seeds are planted in limestone rock crevices containing soil. Unfortunately, corn planted on these places does not give fair yield as its production ranges from a few gantas to a maximum of 6 cavans per hectare. In areas where the soil is deep, the production ranges from 5 to 20 cavans per hectare.

In certain places, a system of crop rotation and inter-cropping, is practiced to a limited extent. But this practice does not seem effective as soil-building process in that negligible amount of organic matter is incorporated in the soil because the trashes are customarily burned.

The common varieties of corn planted commercially in the province of Cebu are the white and yellow flint.

The distribution of corn production in 1938 is shown in Fig. 8. The ten leading municipalities in Cebu producing this crop are: Tuburan, Carcar, Toledo, Argao, Balamban, Barili, Cebu City, Pinamungajan, Dalaguete and Tabogon.

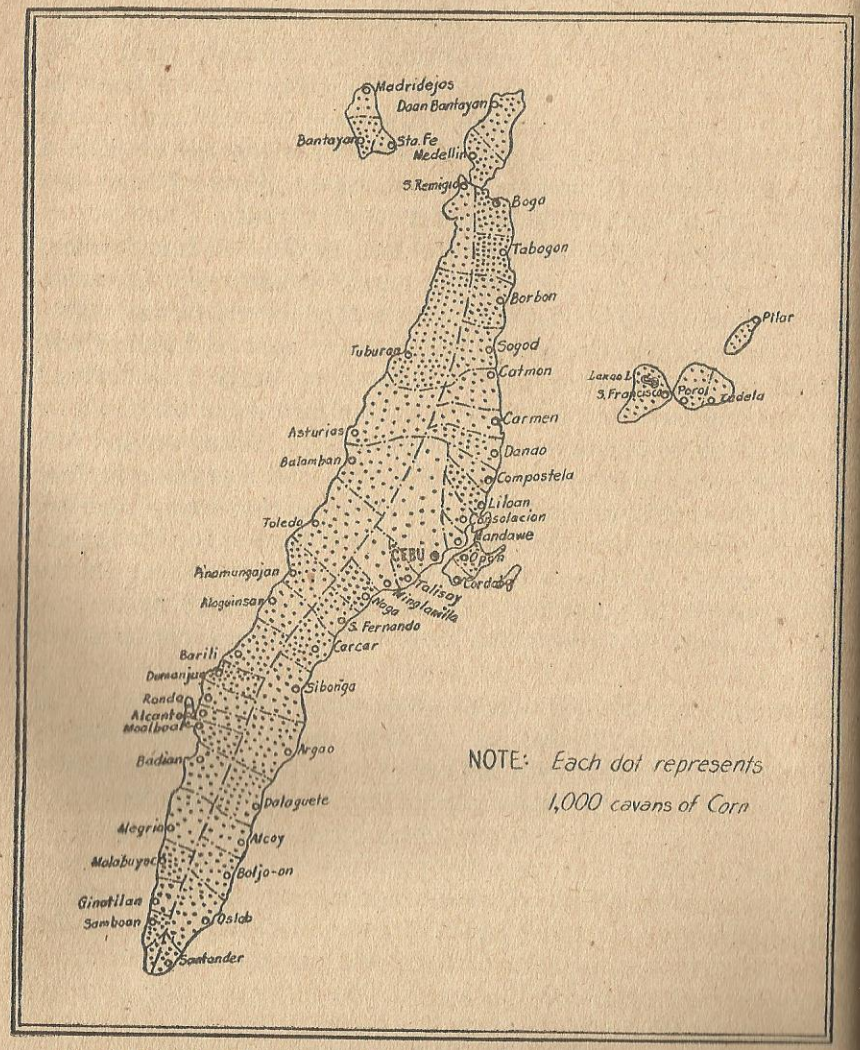


Fig. 8. Map of Cebu Province showing distribution of corn in 1938.

Coconut.—The second ranking agricultural crop of the province is coconut. In 1939, about 39,127.49 hectares or 27.74 per

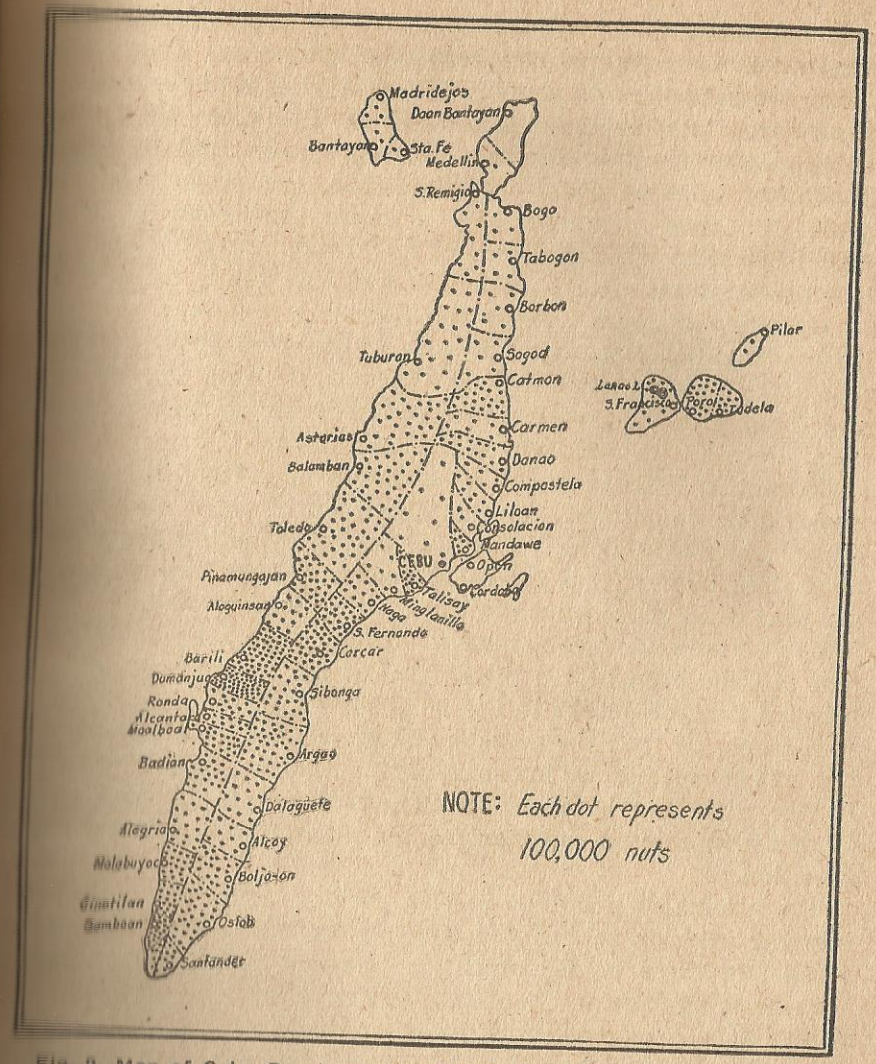


Fig. 9. Map of Cebu Province showing distribution of coconut in 1938.

cent of the total cultivated area were devoted to this crop. In this area, a total of 5,409,926 trees were planted of which 3,073,949 trees had borne 79,023,181 nuts from which the following products were derived:

Copra	kilos	16,024,396
Oil	liters	189,556
For food	nuts	5,574,928

The distribution of coconut production in 1938 is shown in Fig. 9. From the total number of bearing trees, 136,758 trees

were tapped for *tuba* with an output of 19,203,471 liters. The total value of coconut products was 1,542,708 pesos. Comparing the production of copra alone in 1939 with the 1918 production, there seems to be a decline in the output of this important item of export. According to the Census of 1918, Cebu produced 26,423,014 kilos of copra while in 1939, the production was 16,024,396 kilos. This decrease in copra production of about 10,000,000 kilos was attributed to the abandonment of most coconut plantations after the First World War due to the decline in the price of copra. After the Second World War, this industry brightened up again because of the good price of copra offered by foreign markets. The coconut growers actively engaged again in the production of copra by giving their coconut plantations the proper care and management.

Coconut in Cebu is grown on a wide range of soil types and topographic conditions. It was significantly noted that those coconuts growing along the coastal region to within about five kilometers inland from the coast produce 45–80 nuts per tree per year while those grown in the interior areas produce from a few to 30 nuts per tree annually. Coconut has been in cultivation in Cebu even before the arrival of the Spaniards and has been an item of export to the neighboring ports. But despite such length of time the present management of coconut plantation and the techniques in copra making have not been improved. Proper distances of planting, rejuvenation of old trees and other systematic management of the plantations are not given attention.

The growing of coconut in this province has been extended into the interior rolling and severely-eroded areas. The conversion of these eroded areas into coconut plantations rather than devoting them to the culture of short-season crops will help much in the conservation of the soil. Growing fruit trees, ipil-ipil and maguey in between the rows of coconuts will increase the income of the plantation. Other crops that may be planted in the vacant spaces in the coconut plantation are camote, cassava, gabi, ubi, and peanut. Interplanting is practiced in some coconut plantations of the province where the soils and topography of the area warrant.

The ten leading coconut growing municipalities of Cebu Province are Toledo, Argao, Barili, Dumanjug, Asturias, Balamban, Oslob, Badian, Pinamungajan, and Tuburan.

Sugar cane.—This is the third ranking crop of the province. It has been cultivated in Cebu long before the arrival of the

Spaniards. It occupies an area of 7,051.57 hectares or 4.99 per cent of the total area cultivated, producing canes of various types—for chewing, for "panocha," and for the manufacture of centrifugal sugar. In 1939, the total production of the province for "panocha," centrifugal sugar, and chewing canes were as follows:

Panocha	pieces....	1,204,435
Centrifugal sugar	piculs....	383,268
Chewing canes	stalks....	1,350,216

Of the total area devoted to sugar cane in 1939, which was 7,051.57 hectares, 5,059 hectares were utilized for centrifugal sugar production and the rest for "panocha" manufacture and for chewing. The Province of Cebu has two sugar centrals and 187 muscovado mills. Wooden sugar mills run with animal power are still in use in certain places.

Sugar cane like corn grows best on alluvial, deep fertile soil, and well-drained land with almost flat to slightly rolling topography. Cebu Purple is the first native variety used in the culture of canes in this province. High yielding sugar cane varieties like P.O.J. 2878 and 2883 are also successfully planted by the cane growers. The cultural method followed is almost the same as in the other cane growing provinces although the use of tractors and other heavy farm implements is limited only in big haciendas. Generally, the stand of sugar cane in this province is very poor. The cane varieties commercially planted are the P.O.J. 2878 and 2883. Fertilization and manuring of the cane fields are seldom practiced, except on plantations which are under the administration of sugar centrals and big land owners. The rate of application in this area generally ranges from 150 to 250 kilos per hectare of ammonium sulfate, 150 to 200 kilos per hectare of Warner-phos fertilizers. When this survey was made, there was a limited supply of fertilizers, hence, a poor crop of sugar cane. Those areas under the Central gave a production of from 70 to 90 piculs of centrifugal sugar per hectare and the muscovado production ranged from 15 to 60 piculs per hectare.

The ten leading sugar cane towns in Cebu are: Medellin, Bogo, Cebu City, Talisay, Danao, Minglanilla, Mandawe, Naga, Barili, and Carcar.

Rice.—One of the oldest staple crops cultivated in the province is rice. This crop with an area of 4,538.40 hectares (both lowland and upland rice areas) or 3.27 per cent of the total area cultivated in 1939, produced a total of 78,771 cavans

of palay valued at 226,285 pesos. Rice production in 1939 was considerably lower than that obtained in 1918, which was 223,907 cavans.

The lowland culture of rice in Cebu is similar to that of Central Luzon. The field is divided into paddies and is plowed once or twice while saturated, after which several weeks are allowed to decompose the weeds and other plant debris. Oftentimes, the fields are prepared during the early part of the rainy season. After the weeds and other organic trashes are thoroughly decayed and the water is sufficiently deep, the field is harrowed with the use of *suyod* until the soil is completely puddled. The seedbed is prepared in the same manner that the rice field is prepared. Usually a small paddy is used for the purpose. After the soil is well puddled, soaked seeds are broadcast thickly and evenly as in the "Dapog" system. When the seedlings attain the height of about 6 inches or more usually at the age of 15 to 20 days, they are pulled, bundled, and transplanted to the field prepared for them. The water in the field is drained before transplanting. After transplanting, the field is irrigated gradually to prevent the seedlings from drowning and to check the growth of noxious weeds. Weeding is also done after two months to remove whatever weed resisted irrigation water.

On the northern central part of Cebu, the planting season for lowland rice is from May to July and the harvesting season is in December. The second crop of rice is planted a month later in places where there is irrigation water. On the southern part of Cebu, the season for planting is November while harvesting starts in February.

The medium-late maturing local varieties for the lowland are Bug-atan, Malagaya, Caramayan, Cabunay, Caintem, Capatal, and Catadman. The Bureau of Plant Industry of the province has introduced some standard high yielding varieties such as Apostol and Mariposa, both early maturing varieties; Guinangang and Kinawayan for medium-late maturing varieties; and Elon-elon, a late maturing variety. Sipot, a palagad variety of rice and belonging to the medium-late maturing varieties, is also grown. The average production for the first crop of lowland rice ranges from 15 to 25 cavans per hectare while the palagad planting or secondary crop yields from 10 to 15 cavans per hectare.

Farmers of Cebu do not use commercial fertilizers, nor practice crop rotation or any manuring program to build up

soil and improve soil fertility. They noted, however, that continuous cropping of grains is detrimental to the soil. Sufficient irrigation system is another factor which definitely increases crop yields. Good dikes mean more water in the paddies and less weeds.

The upland culture of rice in Cebu is similar to the culture of corn. After the land is prepared, the seeds are broadcast over the field with prepared furrows during the early part of the rainy season (April). The field is then weeded whenever necessary until the crop is harvested 3 or 4 months after sowing. Under favorable conditions, the production for the upland rice ranges from 8 to 12 cavans of palay per hectare.

The ten leading municipalities growing rice in the province are: Lowland rice—Carcar, Argao, Toledo, Liloan, Mandawe, Cebu City, Dalaguete, Talisay, Ronda and Tabogon. Upland rice—Daan-bantayan, Poro, Cebu City, Tudela, Pilar, Dumanjug, Catmon, Tuburan, San Remigio and Medellin.

Maguey.—One of the economic plants introduced into the Philippines from tropical America through the Galleon Trade is maguey.

During the early days, the natives grew this crop, the fibers of which are woven in native wooden looms into garments. Maguey is a widely propagated fiber crop of the province. The total area grown to maguey in 1938 was 4,230.02 hectares or 3.00 per cent only of the total cultivated area of the province, which yielded 2,993,445 kilos of fiber valued at 148,063 pesos.

Most of the maguey crops are grown on the rocky limestone regions of the province. The land which is generally rocky, hilly to mountainous is first "kaiñgined" and cleared before the suckers are planted at the rate of one sucker to a hill during the early part of the rainy season. The crop matures one year after planting. The mature leaves are cut close to the base, bundled and soaked for several days in salt water until the leaves become soft, after which, they are beaten to remove the pulpy material. The fibers thus left after beating are washed, dried, and bleached in the sun. The bleached fibers are then bundled into bales for export. The production of maguey ranges from 400 to 1,000 kilos of fiber per hectare.

At present, maguey fiber commands a good price in foreign markets. Because of the increased demand for maguey fibers, the farmers restored their old maguey plantations that had been previously abandoned. Most of the fibers exported are utilized for rope manufacture. Cloth weaving of the fibers

was done during the Japanese occupation due to the scarcity of cotton cloth. However, when the trade was resumed after liberation, the influx of cheap imported cotton cloth successfully threw the home-weaving industry out of competition. Only the local home-manufactured ropes from maguey was continued in the province.

The ten leading towns producing maguey are: Daanbantayan, Opon, San Remigio, San Francisco, Bogo, Medellin, Cordova, Tudela, Liloan and Tabugon.

Tobacco.—Another important crop brought to the islands through the Galleon Trade from Tropical America is tobacco. This crop thrives well under the soil and climatic conditions of the islands.

According to the Census of 1939, the Province of Cebu devoted 3,543.94 hectares or 2.51 per cent of her cultivated area to tobacco and produced 1,969,793 kilos of cured leaves valued at 152,287 pesos. Unfortunately, tobacco like some other export products did not survive the stress of foreign competition as shown by the fact that in 1918, the total production of 3,639,658 kilos decreased in 1939 to 1,969,793 kilos or a difference of 1,669,865 kilos. At present, tobacco farmers seem to have lost the incentive of planting bigger areas for export purposes, except in planting sufficient area to supply the local market.

With regard to the culture of the crop, there seems to have been profound changes in the method of culture from the time it was introduced into the island up to the present day, especially in the preparation of the land, distance of planting, seeding, harvesting, curing method, varieties, and other cultural operations. Such changes were brought about in the hope to increase the unit and cost of production. The land is prepared similar to the preparation of land for corn. Partially shaded seedbeds are usually prepared on fertile and sterilized soils, the size depending upon the area of the field to be planted. Tobacco seeds mixed in equal amount of fine wood ash are sown evenly over the well-pulverized soil of the seedbed and covered with a thin layer of fine soil, and moderately pressed. The seedbed is kept moist to hasten germination. Seedlings that are thickly sown are pricked to another prepared seedbed to allow more room for their growth. Transplanting is done in the latter part of November or in early December when the leaves of the seedlings are about ¾ centimeter wide. Cultivation like weeding is done by farm

hands with the aid of the native implement (gona). However, hilling up is done with the use of the plow and work animals. Worms are handpicked early in the morning. When the plants are about to bloom, the flower buds are nipped off to induce better production of leaf tobacco. The side shoots are also removed. The leaves are harvested by priming which usually starts with the sand leaves when the latter turn yellow. Subsequent harvesting of the other leaves is done depending upon the degree of leaf maturity. Poling and drying of the leaves go hand in hand with harvesting. Drying of the leaves is done either in the shade or directly in the sun. The dried leaves are bundled into "manos" or hands and are piled for curing. Aging the tobacco leaf further assists in the production of better quality product.

During the survey of the province, the planting of this crop is not as extensive as that reported in the Census of 1939. Tobacco when planted on old worn-out land is certainly poor and could not promise a good crop unless well-balanced commercial fertilizers or other soil amendments are applied. However, newly opened land may produce a good stand of tobacco crop (Plate 3, fig. 1).

The following local varieties of tobacco are grown for the *batek* leaf tobacco production, namely, Magsilang, Caloyloy, Casites and Cantong. Standard varieties like the Simmaba and White Burley were tried in this province but did not prove profitable. The production of this crop ranges from 300 to 800 kilos of dry leaves per hectare.

The ten leading towns of the province which are noted for its tobacco are: Borbon, Sogod, Tuburan, Tabogon, Asturias, Balamban, San Remigio, Carmen, Carcar and Bogo.

Camote, cassava, gabi, ubi, and other root crops.—Most of the root crops now raised in the province were introduced from Asia by the Malayan traders and by the Spaniards from Tropical America. These crops are raised mainly for food purposes. The root crops raised with their respective areas, productions and values are as follows:

Crop	Area (*Ha.*)	Production (*Kg.*)	Value (*Pesos*)
1. Camote	3,387.95	4,205,949	89,961.00
2. Cassava	2,201.10	3,266,468	61,991.00
3. Gabi	658.01	959,126	27,956.00
4. Ubi	590.27	947,486	31,035.00
5. Tugue	63.03	111,362	4,050.00
6. Ginger	5.20	4,338	187.00
7. Potatoes	8.91	8,332	990.00
8. Derris	702.81	135,646	38,886.00

Root crops planted on small areas as in backyards are intended only for home consumption. Irish potatoes and derris are of recent introduction to the country. Commercial planting of derris had been started a few years before the war, but due to the dull prospects in the market, this industry is now abandoned.

The culture of root crops are relatively similar to the culture of corn except with some variations in the distance of planting, depending on what kind of root crop is grown. For instance, camote and derris are planted one meter between rows and 30 to 50 centimeters between hills in the row. Weeding is done by hand, and hilling up, with the use of a plow and draft animal. In stony areas where plowing is not convenient, cultivation is done with the use of native implement called "gona". Camote and cassava are propagated commercially by stem cutting while gabi, ubi, potato, and arrowroot are propagated by suckers and eye cuttings.

The average production of these root crops per hectare in this province is as follows: cassava, 500 to 2,000 kilos; camote, 800 to 1,500 kilos; derris roots, 100 to 200 kilos; ubi, tugue, and gabi, 1,000 to 1,700 kilos; ginger and potatoes, 300 to 1,000 kilos.

The following are the ten leading towns producing major root crops commercially:

Camote—Dalaguete, Argao, San Francisco, Badian, Tuburan, Poro, Daanbantayan, Borbon, Pilar and Moalboal.

Cassava—Opon, Santa Fe, San Francisco, Daanbantayan, Tabogon, Argao, Medellin, San Remigio, Poro and Bago.

Gabi—Poro, Cebu City, Badian, Argao, Asturias, Balamban, Moalboal, Tuburan, Pinamungajan and Talisay.

Ubi—Tudela, San Francisco, Tabugon, Tuburan, Poro, Cebu City, Argao, San Remigio, Borbon and Catmon.

Derris—Barili, Toledo, Minglanilla, Opon, Medellin, Bogo, Danao, Cebu City, Naga and Tuburan.

Abaca.—One of the abandoned fiber crops of the province is abaca. In 1938, it occupied an area of 745.54 hectares or 0.54 per cent of the total cultivated area of the province with a total output of 362,850 kilos of fiber valued at 32,976 pesos. This production is less than one-tenth of the abaca production of 1918 which was 3,959,215 kilos. The normal production of this crop ranges from 200 to 600 kilos per hectare.

The abaca industry is the most neglected enterprise in the province. The decline of the industry began in 1920, and

Most of the tobacco crops of Cebu come from the northern towns. Good size crops like the one shown above taken in Luyo, are planted in the latter part of November and are ready for harvest in February.

Maguey is commonly grown in the red soils of Cebu, such as those found in the northern part of the island, in Bantayan, Mactan, and Camotes Islands. These areas, abandoned during the war, are consequently engulfed by cogon.

gradually dwindled until the lands which were once planted to abaca were converted to the growing of some other crops. It is probable that this change was due to soil depletion, because of the exploitative way of farming followed. Consequently, the general stand of the plants did not warrant any further investments and the farmers' concentrated efforts were diverted to the production of food crops.

The ten leading municipalities in the production of this crop are: Daanbantayan, Argao, Badian, Carmen, Boljoon, Minglanilla, Alegria, Alcoy, Dalaguete, and Cebu City.

Mungo, peanuts, soybeans, and other dry beans.—Legume is generally grown for its green pods, but very few farmers are aware of its soil rejuvenating effects when plowed under as green manure. Leguminous crops may be grown as main crop, catch crop, inter-crop or as green manure crop. The province grows several kinds of legumes. The most important ones are peanut, mungo, soybeans, and other dry beans. The area planted, production, and value of each crop are shown below as follows:

Legume	Area (*Ha.*)	Production (*Kg.*)	Value (*Pesos*)
1. Mungo	607.59	130,713	15,142.00
2. Peanuts	311.32	125,722	9,714.00
3. Soybeans	13.09	7,577	1,293.00
4. Other dry beans	69.80	29,161	3,696.00
Total	1,001.80	293,173	29,845.00

There are certain limiting factors necessary for a successful legume production. Two of the most important limiting factors needed are correct soil reaction and right kind of legume bacteria. Cebu soils are generally not fertile as shown by the growth of crops in the field as well as the results of chemical analysis obtained. The poor condition and color of the plants speak of the organic matter and mineral deficiency of the soil.

In Cebu, the planting of legume is done as follows: The field is plowed and harrowed several times until a good tilth is attained. Furrows usually 60 to 80 centimeters apart are laid out. In rolling areas where plows can not negotiate the terrain, the area is just "kaingined" and cleared with native implements. Seeding and distance of planting vary depending

on the kind of legume and time of planting. The following planting calendar for legume in Cebu may be given:

Legume	Seeding time	Harvesting time
1. Mungo	November to December	March and April
2. Peanuts	April and May	September
3. Soybeans	November	March
4. Other dry beans	Any time of the year. Usually planted in kaingins or upland areas as catch crops.	

Generally, legume crops are planted as inter-crop for crops like corn, camote, cassava and other cultivated plants. According to field results, the production of mungo per hectare ranges from 1 to 7 cavans; peanuts—2 to 14 cavans; and for dry beans—2 to 10 cavans. The wide variations in the production of legume might have been due to the differences in soil types where the crops were grown.

The ten leading municipalities of the province in the production of legumes are:

Mungo—Santander, Oslob, Dumanjug, Carcar, Samboan, Tuburan, Toledo, Medellin, Moalboal and San Remigio.

Peanuts—Daanbantayan, Liloan, Tabogon, Carcar, Barili, San Remigio, Compostela, Bantayan, Sibonga, and Argao.

Dry beans—Malabuyoc, Dumanjug, Argao, Alegria, Cebu City, Catmon, Barili, Samboan, Dalaguete and Borbon.

Fruits trees, vegetables, and other crops.—The perennial and annual crops of Cebu are so widely diversified in that nearly all kinds of crops—fiber, food or ornamental, are grown either commercially or for home consumption. Other important crops which are worth mentioning are eggplant, pineapples, cotton, tomatoes, watermelons, onions, ampalaya, upo, cabbages, pechay, lettuce, malungay, forage grass, buyo, pepper, garlic, squash, biga, lemon grass, and many others. These crops cover approximately 1,122.97 hectares with a total production value of 90,702 pesos.

The Census of 1939 gives the following agricultural statistics:

Crop	Area (*Ha.*)	Production	Value (*Pesos*)
1. Eggplant	255.15	1,452,174 fruits	3,495.00
2. Pineapple	99.96	134,826 fruits	3,506.00
3. Cotton	25.12	10,422 kilograms	810.00
4. Tomato	55.92	92,613 kilograms	5,677.00
5. Watermelon	3.47	14,309 fruits	509.00
6. Onion	83.98	55,665 kilograms	6,822.00

Crop	Area (*Ha.*)	Production	Value (*Pesos*)
7. Ampalaya	5.38	17,726 fruits	139.00
8. Upo	1.22	1,857 fruits	144.00
9. Cabbage	111.74	170,803 kilograms	24,003.00
10. Buyo	.03	3,176 kilograms	148.00
11. Forage grass	90.73	913,374 bundles	25,190.00
12. Biga (palauan)	37.91	35,875 kilograms	659.00
13. Squash	30.15	74,431 fruits	5,798.00
14. Pepper (black)	3.17	4,979 kilograms	2,082.00
15. Garlic	21.11	14,322 kilograms	3,266.00
16. Malungay[a]	281.00	321,829 kilograms	7,378.00
17. Libato	9.74	23,462 kilograms	494.00
18. Radish	1.04	3,004 kilograms	269.00
19. Chile (red pepper)	3.40	2,770 kilograms	598.00
20. Pechay	2.75	4,391 kilograms	373.00
Total	1,122.97		91,360.00

Cabbage, pechay, cauliflower and other temperate vegetables have commercial potentialities in certain highly elevated places of the province, thus in the Mantalongon area in Dalaguete, cabbage, lettuce, pechay and other temperate-vegetable crops are raised profitably.

In the field of horticulture, bananas, jackfruits, mangoes, papayas, cacao, oranges, lanzones, kalamansi, breadfruit, seniguelas and other fruit trees give good income to the farmers of Cebu. On the basis of the favorable stand of the different fruit trees in the field, the feasibility of raising bananas, citrus, mangoes, lanzones, and jackfruit commercially is promising. Bananas in particular seem to be very well adapted when grown on nearly all the calcareous soils of Cebu as the fruits produced are bigger and of better quality. Manila is one of the best markets of Cebu bananas. The mangoes of Cebu usually demand a higher market price because of its early fruit production induced by sound horticultural management. To safeguard excessive erosion in the rolling, hilly and mountainous areas, the planting of fruit trees with a cover crop is very ideal. The conversion of submarginal, eroded and rolling lands under Faraon and Bolinao soils into citrus orchards under good systematic management may bring forth good results both in production and protection against further soil washing.

[a] Representing 112,201 trees.

The following are the ten leading fruit trees of the province from which fruit growers derived good income:

Fruit tree	Total number planted	Production	Value (*Pesos*)
1. Banana	2,543,205 hills	1,591,389 bunches	340,700.00
2. Jackfruit	114,101 trees	577,428 fruits	90,521.00
3. Mangoes	39,992 trees	3,468,050 fruits	79,485.00
4. Papayas	207,065 trees	4,165,350 fruits	71,048.00
5. Cacao	68,666 trees	21,511 kilograms	12,394.00
6. Pumelo	24,359 trees	673,624 fruits	11,120.00
7. Oranges	31,109 trees	688,930 fruits	10,825.00
8. Breadfruits	23,804 trees	619,027 fruits	9,723.00
9. Lanzones	15,081 trees	84,265 kilograms	9,660.00
10. Kalamansi	15,448 trees	8,520 "Kaings"	9,333.00

AGRICULTURAL PRACTICES

The transition from the use of primitive and wooden farm implements to the employment of mechanized implements such as tractors, disc plows, disc harrows, etc., reflects an indirect measure of the farmers' ingenuity and resourcefulness in farming enterprise. Farm practices such as crop rotation, contour cropping, strip cropping, intercropping, catch-cropping, fertilization, terracing, and irrigation are being done today. Our present agriculture is unlike a mining enterprise wherein the miners simply get all the ore available in the area. A farmer who does not return what his plants and animals get from the soil is doing an exploitative way of farming, which would certainly impoverish soil fertility. Farming should be run on a mutual "give-and-take" basis in so far as the soil and the harvested crop are concerned.

Crop rotation is one of the methods of maintaining soil fertility, especially where a legume crop is included in the rotation. In Cebu, the system of rotation followed is exhaustive and not in conformity with the principles of a good rotation system. The typical rotation of crops in this province is to plant corn, followed by sugar cane or rice or tobacco, and then by camote. In some instances, corn is followed by mungo or peanut. But in most cases, continuous cropping of corn is practiced on the same area throughout the year. Such system of agriculture no doubt would mean a rapid exhaustion of the soil fertility.

Strip cropping is rarely practiced in this province. In the first place, the topographic and climatic conditions of Cebu prohibit the intensive cultivation of the soil in the upland

area. These places need strip cropping. On the other hand, the fractional land ownership also makes the execution of a good strip cropping system impossible. Big landowners, however, are in a better position to practice strip cropping on their land in order to conserve their soils.

Inter-cropping and catch-cropping seem to be extensively practiced to increase the return per unit area. The planting of corn with peanuts, corn with mungo, corn with camote, etc., are the common combination of crops planted. The increased return per unit area corroborates the findings in the College of Agriculture that, while it is true that there is a decrease in corn production, such decrease is more than compensated by the value of increase of the intercrop.

On rolling lands, despite the fact that contour planting is followed, rill and sheet erosions occur. Soil washing in these areas cannot be totally prevented because of the erodibility of the soil, heavy rainfall, conditions of vegetation, and the steepness of slopes of the land (Plate 4).

The use of commercial fertilizers for improving soil productivity is commonly done on sugar cane lands that are under the management of sugar centrals. The common fertilizers used by the sugar cane farmers are ammonium sulfate applied at the rate of 150 to 250 kilos per hectare and Warner-phos at the rate of 150 to 200 kilos per hectare. The average production of 75.75 piculs of centrifugal sugar per hectare in Cebu is somewhat lower than the average production in the other cane-producing provinces like Negros Occidental and Negros Oriental where the sugar cane farmers apply at least 500 kilos of commercial fertilizer per hectare. Fertilization of cereal crops like corn and lowland rice has not yet been tried in the province. It should be stated that fertilizing the land is one of the methods by which a substantial increase in crop production can be realized in a short time.

Terracing, which has been started probably during the Spanish time, is also one of the most essential agricultural practices in Cebu. This tool of conservation farming is particularly done in the culture of lowland rice with properly constructed dikes to hold uniform depth of water in the rice paddy. The size of the paddy depends upon the topography of the land. Obviously, steeper slopes will have more but smaller paddies. Every planting season, the dikes are repaired.

Terracing is also done on the upland areas to prevent soil erosion. The dikes are made up of stones, trashes, twigs or pieces of wood and earth compacted along the contours at few meters interval (Plate 4, fig. 2). Another measure done to check runoff is to plant ipil-ipil on contours. It must be borne in mind that the conservation measure thus followed is designed not to completely check soil erosion but to assist in diminishing the hazards of soil erosion.

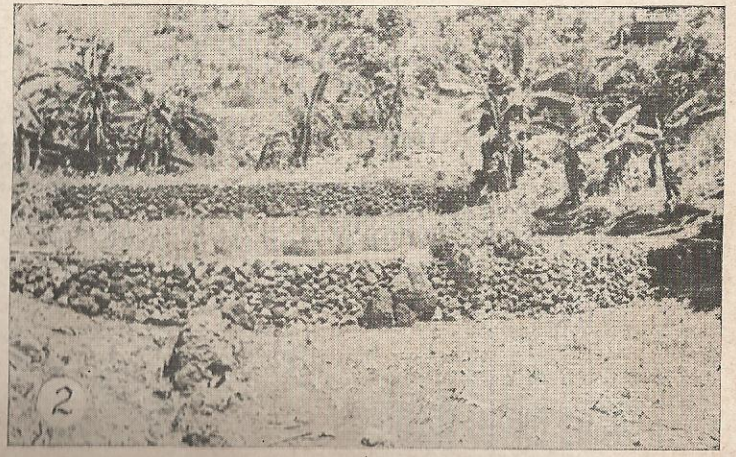
Irrigation water is supplied only on lowland rice areas by gravity from the creeks or rivers. In Cebu Province, there are no government-owned or corporation-owned irrigation systems. The rice farmers cooperate in constructing dams across the creeks or small rivers to divert the water through canals into the rice paddies. Under Cebu climate, crop failure due to drought is not to be feared of, as there is sufficient water to produce even two crops of lowland rice a year. The total area of ricelands under irrigation is 1,879.97 hectares.

One of the most destructive agricultural practices of the upland farmers in Cebu is the kaiñgin system of farming. This practice has caused severe erosion on mountain tops and steep hillsides. It did not only make these lands unfit to agriculture but, because of the cutting down of the forest trees and other native vegetations, a change in the environment, especially climate of the locality has been brought about. Similarly, nothing else could hold or impede water runoff and, therefore, destructive floods oftentimes occur on the lowlands. This system of farming must be totally discouraged and stopped because of its deleterious effects on the soils and crop yields and on the value of destroyed timber trees.

LIVESTOCK AND POULTRY INDUSTRY OF CEBU PROVINCE

Agriculture in the province is not confined to crop farming alone for her livestock and poultry industries are just as well developed. The province is well known for its cheap chickens, eggs, and hogs. Thousands of chickens and boxes of eggs are being shipped by steamers to Manila every week. This trade in poultry was very progressive before the war and remains to be so after liberation. At present, eggs are oftentimes sent to Manila by transport planes. Hogs of Cebu find good market in Davao City. The distribution of hogs and chickens is shown in Fig. 10 and Fig. 11, respectively.

Upland soils like the Lugo clay, if planted continuously to crops without resorting to erosion control measures, may soon lose their value due to soil erosion. Note that the crops are planted down the slopes. The white areas in the background are seriously eroded soils showing part of the substratum exposed.



A system for erosion control is also followed. Small valleys are protected from soil washing by piling limestone rocks across, as may be seen in the above picture.

PLATE 4.

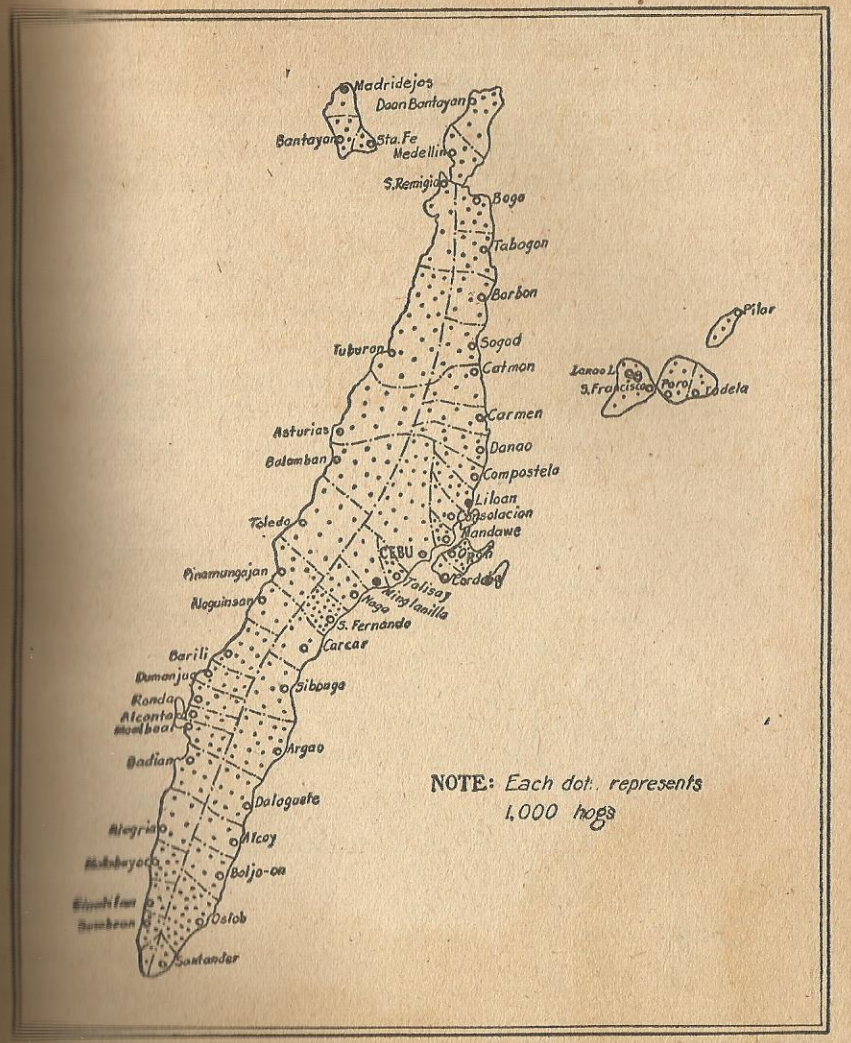


Fig. 10. Map of Cebu Province showing distribution of hogs in 1938.

The animal industry of Cebu like any other industries in the Philippines suffered tremendous losses as a result of World War II. A large number of the animals were commandeered by the enemy and some were killed for local consumption. The percentage of animals slaughtered during the Japanese occupation was much higher before the war. The importation of animal products during the war was cut off so that the local supply was increased to meet the demand. Whatever animals survived the war became the foundation stock of the industry in Cebu after liberation.

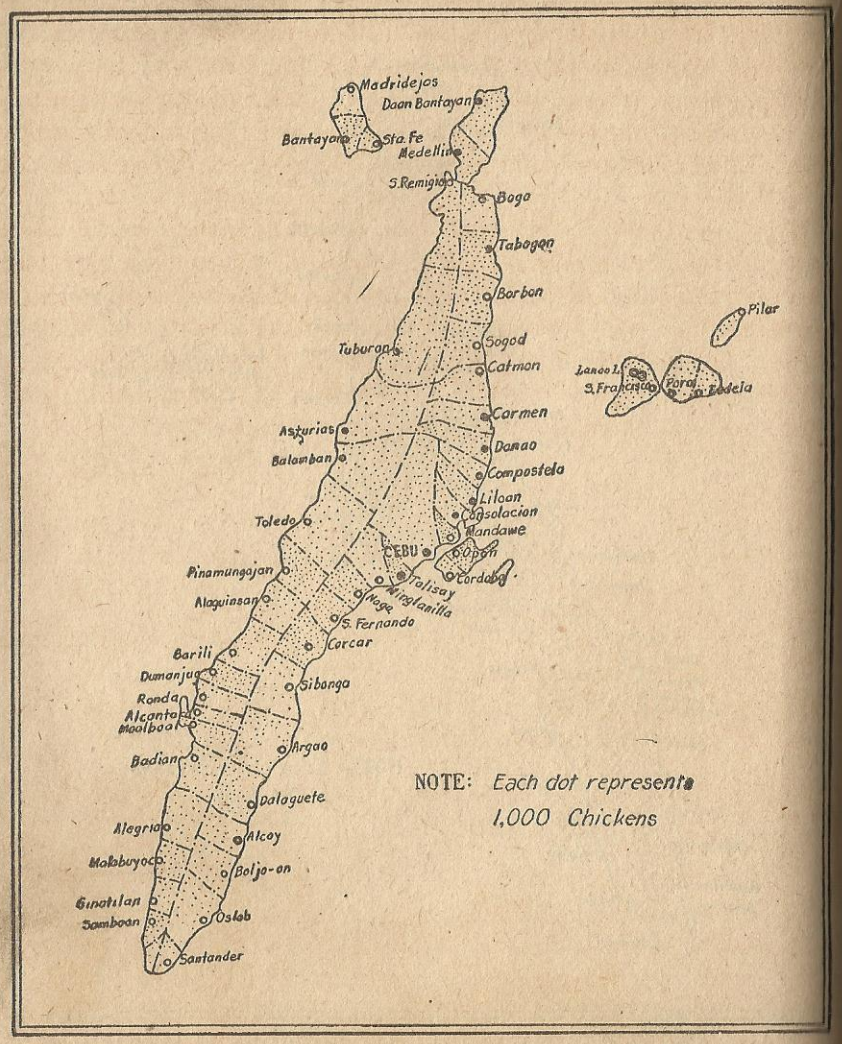


Fig. 11. Map of Cebu Province showing distribution of chickens in 1938.

According to the partial report of the Bureau of Animal Industry in Cebu, the number of animals in twenty municipalities of Cebu that survived the war is as follows:

Livestock	Existing	War losses
Carabao	7,162	3,877
Cattle	2,999	2,059
Horse	1,471	755
Hog	14,546	13,813
Sheep and goat	5,370	3,727
Poultry	70,938	126,058
Others	516	974
Total	102,702	151,288

Despite the absence of good grazing lands in Cebu, a large number of animals are raised. The animal population of Cebu is shown in table 6. Livestock farming and crop production make a good combination for a profitable agriculture in the sense that plant by-products are used by animals while the latter's by-products are decidedly used by plants to advantage.

The province has started the dairy industry on a commercial scale but because of the war all of the animals and the dairy equipment were destroyed. Imported dairy cattle were used on one of the dairy farms on the northern part of Cebu. Local production of milk from individual farmers in 1939 totaled 5,826 liters. The following shows milk production from the different classes of animals:

	Liters
Carabao	5,293
Cattle	451
Goat	42
Total	5,786

After the war, steps were taken to rehabilitate the livestock industry. Government institutions, especially the Bureau of Animal Industry have imported good breeds of animals like poultry and hogs for breeding purposes.

TABLE 6.—*The kinds and breeds of livestock in Cebu Province showing their population and value, 1939*[10]

Livestock	Total number of livestock	Value in pesos
Carabaos	99,645	2,203,472
Cattle	73,023	914,768
Hogs	393,922	2,339,278
Horses	12,099	191,804
Goats	80,426	125,976
Rabbits	265	.....
Sheep	931	2,378
Buffaloes	4	220
POULTRY		
Chickens	1,666,387	520,263
Eggs	3,010,450	.....
Ducks	6,090	3,722
Eggs	7,899	.....
Turkeys	2,928	6,286
Geese	521	803
Pigeons	11,885	2,283
Guinea fowls	756	824

LAND-USE CHANGES

Since the settlement of the island, farming has been a system of taking from the soil all what it could without returning to the soil what it got. The farmers have never thought of improving the land for better crop production not only for their immediate needs but also for the generations yet to come.

It is a fact that soil is the most important natural source of wealth. The maintenance of its productivity by proper methods of soil management is essential to prosperity. The soils of Cebu present a classical example of soil misuse and abuse. The extensiveness of the activities and the intensity of cultivation of the land are relatively correlated to the growth of the population. Cebu soils have been "mined" of their fertility for centuries to support its increasing population. There are signs of degeneration to indicate this. For this matter, the farmers were prompted to change their farming systems into a more conservative way.

It is imperative to start a program of soil conservation that will suit its soil, topography, cultural management, and climate. Foremost of this program of work is that confronting the restoration of the original fertility which has been lost through land misuse.

A separate survey on the soil erosion and land-use capabilities of Cebu was conducted. The report will be treated separately. In brief, it is probably significant to state that the farmers, in most cases, abandoned all seriously eroded lands because of their expected low yields. This method of farming our land which is in disparity with soil conservation method is indeed very disastrous to our natural resources and should be discontinued. Cultivation of a large number of farmlands should be avoided because of the steep slopes of the land. All farmers in these areas should be encouraged to plant perennial crops so that soil erosion may be reduced to the minimum, while at the same time a program to further aid the control of soil erosion should be instituted.

FARM TENURE

Our history states that a group of family called "barangay" have their own farm land to cultivate. The wealth of the rivers, forest, and grasslands were previously owned by all. Later, the so-called chiefs gained control of the lands as well as the people and begin to collect a certain amount of the produce as rent for the use of the land. Towards the close of the Spanish

regime, gratuitous land grants were offered to any individual who had cultivated a piece of land for four consecutive years. During the American occupation, lands were disposed of either as homestead or by sale. Unfortunately, not all the lands in Cebu were adapted for cultivation and, therefore, some farmers who did not possess tillable land had to farm on somebody's land for their existence. Thus, farm tenancy came to light.

There are four general classes of farm tenure in the Province of Cebu on the basis of proprietary relationship of the farmer to the land on the method of paying the rent: (1) Owners—or farm operators who work on all the land they own; (2) Part-owners—farm operators who own part and rent or lease from others part of the land which they work; (3) Managers—farm operators who supervise the work of the farm for the landowner and receive wages or salaries or share the crops for their services; and (4) Tenants—farm operators who rent or lease from others all the land on which they work. This tenant class is still divided into three groups, namely, (*a*) share tenants or those who rent the land they work 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 crop or crops grown; and (*c*) share-cash tenants or those who rent all the land which they work on and pay as rent a share of the crops in addition to a specified amount of money. Fig. 13 shows a graphical illustration of the percentage number of farms and farm areas operated under different systems of management in Cebu as compared with other Eastern Visayan provinces.

A large number of farms are operated by their owners and the rest by tenants. Of the 50,496 farms in Cebu, 58.54 per cent are operated under the owner and part owner system while only 41.44 per cent are run under the tenant system.

Of the 100,887.97-hectare farm in Cebu, 50.68 per cent are worked by the owners and only 49.32 per cent by the tenants. Comparing the areas operated by owners and part owners of Cebu with the Eastern Visayan provinces, the following may be given: Cebu—69.38 per cent; Bohol—72.00 per cent; Leyte—70.25 per cent; Samar—86.77 per cent. These data generally show that more than half of the cultivated areas of the land in the above-mentioned provinces are worked or operated by the owners themselves. This may partly account for the absence of agrarian troubles in these provinces.

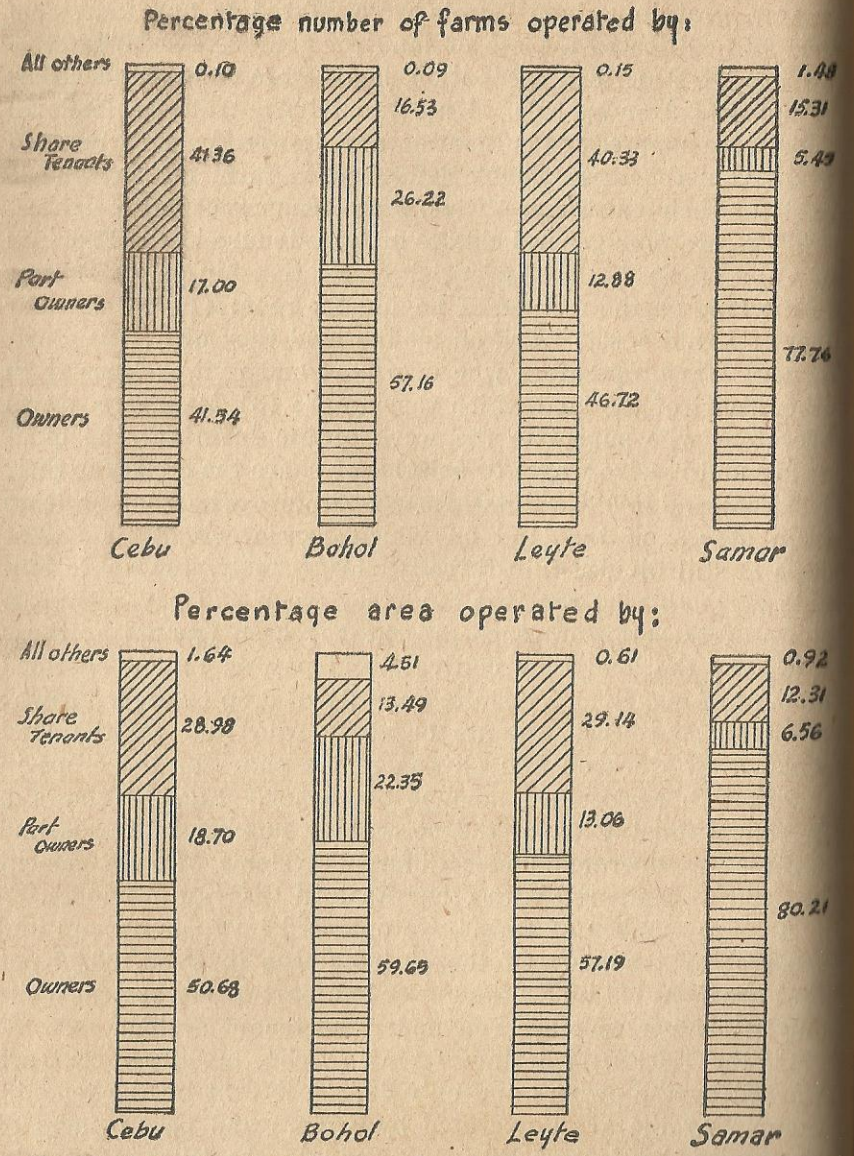


Fig. 12. Chart showing the percentage distribution of different systems of farm tenure in four provinces of the Visayas.

Another reason why there is seldom agrarian trouble in Cebu is that the land divisions are small thus, the availing opportunity for many to become owners of or tenants to somebody's land.

Table 7 shows that 52.07 per cent of the total number of farms in Cebu ranges from 0.2 to 0.99 hectares and 44.99 per cent, from 1.00 to 4.99 hectares. The big-sized farms ranging from 5 to over 29 hectares represent only 2.94 per cent of the total number of farms in the same province.

TABLE 7.—*Showing number of farms by size in the Province of Cebu, 1939* [10]

Grouping of farms (Hectare)	Number of farms	Percent
Under 0.2 to 0.99	63,282	52.07
From 1.00 to 4.99	54,680	44.99
From 5.00 to 9.99	2,752	2.26
From 10.0 to 19.99	595	0.49
From 20.0 and over	239	0.19
Total No. of farms	121,548	100.00

TYPES OF FARM

The degree of diversification of agriculture in the Province of Cebu, may be seen in table 8. Note that Cebu has eleven kinds of farms, namely:

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

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

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

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

5. Coconut farms are farms on which the area planted to abaca is equal to 50 per cent or more of the cultivated area.

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

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

8. Palay-tobacco farms are farms on which the area planted to palay is equal to at least 25 per cent, and the area planted to tobacco is equal to at least 25 per cent of the cultivated land.

9. Vegetable farms are farms on which the area planted to camotes, mungo, soybeans, tomatoes, sitao, cowpeas, patani

beans, cadios, onions, radishes, eggplant, cabagges, gabi, watermelons, potatoes, and other vegetable crops is equal to 50 per cent or more of the cultivated area.

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

11. Other farms are farms which could not be classified under any of the above ten groups.

Based on the foregoing classification and the figures presented in table 8, it is easy to see that almost three-fourths of the 121,548 farms of the province are devoted to corn production. Coconut farms rank second in magnitude. These data prominently show that Cebu is a corn-producing province, yet she needs the influx of corn from other provinces. Corn is the most important staple food of the people in Cebu. With this cereal crop, the general good health of the people is maintained. Corn grows well on the limestone soils of Cebu. Rice on the other hand does not grow well on soils high in lime content. The naturally adapted soils of Cebu to corn growing may have been the major reason why its people are corn consumers. Coconuts also grow well in limestone areas especially when planted along the coastal regions.

Tobacco is grown on the northern part of Cebu. In general, the Cebuanos especially the farmers, prefer home-made cigars to the imported ones. Tobacco leaves are sold in the market in bundles. Some of the cured leaves are sold to the other neighboring provinces like Leyte and northern Mindanao.

TABLE 8.—*Showing the number of farm types in Cebu, 1939*[10]

Kind of farm	Number of farms	Percent
1. Rice	2,409	1.982
2. Corn	89,201	73.387
3. Abaca	76	0.063
4. Sugar cane	1,828	1.503
5. Coconut	18,550	15.261
6. Orchard	98	0.081
7. Tobacco	352	0.290
8. Palay-tobacco	1	0.001
9. Vegetable	309	0.254
10. Livestock	1	0.001
11. Others	8,723	7.177
Total	121,548	100.000

SOIL SURVEY METHODS AND DEFINITIONS

Soil survey is an institution devoted to the study of the soil in its natural habitat. It consists of (*a*) the determination of the morphological characteristics of soils; (*b*) the grouping and classification of soils into units according to their characteristics; (*c*) their delineation on maps; and (*d*) the description of their characteristics in relation to agriculture and other activities of men.

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

On the basis of both the 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 that have no true soil, such as river beds, coastal beaches, and inaccessible mountains are classified as (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 Lugo

series was first found and classified in the vicinity of Lugo, a barrio on the northern part of Cebu.

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, Lugo clay is a soil type within the Lugc 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 in the surface soil is usually segregated on the map if the area can be delineated.

A complex is a soil association composed of such intimate mixtures of series, types, or phases that cannot be indicated separately on a small scale map. This is mapped as a unit and is called a soil complex. If in an area there are several series such as Faraon, Lugo, and others that are mixed together, the two dominant series must bear the name of the complex, as Faraon–Lugo complex as the case may be.

Surface and subsoil samples for chemical and physical analysis are collected from each soil type or phase, the number being determined by the importance and extent of such soil types or phases. Profile samples are also obtained for further morphological studies of important soil types.

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

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

SOILS OF CEBU PROVINCE

Soil is the most vital resource of the earth. Sustained food production could only be made possible if soil were given proper care. Some regions are naturally endowed with fertile soil and, therefore, could suport a high level of crop production. But in spite of the high significance of soil to our well being, very little effort is given to conserve its productivity. Soil is generally a variable mixture of minerals, organic matter, water, and air. It covers the earth in a thin layer and primarily gives mechanical support to plants. It is the product of action of the physical, biological and chemical forces upon the rocks for thousands of years. Soil formation is apparently a slow process. Soil characteristics vary greatly from place to place, not only in quantity but also in quality. Knowledge of these factors is important for it serves as guide in determining the capacity of the soil to produce the products needed by man. Thus, mountain soils in most parts of Cebu are wanting in quality; some are good in quality but lacks quantity as some alluvial flood plains.

Quantity and quality characteristics of soils, however, are very broad terms and they lack details in scientific classification of the soil material for practical applications needed in any program of agricultural planning and development. For this reason, the soils of Cebu Province were classified in a scientific way based on their genetical and morphological characteristics. The whole system of classification is based on the methods and techniques employed by the Division of Soil Survey of the United States Department of Agriculture.

After having been classified into soil series and finally into soil types and phases, the soils of Cebu were found to consist of ten soil types and two phases. The distribution of these types is shown in the accompanying colored map of the province. Their areas in hectares, proportionate extent, and land uses are shown in table 9. For convenience in discussion, these soil types and phases are divided into three groups based on drainage capabilities, relief and lime content as follows:

TABLE 9.—*Showing the area of each soil type, proportionate extent, and present land use of the soils of Cebu Province* [a]

Soil type No.	Soil types	Area in hectares	Per cent	Present land use
1	Hydrosols	7,650	1.53	Nipa palms, fishponds, bakauan, and other halophytic plants.
118	Beach sand	1,660	0.34	Coconuts, cassava and other root crops.
132	Faraon clay	40,435	8.31	Coconuts, corn, maguey, molave, bananas, root crops and other forest trees.
153	Bolinao clay	58,575	12.03	Corn, coconuts, maguey, molave, root crops and fruit trees.
154	Bolinao clay, steep phase	23,500	4.82	Second-growth forest, grasses, coconuts.
155	Faraon clay, steep phase	87,516	17.98	Grasses, second-growth forest, root crops.
156	Lugo clay	98,321	20.19	Coconuts, corn, tobacco, sugar cane and grasses.
157	Mandawe clay loam	28,220	5.80	Corn, rice, mongo, root crops, sugar cane, bananas, coconuts, and fruit trees.
158	Mandawe silt loam	13,705	2.82	Corn, tobacco, mongo, rice, sugar cane, coconuts, and root crops like cassava.
159	Medellin clay	7,710	1.58	Corn, sugar cane, mongo, coconuts.
160	Mantalongon clay loam	20,225	4.15	Cogon, corn, and coconuts, cabbage, rice, abaca.
169	Baguio clay loam	96,336	19.79	Corn, coconuts, cogon, second-growth forest.
	Area of unclassified islets	2,997	0.66	Coconuts, grasses, camote, cassava, and forest trees.
	Total area	486,850	100.00	

I. Poorly drained lowland areas.
   1. Cebu hydrosol ..... (1)

II. Moderately drained areas.
   A. Noncalcareous flat lowland.
      1. Mandawe clay loam ..... (157)
      2. Mandawe silt loam ..... (158)
   B. Calcareous flat upland.
      1. Medellin clay ..... (159)

III. Well drained areas.
   A. Calcareous flat lowland.
      1. Beach sand ..... (118)
   B. Calcareous hilly and mountain land.
      1. Faraon clay ..... (132)
      2. Faraon clay, steep phase ..... (155)
      3. Bolinao clay ..... (153)
      4. Bolinao clay, steep phase ..... (154)
      5. Lugo clay ..... (164)
   C. Noncalcareous hilly and mountain land.
      1. Baguio clay loam ..... (169)
      2. Mantalongon clay loam ..... (160)

[a] Area obtained with the use of a planimeter. No deduction were made for area occupied by roads, buildings, and rivers.

POORLY DRAINED LOWLAND

Cebu hydrosol (1).—The marshes, swamp lands, and all wet lands along the coast of Cebu which upon high tide are covered by sea water are classified under hydrosol. There are soils that have water which is the principal gross component as classified by Veatch. The horizons are divided into aqueous layer consisting of the water portion, the subaqueous horizon or the muddy portion which is the "A" horizon in the normal soil, and the basal horizon or the "B" horizon in the normal soil. Hydrosol are best developed along the mouths of rivers and quiet bays. The principal characteristics of hydrosols may be described as follows: The low level area extends from the shore at high tide to the limit of the brackish water at low tide; at high tide it is entirely covered by the sea water and at low tide the subaqueous horizon is saturated with brackish water. This horizon is bluish to grayish soft sandy clay or clay. Only a specific type of plant association is found in this area.

Soils in the hydrosol areas are accumulations or deposits of fine silt, clay, and sand forming themselves into a low delta. Such soils have very poor agricultural value because of their poor drainage and high salt content. The plant association found is the mangrove type consisting of bakauan, api-api, pagatpat, tangal, langaray, nipa palms, and lagolo (Plate 5). The above-mentioned trees are good sources of firewoods while the nipa palm leaves are used as thatching materials for houses. Under native vegetation, these are a very good breeding place for crustaceans but when cleared, they make good fishponds for the culture of milkfish (bangos). In some places like those in Mandawe, beds for salt making are constructed. The hydrosol type covers only 7,650 hectares or about 1.53 per cent of the land area of province.

MODERATELY DRAINED AREAS

These areas have a flat to very gently undulating surface. There are two soil series included under this drainage condition, namely, the Mandawe and Medellin series. The former is of alluvial formation while the latter is an upland soil which have been formed from limestone and shale. The soil types in these series are the best agricultural soils in the province. Their areas, however, are very limited.

Soils in the Mandawe series are generally cultivated to lowland rice as the land is level and the slightly compact layers below the subsoil favor the retention of the irrigation water in the

paddies. The Medellin soil on the other hand is devoted mostly to sugar cane. The drainage on land that is level to indulating with clayey soil throughout the whole depth of the profile is generally poor. Drainage canals should therefore be constructed to facilitate the removal of excess water, as waterlogged soils are inimical for a successful cane production.

MANDAWE SERIES

The alluvial soils of Cebu Province are classified under this series. These are young secondary soils of recent formation having almost flat topography. These soils have been deposited and formed along some of the big rivers on both sides of the coast on the central part of the island as the rivers there are much longer and have more capacity to carry and deposit alluvium than those rivers found at either ends of the province. These alluvial deposits consist of a series of layers of sand, silt and clay which in some places reach to a depth of about ten meters. There are no stones or boulders present on the surface.

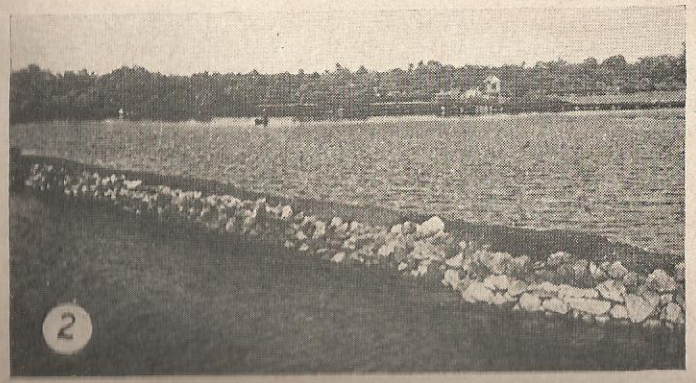
This series is almost entirely cultivated to crops except in those areas which are covered with bamboo groves, buri palms, cogon, and many species of second-growth trees. Plant roots have gone deeper on this kind of soil than on any other soils classified in Cebu, and this may be attributed to its comparatively friable soil.

The surface soil and the subsequent layers beneath are free of carbonates. The depth of ground water varies from two to five meters.

Mandawe series are generally brown to light brown soils having fairly thick surface layer with a texture ranging from sandy loam to clay loam. The coarse textured soils are only phases of the soil types, as they are oftentimes erosion deposits confined along riverbanks. These phases, however, are not delineated on the map used because of their small areas.

The soil profile as a whole has a homogeneous color and the soil of the different layers, grades gradually both in texture and boundaries. Gravels and stones may be present in the deeper layers of the profile along the river-banks and on the river beds, and such materials are quarried for construction purposes whenever the rivers dry out. Because of these characteristics, Mandawe soils like Medellin soils can be plowed deeper without danger of hitting rocks unlike the other soils in the province. The Mandawe series is the center of most activities of the

There are only few small areas under hydrosol in Cebu. Bakauan is common on these lands, as shown in the above picture taken at Carmen. Langarai, pagatpat, and nipa palms form the plant association on this soil type.



Hydrosol areas when cleared of their native vegetation make good sites for bañgos fishponds. The above fishpond is in Cordova. Maetan Island has dykes made of limestone rocks.

PLATE 5

Cebuanos, not only because of producing most of the food the people need but also because the towns are as well situated thereon.

A typical profile of this series is represented by Mandawe clay loam (Plate 6, Fig. 1) as follows:

Mandawe clay loam

Depth of Soil cm.	Characteristics
0–30	Surface layer, light brown to dark brown clay loam; good to poor coarse blocky structure. When wet, it is moderately friable to slightly hard but hard when dry. It has a moderate amount of organic matter. It is non-calcareous but slightly to moderately alkaline. There are no stones or boulders of any kind in this layer. Thickness varies from 20 to 30 centimeters.
30–50	Dark brown to dark grayish brown clay loam; good coarse blocky structure. When wet, it is slightly compact and hard, and when dry, it is very hard and compact. Poor in organic matter; non-calcareous; with pH of 7.96[1], which is medium alkaline. Separated from the above layer by a wavy and diffused boundary.
50–120	Yellowish brown clay loam, with a moderately coarse columnar structure. When dry it is hard and compact but becomes only slightly soft and compact when wet. It is also non-calcareous with a pH value of 7.84 which is medium alkaline. No coarse skeleton. Separated from the above layer by a wavy and diffused boundary.
120–150	Yellowish brown with mottling of brown to dark brown clay loam. It has a medium coarse granular structure and the same consistency as the above layer. Also non-calcareous and free of any coarse skeleton. This layer has a pH value of 7.84 which is medium alkaline. Separated from the above layer by a wavy and diffused boundary. Sometimes in deep layer of this series may be found pebbles of river wash origin.

Mandawe clay loam (157.—The alluvial plains along the eastern coastal areas of Cebu having an aggregate area of about 20,220 hectares are classified under this type. This area comprises those of Carmen, Danao, Compostela-Danao, Mandawe, Cebu City, Talisay, Naga, Carcar, and Argao. This plain is not really level for there are wide depressions and very gentle undulating topography. Surface drainage is fair, but internal drainage is rather poor owing to the fine texture and slight compactness of the soil in the substratum. This soil like the other

[1] pH determination conducted by Mr. Severino Etorma, Soil Chemist, Soil Survey and Conservation.

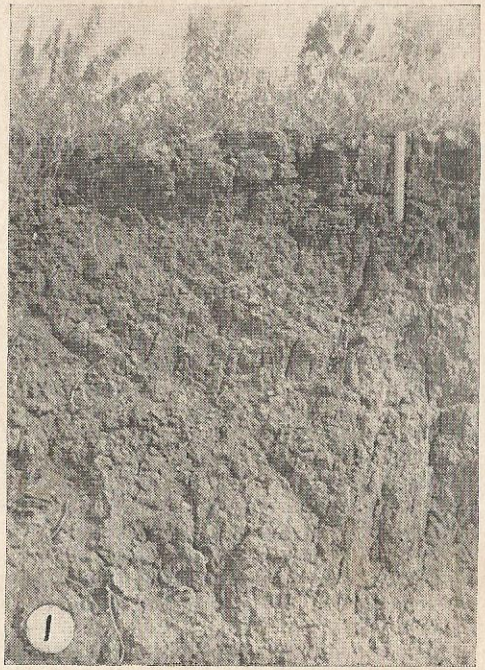
soil types under this series is also made up of alluvium originat ing from the inner uplands whose materials are of igneou origin. The surface is also free from any salt concentration outcrops, or stones. Deep plowing can be done on this soil b any type of farm tillage machinery without fear of hitting bi stones.

Bamboo groves are found all along the riverbanks. In ope uncultivated areas, cogon, talahib, Bermuda grass, bongalon and many kinds of vines are luxuriantly growing. In the town like Mandawe and Consolacion, buri palms are abundantl growing. This native vegetation has comparatively goo growth because its root system can penetrate deeper into th substratum.

The water table in this soil type is deeper than that of th silt loam, being from 1 to 2 meters deep. Another charac teristic of this type is the abundance of underground stream Many artesian wells in Cebu City and Talisay are continuousl flowing. The volume of flow, however, varies depending upo the season of the year, it being less during summer.

The surface soil of this type, which ranges in thickness fro 25 to 30 centimeters, is light brown to dark depending upon th amount of organic matter and moisture content. It is friabl when just moist, thick, sticky, and soft when wet, and hard whe dry. The substratum is made up of compact clay loam. A such, internal drainage is rather poor and unless drainage canal are constructed the land will be unsuitable for the growing o corn, sugar cane, and other crops except lowland rice. Th drainage system in such soil is not a problem during the latte part of the rainy season. During this time plants that are ver susceptible to waterlogged condition like corn can be plante even on the rice paddies. The greater part of this soil typ is planted to lowland rice. The other part which is bette drained is devoted either to corn, coconut, cassava, sugar can or fruit trees (Plate 6, Fig. 2).

Lowland fields are planted to rice during the onset o the rainy season. After its harvest, a second crop of rice i planted on the same field and on areas where there is availabl water. Rice fields that have no sufficient water for rice cultur are planted to corn, tobacco, and some vegetables. Some ric fields, however, are not planted to any crop and are allowed t rest or fallowed up to the next rainy season. The usual ric varieties grown are Cainte White and Cainte Red, both giving



Profile of Mandawe clay loam. Note the deposit of the compact clay loam to silt loam soils in the different layers of the profile. Soil color in the different layers gradually changes from brown on the surface to light brown in the substratum.

Mandawe clay loam has a level topography, as shown in this rice field in Carmen. Two crops of rice during the year are raised here. The coastal margin of this soil type is grown to coconut.

PLATE 6.

yield that ranges from 20 to 25 cavans per hectare. In the rice growing areas of Mandawe, Carmen, Carcar and Argao this type is mostly found.

Sugar cane had been an important crop on this soil type in Talisay area before the war. The destruction of the sugar mill as a result of the last war limited the planting of sugar cane to a small scale. The average yield in Talisay is 60 piculs of sugar per hectare. The varieties commonly grown are the POJ 2878 and Badila. The success of sugar cane production in this place was due to the proper fertilization of the field at the rate of 300 kilograms of ammophos per hectare, and the construction of deep drainage canals for proper drainage.

Mandawe silt loam (158).—This soil type with an area of 18,705 hectares is located on the western coastal part of Cebu from Asturias to Toledo forming the low, level, alluvial plains and fringing from the mountain ranges. The river and rivulets that usually abound in this type afford moderate drainage outlet. Where the soil is puddled as in the case of the rice paddies in the greater plain of Asturias and Balamban, internal drainage is impeded but in places where the soil is prepared for the planting of corn, sugar cane, or tobacco, there is good drainage. Surface drainage is rather poor owing to the low grade of the land.

Since the surface soil is free from any boulders or stones, deep plowing can be done conveniently. Tractors and other tillage machinery can be used to good advantage on this soil type.

Along the riverbanks and in areas not cultivated, talahib, cogon and bamboo groves make up the native vegetation. The soil is comparatively loose and friable so that the roots penetrate deep down the substratum. The soil material which makes up this alluvium has originated from the inland mountains of igneous origin, and as such it is free from any kind of carbonates. The water table on this type is rather low averaging only three meters.

The surface soil of this type, which ranges in depth from 20 to 30 centimeters, is brown to light brown and ranges in texture from silt loam to silty clay loam. The former name was preferably adopted because it predominates over the latter. This soil when wet is moderately friable and can be plowed without much danger of puddling, but when dried, it becomes hard, hence it is difficult to work. This difficulty, however, is felt only in the first plowing. The subsequent plowing and harrowing are easier.

The surface soil has a coarse blocky structure which partly makes the soil hard when dry. This form of structure can be improved by adding organic matter. The incorporation of organic matter assists the formation of fine granular structure.

The subsoil, whose depth ranges from 50 to 60 centimeters, is brown to dark grayish brown. This layer separates from the surface by a very gradual or diffused wavy boundary. It has also the same structure as that of the surface, but it differs in texture. The subsoil which is clay loam has a light consistency when wet but becomes slightly hard when dry.

The depth of from 60 to 120 centimeters consists of a layer of yellowish brown clay loam soil that is also slightly compact like the subsoil. It has a moderate, coarse, columnar structure. This layer is separated from the layer of subsoil by a very gradual or diffused wavy boundary. The horizon lower than 120 centimeters from the ground level is also clay loam that is yellowish brown with mottlings of dark brown. All other characteristics remain the same with the layers directly above it except in certain places where there exist some gravels.

The surface soil, because of its loose consistency, is more porous than any other layer in the profile which is more compact and consequently, has less air spaces. The addition of organic matter increases aeration of the soil. The idea of using organic matter to help aerate lowland rice field is not much needed. Wet soil has limited air spaces, but when it dries out, the soil in the substratum being clay loam, produces more shrinking than the surface soil and consequently, more air spaces are formed.

Mandawe silt loam is mostly cultivated to lowland rice. The varieties commonly grown are Pinogatan, Cainte, Tapol, Datapnak, and Elon-elon. Their yields vary from 25 to 40 cavans per hectare. Whenever irrigation water is available a second crop of rice is planted, but ordinarily, only one crop of rice is grown from May to December, after which the field is rotated with either corn or tobacco. Sugar cane had previously covered a big area of this type, but the raising of more food during the Japanese occupation placed these sugar cane lands under corn, cassava and sweet potato cultivation.

Soil erosion on this type is not a problem. On the other hand, eroded materials from the upper areas are deposited on this type. In certain sectors, deposition of sands, gravels, and stones renders this type of soil unfit for cultivation. Riverbank erosion is very serious especially after heavy rains.

CALCAREOUS FLAT UPLAND

MEDELLIN SERIES

Medellin soil, which is found on the northern part of Cebu is flat to gently undulating upland. Small areas are also distributed in Talisay, Oslob, and Pacijan Island with an aggregate size of 7,710 hectares representing about 1.58 per cent of the land area of the province. This soil type ranges in altitude from 10 to 70 meters above sea level.

This soil has a poorer drainage condition than that of the Mandawe because the surface soil and the soils beneath it have heavier texture. External drainage must be provided by constructing drainage canals especially in areas that are almost flat. However, even on wide areas with undulating topography, drainage canals are also needed in order to be able to control the flow of water and make it course where it is needed.

Medellin soils have been developed from parent materials derived from limestone with occasional shale rocks. The bedrocks are very highly weathered. The limestone appears as a mass of soft and crumbled material and the shale rocks are soft and easily pulverized. Although this soil is calcareous, there are no outcrops on the surface. Such characteristic is highly desirable for mechanized farming.

The soil of this series is cultivated mostly to sugar cane, with some coconut and corn as minor crops. The native vegetation consists of cogon only which grows very luxuriantly owing to the deep fertile soil and the even distribution of rainfall. The roots of the grass penetrate down to a meter while the roots of second-growth trees extend much deeper.

The water table ranges from 4 to 10 meters below the surface of the ground.

Medellin clay (159).—This is the only type classified under this series. The profile characteristics of this series (Plate 7, Fig. 1) have the following description:

Medellin clay

Depth of soil cm.	Characteristics
0–25	Surface soil, black to very dark brownish gray; fine clay; good, coarse granular structure; strongly plastic and sticky when wet, hard when dry; fairly rich in organic matter; noncalcareous; very slightly acid to neutral in reaction. No rock or stone outcrops.
25–60	Subsoil, heavy clay; blackish-brown; with good coarse granular structure; strongly plastic when wet but slightly hard when dry. Poor in organic matter content, and also

Depth of soil cm.	Characteristics
	noncalcareous. There is no rock or any coarse skeleton in this layer. This horizon is separated from the above layer by a smooth and gradual boundary.
60–140	Substratum, clay; grayish brown; with good medium blocky to columnar structure; strongly plastic when wet but slightly friable when dry. There is no stone or any sort of coarse skeleton in this horizon. This layer is separated from the subsoil by a smooth and abrupt boundary. It is noncalcareous and with a pH of 7.76.
140–below	Substratum, coarse gravelly clay; gray; structureless; slightly compact. Gravels are undecomposed limestone which resist weathering. This layer is calcareous and slightly alkaline in reaction. It is separated from the above layer by a smooth and abrupt boundary.

The surface soil of Medellin clay which ranges in thickness from 25 to 30 centimeters has a characteristic black color. The deep heavy clay is very sticky when wet and becomes hard when dry. Soil structure ranges from poor coarse granular to weak coarse blocky. There is no stone or rock outcrop on the surface layer.

The subsoil is as thick as the surface soil and has a good coarse granular structure with a strongly plastic consistency when wet but slightly hard when dry. It has, however, a lighter color than the surface layer. Similarly, there is no stone or rock in this layer.

The substratum, which is also clayey, has a much lighter color than either the surface or subsoil. It also differs in structure and consistency, it being a good medium columnar and slightly friable when dry. Farther down the substratum is a grayish, partially weathered bedrock consisting of a highly disintegrated limestone. Weathered shales are sometimes mixed with the limestone rocks.

This soil type is devoted mostly to the growing of sugar cane (Plate 7, Fig. 2). There are, however, some areas planted to coconuts, corn, mongo, and peanut. The sugar cane fields are big-sized farms mostly operated by farm managers. Because of their size, they are plowed and cultivated mostly by tractors. This soil type is very much different from other soil types of Cebu, and requires careful consideration before it is worked on. Being clayey and highly plastic, it is very undesirable to plow it when wet because the soil will puddle and will certainly be difficult to pulverize it later. On the other hand, plowing or harrowing it when dry is equally harmful as big soil aggregates

A profile of Medellin clay. A thick, heavy, black soil had been developed from the parent material below consisting of highly weathered limestones and shales.

Sugar cane is the principal crop grown in Medellin clay. The land is almost level and the soil is fertile. Drainage condition is poor.

PLATE 7.

will form which are tenacious. There is an optimum moisture content of the soil when plowing or harrowing can be effectively done. The test for this optimum moisture condition is known as the finger test method and is accomplished by applying a moderate pressure on a small amount of soil with the fingers. Soils with correct moisture content break easily, indicating that the soil is friable and mellow to work on. Too wet soils will be sloppy to feel. Very dry soils are brittle and sharp.

The soil structure and consistency can be improved by the application of agricultural lime and organic fertilizers. Lime makes the soil loose. It is generally added in sugar cane fields to correct soil acidity. A large amount of organic matter can be added to the soil in the form of green manure crop. This is done by growing legumes and plowing them under when their first pods begin to appear.

P. O. J. 2878, a foreign cane variety, is widely planted on this soil type giving a range in yield of 70 to 90 piculs of sugar per hectare. Some farmers fertilized their crops with ammonium sulfate and have obtained increased yields from 100 to 150 piculs of sugar per hectare. The usual rate of application ranges from 100 to 300 kilos of ammonium sulfate per hectare.

Like the Mandawe soils, Medellin soils especially those intended for sugar cane growing must be well drained. The necessity, therefore, of a good drainage system is in order if a good crop of sugar cane is desired.

CALCAREOUS FLAT LOWLAND

Beach sand (118).—This soil type, as the name implies, is found along the coast of Cebu like Liloan, Danao, Cebu City, Talisay, Toledo, Bantayan Island, and Camotes Islands. It has the same elevation as the Mandawe soils. This soil type is not extensively distributed as it represents only about 1,660 hectares.

The drainage in this type is largely internal and very excessive. Beach sand is less fitted for agricultural purposes, instead it affords excellent sites for habitation. This soil type is an accumulation of wave-and current-erosion materials from the sea. The scouring effect of the waves against the shore causes the rocks to peel off into fine or coarse materials. Such materials are carried off by the sea currents, which sort and grind them, and later unload them along the shore line. The materials which are deposited to form beaches are mainly calcareous in origin. It is, however, a mixture of a number of

ground marine shells and some quartzs. Stones or boulders are not common in the beaches.

This soil type, being sand, is well drained, allows the air to circulate freely, and does not hold water. These conditions limit only specific types of vegetation to grow. The common ones are the creeping legume vines, Bermuda grass, aroma shrubs, api-api, and wild maguey. It is interesting to note that although this type is closely related to the hydrosol differing only in drainage condition, such plants as nipa palm, bakauan, tangal, and pagatpat are not found here. The plants on this soil type, however, are shallow rooted which spread horizontally, despite the fact that soil structure and consistency permit them to root deeper. This phenomenon may be attributed to the shallowness of the ground water table which in this case is the sea water.

This soil type has no well defined soil characteristics, being principally a stratum of deposited sandy materials. The surface layer is hardly noticeable and does not differ from the other layer beneath.

The sandy material, however, is oftentimes light gray to almost white, depending upon the proportion of quartz and shell materials that make up the beach. The soil is rather very loose and structureless. The grains of soil do not bind together to form a definite structure.

Coconut seems to be very well adapted to this soil type, and it is believed that coconuts grown thereon have greater oil content than those grown on the inland. Vegetables, if properly fertilized and irrigated, also may do well.

CALCAREOUS HILLY AND MOUNTAINOUS AREAS

Soils in the Province of Cebu are predominantly of limestone formation. Limestone is a form of sedimentary rock which originated from compact limy sediments. These are formed in a number of ways. Numerous species of coral animals secrete limy substance which hardens and accumulates in thick deposits. Such deposit which is called coralline limestone is porous. Lime deposit may also be brought about by chemical precipitation of the lime in the sea water. The rock formed by chemical precipitation is solid and massive. Another source of limestone rocks is the accumulation and deposition of fragments of sea shells. After having been accumulated mostly under the sea, the rock is raised to the surface by the process of diastrophism, of varying topography. Limestone regions in general have uniform configuration at a distance. This

uplift took place during the Miocene and Pliocene periods. Various impurities such as sand, silt or clay may go with the lime deposit. Bodies of dense siliceous materials are also found in the lime rock. As these deposits were formed in a number of ways, it is evident that several kinds of limestone rocks may exist, thus some limestones are hard and massive, others are soft and porous. Their colors also range from white to red. Pure limestone is white. The reddish coloration may be due to the precipitation of iron while it was in the sea before the lime deposits emerged.

It is apparent that soils formed from limestone will vary considerably because of the different characteristics of the latter. Limestone rock is essentially made up of calcium carbonate and a lot of impurities. When acted upon by the forces of weathering, the rocks disintegrate. Being highly soluble in water, the calcium carbonate leaches out as fast as it is dissolved and only the impurities which become the soil are left. Usually soils developed from limestone are clayey and are either black or red.

The calcareous soils in Cebu are located on the upland areas and majority of them have a topography ranging from rolling to hilly and mountainous. The rolling areas are mostly along the coastal margins of the islands and the mountainous parts are along the central portion of the whole length of the province.

The calcareous areas of Cebu are well drained both externally and internally. Being principally of the porous kind of limestone, water percolates easily. The pores in the rocks which serve as the passage of drainage water become larger and larger until the surrounding walls are dissolved by the water. The drainage water in the rocks may find a common opening in the lower hillside and flows as spring. There are several of these springs in Cebu. In time, the pores may become considerably large and caves are formed. The caves in the limestone regions on the central portion of Cebu are some notable examples.

FARAON SERIES

Faraon is one of the several soil series classified under the category of calcareous hilly and mountainous areas. This series has counterparts in Negros, Bondoc Peninsula, Panay, and probably in Mindanao. This soil has striking characteristics peculiar of its own.

The topographic features of this series include areas that are rolling to hilly. The hilly areas, with rounded tops gradually rise in slopes. There are cases, however, where the slopes are very

steep with as high as 45° angle or more and taper to pointed tops.

Generally, Faraon soils are well drained. The topography of the land favors rapid flow of runoff. Water does not stagnate in pockets. Being principally bared of its native vegetation, rain water rapidly drains into the streams and rivers and finally to the sea. Some of the big rivers like Talisay, Mananga, Pandan, and Guadalupe dry out when it fails to rain for sometime. This may be one of the reasons of the prevalence of intermittent streams in the province.

Faraon soils are derived from the weathering of the underlying bedrock of limestone. This rock is classified by Smith (1924) under the coral limestone of the Malumbang formation which emerged during the Pliocene period. The upper bedrocks are oftentimes highly weathered and soft although some parts are hard and massive. It ranges in color from gray to yellowish gray. The lower limestone is generally harder and more compact than the upper bedrocks and more frequently bedded. In other respects, the upper and lower horizons are similar and could hardly be distinguished from each other.

Another distinguishing characteristic of this series is the presence of numerous outcrops and stones of lime varying in size from gravel to boulder. Such rocks are mostly erosion pavements or the materials left after the soils around them are washed away. Outcrops, which are generally present in areas with normal soil profile, also appear as a result of soil erosion.

Native vegetation on Faraon soils is a wide association of second-growth and virgin forests. Generally trees grown on this series are hard wood, characteristic of the molave type of forest. Composed of molave, narra, ipil, and tindalo, this type of forest is common on limestone having scanty or rocky soils under dry conditions. This type of forest is being commercially exploited in Toledo, Danao, Astorias, and Dumanjug. There are also stands of this type in Poro, Dalaguete, and Dumanjug on the southern part of Cebu. It is also found in the forest on the northern part around Carmen, Catmon, and Sogod, but is not exploited because the region is quite inaccessible.

Cogon grass is found on abandoned farms that are very stony with plenty of rock outcrops. Regions along the Lugo–Tuburan road are covered with cogon. Cogonal areas are occasionally interspersed with patches of shrubs and low bushes of perennial plants.

Roots of cogons or shrubs are limited in the shallow upper layers of soils. They seldom penetrate the bedrock unlike the big trees whose roots are sufficiently powerful to insinuate through the porous rocks.

Ground water table is seldom reached in the hilly areas. However, dug wells in the lower portions of this series or in places near the sea have water level from four to five meters below the soil surface.

There are two soil types identified under this series, namely, the Faraon clay and the Faraon clay, steep phase. The former includes the rolling and smooth hilly areas while the latter consists of the very steep hills with narrow tops.

Faraon clay (132).—This soil type is common along the coastal hilly areas of Cebu, including a small part in the Camotes Group. This type, which has an aggregate area of 40,435 hectares, has a typical profile (Plate 8, Fig. 1), with the following characteristics:

Faraon clay

Depth of soil cm.	Characteristics
0–20	Surface soil, clayey; black with good coarse blocky or granular structure; plastic when wet but very friable when dry; fairly rich in organic matter and highly calcareous. Limestone pebbles and cobbles are usually present in this layer. Sometimes outcrops of the underlying bedrocks extend up to the surface. Roots easily penetrate through this layer.
20–50	Subsoil, clayey; yellowish brown to grayish brown; good coarse granular; sticky when wet, but slightly friable when dry. There are more carbonates in this layer than on the surface. Lime rocks are also present. It is relatively poorer in organic matter than the surface soil. This horizon is separated from the surface soil by a smooth gradual boundary.
50–80	Substratum, highly weathered limestone; clayey but gritty; light gray to gray; structureless; soft, friable either wet or dry, wholly made up of carbonates. This layer is separated from the subsoil by an abrupt smooth boundary.
80–150	Substratum or the bedrock, hard coralline limestone, gray to almost white; structureless mass. This layer extends to several meters down and it is separated from the above layer by a gradual smooth boundary.

Usually, the intermediate layers are wanting and only the surface soil which is immediately followed by the bedrock appears more common. There are cases where true soils are formed as fast as the parent materials are developed.

Faraon clay varies in depth from 10 to 25 centimeters. Soil erosion, which is very prevalent on this type, has washed away the entire surface soil leaving only a part of the subsoil or sometimes exposing the bedrocks. This soil, when referred to as type, also includes the eroded area, therefore, no effort was done to classify the eroded from the normal into phase, because generally speaking, the types in the Faraon series already signify soils where erosion is prevalent.

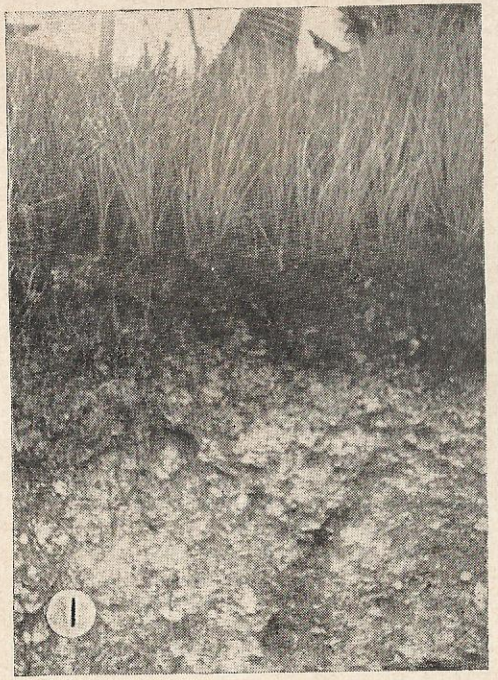
Faraon clay soils are black. This color may be attributed to organic matter. As this soil type has been developed under alkaline condition, the alkali must have dissolved the organic matter which imparted color to the soil. In areas where severe sheet erosion has completely removed the surface soil, the subsoil appears light gray.

The surface soil of this type is moderately friable except when it is puddled. Unlike other clay soils, plowing this soil in wet condition does not produce any detrimental effects on soil structure. This contrasting clay characteristic may be attributed to the high lime content of the Faraon clay soils. On the other hand, this soil remains moderately friable and maintains its excellent good structure when dry. Thus, the soil never shrinks and does not produce noticeable cracks upon drying.

In some areas, this soil type has rock outcrops which make plowing very difficult, if not impossible. Pebbles and cobbles of limestone are also numerous in the surface layer. Occasionally, the farmers get rid of the stones by piling them to form dikes designed to intercept rain water as shown in Plate 4, Fig. 2.

This soil type is widely planted to coconut, corn, cassava, banana, and numerous kinds of fruit trees. Very small part of this type is left uncultivated. The uncultivated areas are mostly abandoned farms where soil conditions do not warrant farming. In such places, bushes, shrubs, ipil-ipil, bagalonga, binunga, and a variety of second-growth trees grow.

Areas of this soil located along the shore are mostly planted to coconut trees. The trees grow well and appear much healthier than those planted inland and on different soil types. The coconuts on the interior section at the time of the survey were chlorotic, stunted in growth, and unproductive. This might be due to soil depletion because of poor soil management and also of soil erosion. The average production of coconut in this type is usually 4,000 nuts per hectare per year.



A typical profile of Faraon clay. The grayish white soft and porous coralline limestone upon weathering produces the black soil above. This soil type is found practically surrounding the coastal areas of Cebu Province.

This is a typical landscape of Faraon clay. The hilly, rolling to roughly rolling land under native vegetation is covered by second-growth trees, shrubs, and open grasslands. The trees are often cut for fuel.

PLATE 8.

White corn (Plate 9, Fig. 1) is the next important crop grown on this type. Mention has been made that corn is the principal food crop of the people. It is for this reason that this grain is raised on any soil type regardless of the economy involved in production. In most cases, there are three crops grown in a year. Continuous cropping is one of the reasons for the decline in production of this crop. Nothing has been done to conserve or restore the productivity of the soil. Crop rotation is sparingly practiced. If practiced, however, it is done by planting tobacco after the corn crop is harvested. But such practice, however, helps very little in the rejuvenation of the soil. The production of corn ranges from 2 to 6 cavans to the hectare. Newly "kaiñgined"areas of this type give better yield of crop as a general rule.

Corn, being a clean culture crop, further encourages soil depletion through soil erosion. This soil type is greatly eroded because of faulty cultivation. Although the farmers arrange the corn rows along the contour of the land and stone dikes are constructed across the gullies, yet soil erosion takes place. The reason is that the slopes of the land are so steep that sheet erosion would certainly occur.

Bananas invariably grow very well on this soil type (Plate 9, Fig. 2.) The plants are very healthy and the fruits produced are big and of good quality. Being a perennial crop and having shallow spreading root system bananas are good in preventing destructive soil erosion. There are several varieties of bananas grown and the more important ones are the Bungulan, Latundan, Saba, and Lacatan. The usual yield of this fruit ranges from 600 to 800 bunches per hectare per year.

Faraon clay, steep phase (154).—This type differs from the Faraon clay in topography, because of its very rough topography and very steep slopes reaching as high as 100 per cent. The hill tops are narrow and sharp. It is generally more elevated than the Faraon clay type. These hills united together to form a long range. There is rarely any part in this soil type which does not have an undulating surface.

Faraon clay, steep phase covers the high, steep limestone hills near Naga, the interior parts of Carmen, Carcar, Barili, Moalboal, Alegria, and Samboan, and from Sogod to Borbon. A small area is also found in Poro Island of the Camotes Group. This type has a total area of 87,516 hectares or about 17.98 per cent of the land area of Cebu.

Like the other soil types of the Faraon series, this type is also well-drained. External drainage on some barren areas is excessive and oftentimes destructive. There are no waterlogged areas. Water freely flows down the slope or percolates into the soil and through the porous rocks. Rivers and streams in the valleys within this type are easily flooded during heavy rains, but are easily drained and dried a few days after. There are numerous intermittent streams in this type.

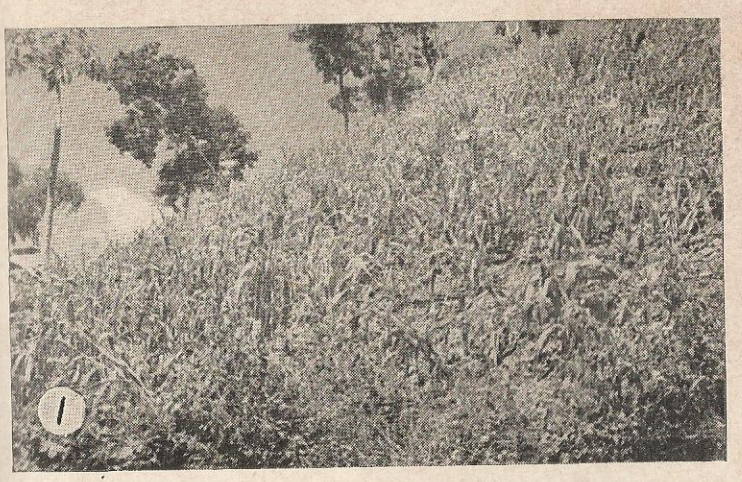
The soil of the type was formed from the underlying bed rocks of limestone. However, the parent materials from which this residual soil is developed seldom exist. Soils are formed as fast as the regolith is developed through weathering. This is especially true in the grassy or open areas of this type, but a gradual development of the soil may take place under thick forest. The bedrock of this type, like that of the Faraon clay, is also calcareous, with porous coralline rocks, whose color ranges from white to yellowish gray. Some parts of the area and the lower layers of the limestone are hard and massive. There are also places where the limestone is pure crystalline white.

In general, this type is more widely covered by forest compared to the other types under this series mentioned above. Being of precipitous hills, the area is hardly accessible by man. There are, however, areas in this type, like those in Sogod and Borbon, traversed by road and thus become partly accessible, so that the native vegetation was cut down, cleared and cultivated to crops. The original plant association of this type consists also of molave type of forest.

Molave trees including a group of hard woods like tindalo, ipil, and narra are some of the commercial forest trees found on this type. Shrubs and low-growing trees predominate in most areas on the northern parts. Some of these trees are cut for fuel purposes while others are cut to prepare the land for kaiñgin.

No ground water was observed on this soil type. Perhaps it is below the sea level.

The surface soil of this phase measures from 10 to 15 centimeters deep. It is shallower than the Faraon clay. The soil is also black, moderately friable when just dry with fine granular structure. In highly eroded areas (Plate 10, Fig. 1), the surface appears white or gray. The color also represents that of either the bedrocks or the subsoil. Sheet and rill erosion are very prevalent on this soil type. Erosion pave-



Corn is the principal crop grown on Faraon clay. Repeated cultivation of such land has resulted in poor crop yields due to fertility depletion and soil erosion.

Banana is another important crop grown on Faraon clay soils. The fruits produced are big and of excellent quality. The varieties commonly grown are bungulan, lacatan, and latundan.

PLATE 9.

ments are also very common. Plowing is seldom done on this phase because of the steep slope, thus cultivation is done by hand implement.

The subsoil of this type is grayish white clay soil which is slightly gritty. It is very shallow and, sometimes if not wanting, is generally very poor in organic matter content. Between the surface soil and subsoil is a diffused gradual soil boundary.

In spite of its very steep slope, the area is also planted to coconut and corn. Coconut, being a perennial crop requiring not cultivation when fully grown, will not do much harm in so far as soil erosion is concerned than when the area is cultivated to corn. Slopes as high as 120 per cent are planted to corn. To hold the soil in place, the farmers tried to construct dikes along the contour as shown in Plate 10, Fig. 2. This dike is made of twigs held together by stakes. Although this system is not very effective, yet it may minimize soil erosion. It is believed that the uneven stand of corn plant may have been due to the washing down of the seed planted in the soil. In newly opened areas, a good crop of corn may give an average yield of 6 cavans per hectare against 2 cavans per hectare for old eroded lands. It is deplorable to state that with this low yield, the November and December corn of 1946 was seriously attacked by migratory locust. The corn fields from Cebu City to the northern tip of Cebu were affected.

Bolinao clay (153).—This type is the most important soil of the Bolinao series. It is widely cultivated to economic crops. The typical soil profile has the following characteristics (Plate 11, Fig. 1):

Bolinao clay

Depth of soil cm.	Characteristics
0–20	Surface soil, clayey; red to bright red; moderately friable granular when dry, slightly sticky when wet, but does not shrink or crack open upon drying. It is fairly rich in organic matter and probably contains exceedingly large amount of iron. It has an excellent fine granular to blocky structure. Erosion pavements ranging from pebbles to boulders are sometimes present and occasionally rock outcrops appear.
20–40	Subsoil, dark, reddish brown clay, slightly compact; good coarse granular structure; relatively poor in organic matter. Pebbles and cobblestones of lime are present. This layer is separated from the surface soil by a wavy to broken gradual boundary. This layer is oftentimes absent.

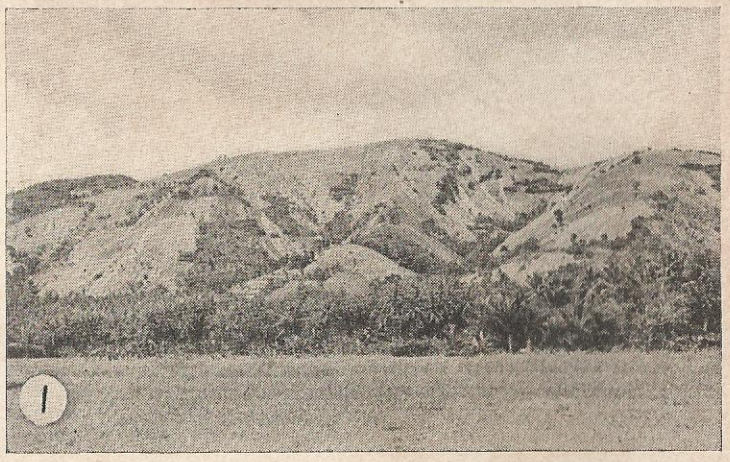
40–150 Bedrock, hard porous coralline limestone. The rock is white to yellowish white, sometimes with streaks of red. Boundary of this layer with either the surface or subsoil is an abrupt wavy to broken line. This layer extends to several meters deep. The layer below 150 cm. is usually white, hard, limestone.

The chief characteristic of Bolinao clay is its red-colored surface soil. The surface soil is of heavy clay and ranges in depth from 15 to 20 cm. This soil is moderately friable when dry, but sticky when wet. When it contains the optimum amount of moisture, it is friable and can be plowed easily. Unlike other clay soils, Bolinao clay does not harden nor does it shrink and crack upon drying. When dry, the soil remains just friable to almost powdery. This soil has an average pH of 7.84. Although the soil is of heavy clay, plowing is very easy. This may be attributed to the high lime content that makes the soil flocculate and form a granular structure. Where the topography of the area in this type is roughly rolling, pebbles and cobbles of limestone are plentiful on the surface. It follows too that the surface soil in this kind of relief is also thin. There are occasional outcrops of limerocks that are conspicuously out of the soil surface making the land difficult to plow.

The subsoil of this type is also clayey and just as thick as the surface, only it is slightly compact and has a brownish red color instead of the bright red color of the surface soil. In structure, it has a coarse good blocky form and a slightly sticky consistency when wet, but slightly hard when dry. In some sections of this type, the subsoil is absent as only the surface and bedrock are present. This is a condition where the true soil is formed as fast as the parent materials are developed. In this case the boundary between the red clay surface soil and the white hard bedrock is very abrupt and wavy.

This soil type, which exists principally on the northern part of Cebu like in San Remigio, Medellin, Daanbantayan, and in the Islands of Mactan and Camotes, is planted to corn mostly, some cassava, coconut, kapok, and maguey (Plates 3, Fig. 2 and 11, Fig. 2). This type has an aggregate area of 58,575 hectares.

Where the soil is thick, an average of 7 cavans of corn can be obtained. Cassava, being principally used in the manufacture of starch and sometimes for food, is also widely grown. The yield varies from 8 to 10 tons of fresh roots per hectare.



The limestone hills and mountains with very steep slopes, as shown in the above picture taken in Naga, were classified under Faraon clay, steep phase. Repeated cultivation to crops on such lands has resulted in very severe soil erosion; hence, the barrenness of the area.

Another view of Faraon clay, steep phase, taken in Naga. Here, the owner of this farm tried to control soil erosion by constructing brush terraces across the slope but with little success. The slope on the front side of the hill is over 100 per cent.

The manufactured starch, which is done only in the farmer's houses, is being sold from 25 to 50 centavos a ganta. Coconuts on this soil type, unless grown near the seashore, do not produce well. Inland coconuts are mostly stunted in growth and are chlorotic. Such is true also of some citrus trees, kapok, and many species of plants both cultivated and wild. Only maguey and bananas are not susceptible to chlorosis. This disease may be due to some mineral deficiency of the soil. Maguey seems to prefer this soil type more than the Faraon clay as there are more of it growing both as cultivated or as wild crop. This crop is more numerous on the rocky areas than on the less rocky portions of this type. Tobacco is also planted on this type in rotation with corn. After the corn is harvested, tobacco takes its place about December or January. This crop makes a fair stand on this type and gives from 1,000 to 1,500 "hands" a hectare.

Bolinao clay, steep phase (154).—The roughly rolling and hilly areas classified under Bolinao series fall under the steep phase. This type is found in Sogod, Bogo, and San Remigio on the northern part of Cebu and a portion in the Camotes Islands with a total area of 23,500 hectares. These hilly areas are well drained as the runoff water easily finds its way to the streams and rivers. This type has a higher elevation than the original soil type under this series. The highest area is located in Dalaguete some 100 meters above sea level.

Generally, Bolinao clay, steep phase is more stony on the surface than the Bolinao clay. Likewise there are also numerous limestone outcrops that make any farm operations unmanageable. This condition may be attributed to frequent and severe soil erosion which naturally exposed the once buried rocks. The surface soil of this phase is thin having only an average of 10 centimeters deep. It is also red, moderately friable when dry, but slightly plastic when wet. It has a good coarse blocky or granular structure that makes it easy to work on. Cultivation on this phase, if all done, is mostly by hand.

A large portion of this soil phase is not cultivated because of the rocky, depleted and eroded soil of the area. The uncultivated portions are open land covered by shrubs, low growing trees of the molave type. "Cading-cading" or "coronitas," local herbs, are also numerous. In other portions, cogon grass make up the rest of the soil cover of this phase. Root development of small plants are confined to the upper soil layer only as the lower limerock beneath is too hard for

their penetration. The bigger trees however have well-developed root system that can penetrate through the relatively porous rocks.

The cultivated crops on this soil type include corn, cassava, coconut, tobacco, bananas, and maguey. As on the other types under this series, coconut, kapok, and many other minor crops are also chlorotic. Corn has a very poor stand on this soil phase and could hardly yield 4 cavans per hectare. The banana plants, on the other hand, thrive well and are not affected by chlorosis as is the case of the other crops.

LUGO SERIES

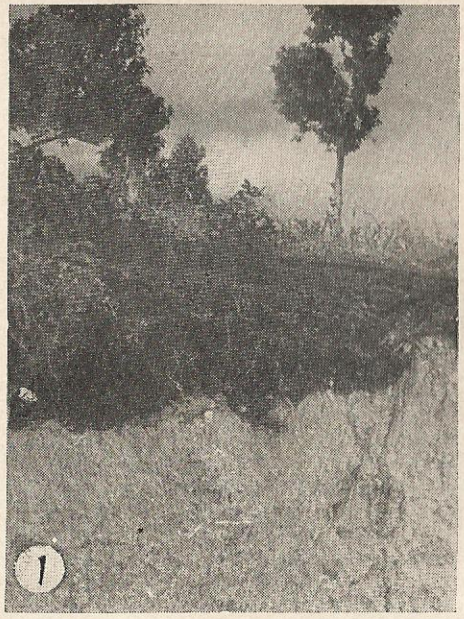
This soil series is also calcareous although its parent rock material is shale. A wide area under this series is found on the northern part of Cebu. Another large area is located on the central portion, and still another area near the southern end of the province.

Lugo series are upland soils which are referred to by Abella as *mesetas*. These *mesetas* are not really flat table lands, but rather roughly rolling to almost hilly in topography that range in elevation from 250 to 580 feet above sea level for areas between Carcar and Barili and from 300 to 700 feet for areas between Lugo and Bogo. These hilly areas may have wide and almost undulating tops that are adapted for cultivation, but the sides are very steep for farming. In general, this series has a rough terrain owing to the numerous gullies, streams and creeks which cut its surface.

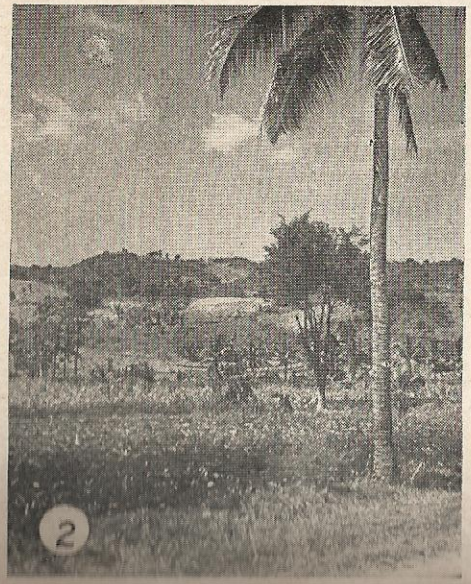
Lugo soils are also well drained like the Faraon. The drainage condition is mostly external or by runoff. These runoffs are responsible for severe soil erosion which is very noticeable on this soil. No instance of waterlogging occur on any part of this series.

Lugo series are residual soils which have been developed from shale rocks. These shale rocks are calcareous or highly impregnated with carbonates. Limestone rock is not found in this soil series. The shale rock is soft, white to grayish white, stratified materials laid in horizontal layers. It is probable that these mesetas were really flat uplands, but the work of degradation has cut its surface into the present form.

There are no stones on the surface nor in the deeper layers of the profile. There are some outcrops of limestone rocks in areas that are near the boundaries of the Faraon series. In areas that are highly eroded, gravels of limy shale rocks are



A profile of Bolinao clay. This soil type is common in the northern part of Cebu, Mactan, Bantayan, and Camotes Island. The dark red soil was produced from the weathering of the hard almost pure limestone rocks.



A typical landscape of Bolinao clay taken at Mactan Island. The land is gently rolling and soil erosion is less evident in this soil type.

PLATE 11

apparent on the surface and appear as concretions. They are not concretions though but are shale rocks that have resisted weathering.

This soil series is widely cultivated to crops. Practically the whole area is denuded of forest trees. There are regions, however, that are covered by cogon grass. These are abandoned farms whose soils are so badly eroded that no substantial crops can be grown. The cogon grass are relatively low and grow only sparingly. Narrow strips along the creek, however, are made up of second-growth trees and bamboo groves.

Roots of plants can go much deeper in this soil series than those of the Faraon or Bolinao. This can be attributed to the relative softness of its bedrocks.

Soil of the Lugo series is clayey and black like those of the Faraon and Medellin. It is very sticky and plastic, and tends to harden very slightly when dried. It has a fine granular structure which is very easy to work on with any agricultural implement. The subsoil is also clayey and has a dark brown to yellowish brown color.

Lugo clay is the only soil type classified under this series. The typical soil type has the following characteristics (Plate 12, Fig. 1):

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; good coarse granular structure and slightly friable when dry but strongly plastic when wet. Boundary separating it 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; weak coarse platy 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 shale rocks which are limy.

Lugo clay (156).—This soil type was referred to by some geologists as belonging to Barili limy clay. Lugo clay, however, was first described and delineated as a soil type on the northern part of Cebu. The same type also exists between Carcar and Barili, and also between Sibonga and Dumanjug and all together total 98,321 hectares.

This soil type is an upland roughly rolling to hilly area which is dissected by numerous gullies and creeks. The hills have rounded tops while the slopes are oftentimes steep (Plate 12, Fig. 2). Below the areas are intermittent creeks which ultimately form into rivers. The tributaries soon dry out after the rain. Although the soil becomes easily wet, water logging or stagnant water in the areas does not exist. Both external and internal drainage are good.

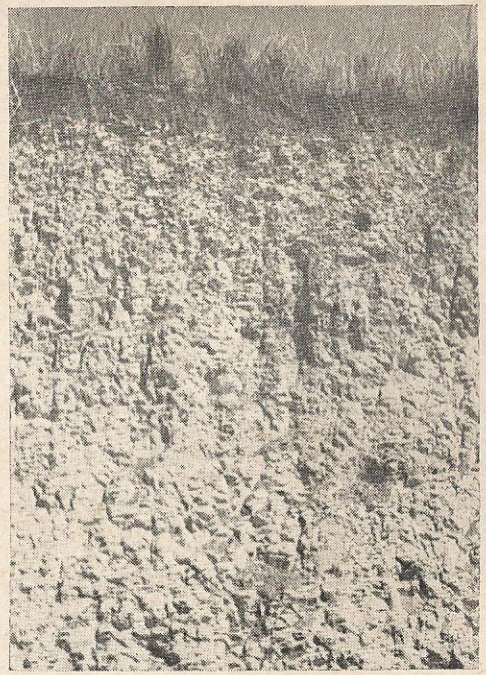
Lugo clay is residual soil developed from limy shale. It has a characteristic black surface soil which is rather thin averaging 15 centimeters deep. Soil erosion is so severe on this soil type that a greater part of the surface soil, especially those along the slopes, has been washed down. For this reason, the color of the surface area at a distance appears black on top which gradually fades out into yellowish brown color of the subsoil. In very extreme case of soil erosion, the surface appears white because of the exposed bedrock (Plate 4, Fig. 1). Under native vegetation, the surface soil, which ranges from 20 to 25 centimeters deep, is dark gray to black.

The area of this soil type is mostly under cultivation and with the exception of some cogonal areas, very little area is covered with second-growth trees. The absence of stones or rock outcrops and the fine granular structure of the surface make plowing easy, but this plowing causes the high erodibility of the soil. Although it is clayey, the surface soil seldom hardens upon drying and yet it is friable. It is sticky and strongly plastic.

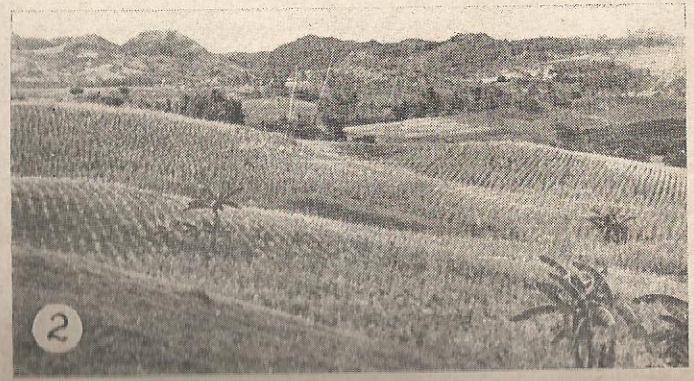
The subsoil, which is clayey, is also as thin as the surface soil. The soil structure and consistency are likewise the same as the surface soil.

Corn, coconut, tobacco, and sugar cane are the principal crops planted on this soil type. Corn is planted any time of the year, but some areas are reserved for tobacco planting during the months of November to March. Sometimes corn is planted in between the rows of coconut trees. It is to be expected that soil erosion will still go on, although the corn rows are laid across the slope. Soil erosion somehow is minimized. Corn grown on this soil type seldom gives good harvest, the range in yield being from 5 to 7 cavans per hectare.

Coconuts, likewise, do not grow well on this soil type. This, however, from the standpoint of minimizing soil erosion is one of the best crops to plant on this soil type. But coconuts grown on most areas of this soil type are chlorotic, small, stunted, and



Lugo clay as shown in the profile picture taken in Lugo consists of a thin layer of black clay soil developed from the grayish white calcareous shale below.



This is a typical landscape of Lugo clay in Tabongon. The strongly rolling slopes are planted to corn, bananas, coconuts, sugar cane, and tobacco.

unproductive. Such chlorosis which is intensely distributed among the older leaves might be due to mineral deficiencies in the soil. A hectare of normal coconut trees usually gives from 3000 to 4000 nuts a year.

Tobacco is the third important crop grown on this type and is grown mostly on the northern part of Cebu. This crop is planted in rotation with the corn. Tobacco occupies the field from December to March. Good quality leaves are produced and these are used locally (Plate 3, Fig. 1).

Sugar cane, bananas and some fruit trees are also grown. Sugar cane is planted on a large scale on this soil type on the northern part of Cebu, and the canes are sent to the Bogo-Medellin Sugar Central for milling. This soil is not as good as the Medellin soil for sugar cane. A maximum yield of 60 piculs per hectare can be realized.

Bananas seem to grow well when grown along the gullies. The plants produce big and good quality fruits.

Reports of the existence of mineral oils in this soil type has led many prospectors to drill for them even after the war. So far, no oil has yet been obtained. Drilling is being done at Medellin and Barili. There are oil sips in Alegria, which the people collect and use for lighting purposes after separating the oil from the water.

NONCALCAREOUS, HILLY, AND MOUNTAINOUS AREAS

Some of the rugged mountainous areas occupying the central portion of Cebu Province are not calcareous. They are lofty mountains with characteristic deep V-shaped gorges. The altitudes of most peaks reach as high as 1,000 meters above sea level. They have sharp-edged tops with very steep, precipitous slopes.

Vegetation in these regions is mostly grass. Small patches of virgin forest still stand in widely distributed areas. The remainder of the area which constitutes a small portion is under cultivation. The grassland consists mostly of cogon, talahib, ferns, and a mixture of low growing shrubs that are characteristics of high altitude. Along the creeks are bamboo groves and second-growth trees.

In general the area is well drained because of its topography. The drainage is mostly external as the water rapidly flows as runoff, hence the deeper layers of the soil have very little chance of getting wet. But, because of the cold climate and frequent heavy rains, which are characteristics of the locality, sufficient

moisture is stored for the needs of the plants especially during dry spell.

These mountainous areas were believed to have been formed during the Pre-Miocene period. Their bedrocks consist of igneous and metamorphic materials like diorite, quartz diorite, andesite, slate, greenstone, sandstone, and shale which are partly coal-bearing.

BAGUIO SERIES

This soil series occupies the north central portion of Cebu Province. It represents the highest, bold and rugged mountains. It is characterized by narrow, sharp-topped edges with steep, almost precipitous slopes, and separated from each other by deep V-shaped gorges. Elevation ranges from 200 to 1,000 meters above sea level. Narrow and long valleys between the mountain ranges are common and well inhabited.

The bedrocks of this mountain which were classed as basement complex and emerged during the Pre-Miocene time consist of igneous and metamorphic rocks of unknown ages. The igneous rocks like diorite, quartz diorite, and andesite flows make most of the big boulders along the Talisay-Toledo road. Farther north are metamorphic rocks like greenstone and slate, and conglomerate and hard limestone. Unlike those of the Faraon and Bolinao, there are no rock outcrops in the Baguio series. The drainage, which is principally external is good. The topography of the land favors the rain water to flow easily as runoff. Being mostly open land, there is very little chance for the water to percolate into the ground. The creeks and some of the rivers flowing through this soil series become dry whenever rain falls occasionally. It is also characteristic in these areas after a heavy rainfall for the rivers to easily top the bank and flood the lower plains.

Native vegetation in this soil series consists primarily of grassland with occasional patches of virgin forest and second-growth trees. The grasslands are dominantly cogon intermixed with ground ferns and many kinds of low shrubs. Bamboo groves are very common along the gullies and banks of creeks.

The virgin forest, which is relatively small, consists of a mixture of several kinds of forest trees. Found in the lower part of this series are species of Marig, Anubing, Apitong, Amugis, Balete, Kaluto, Banuyo, Saka, Anislag, and Yakal. Farther north of this series are species of Makaasin, Malugui, Nato and White Lauan.

Reforestation of the open land in this soil series has been started and hundreds of hectares have been planted to forest trees. The plants are still small but once fully grown, they will not only help in the control of flood but will also beautify the area further.

Soils of Baguio series are fairly deep. It is much deeper than either the Faraon, Lugo, or Bolinao soils. Roots of shrubs can penetrate to a meter down the regolith. There are, however, no dug wells or any artesian well within this area. Most likely, the ground water table is very deep. This area is comparatively sparsely populated owing to its rough terrain and lack of transportation facilities except by trails.

There is only one soil type identified under this series. This is the Baguio clay loam whose typical profile has the following characteristics (Plate 13, Fig. 1):

Baguio clay loam

Depth of soil cm.	Characteristics
0–25	Surface soil, clay loam; brown to dark brown; medium, coarse granular structure; and moderately, friable when just moist, but is slightly sticky when too wet. There are no stones or rock outcrops in this layer. Fairly rich in oragnic matter. Roots of trees go down to the regolith.
25–30	Subsoil, light brown to grayish brown clay loam; medium-coarse granular to almost columnar structure. It has a moderately friable consistency when dry, but tends to be slightly sticky when wet. There are no stones or any rock in this layer. Separating the surface soil from the subsoil is a smooth gradual boundary.
35–150	Substratum, light brown to brown bedrocks of igneous formation. Some partly weathered and soft and some massively hard. This layer is separated from the above horizon by a smooth gradual boundary. Farther down the profile are big boulders of rocks like andesite, diorite, quartz diorite, and greenstone.

Baguio clay loam (169.)—The soil of this type, which is of residual formation, has dark brown to brown surface soil that ranges in depth from 20 to 30 centimeters. The surface soil is much thicker at the lower part of the slopes than on the tops of upper sides. Its medium-coarse granular structure is desirable for plowing. This soil, however, tends to harden when plowed too wet.

The surface soil is fairly rich in organic matter. Those under grasslands have darker color than those under cultivation or under forest cover whose color tends toward the brighter

tinge of brown. All these colors reflect on the organic matter content of the soil.

Stone or rock outcrops are not common on the surface soil, which is very desirable in any farm operation. On mountain tops, however, the soils are so thin that the bedrocks are oftentimes hit by the plow points and the broken rocks are plowed out of the surface.

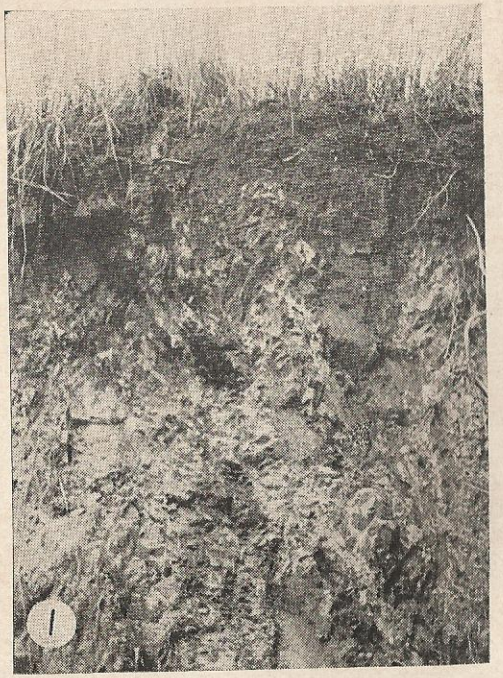
There are only very small and few patches of arable land on this soil type; the greater portion which has rough topography is not suitable for cultivation. It being on the central upper portion, the headwaters of many rivers that flow to the lower plain are located in this area. In addition, the watershed that collects water for Cebu City is also located on this soil type. Because of these important functions, it is advisable that this soil type be fully reforested. But in spite of its steep slopes, there are patches of land that are cultivated to corn mostly and oftentimes to coconuts. Corn planted in kaiñgin areas usually gives a fair yield. At most about 7 cavans of shelled corn may be expected from a hectare. There are only very few coconuts planted on this soil type. The trees do not grow well in comparison with those planted along the coast. It requires from 600 to 700 pieces of nuts grown under this series to produce 100 kilos of copra. A hectare of coconut on this soil type usually gives 3,750 nuts per hectare a year.

Because of its high altitude, good quality cabbage, lettuce, cauliflower, and a variety of leguminous vegetables are grown on this soil type in the inner valleys. Spiny bamboos are also abundantly growing wild along the gullies and banks of creeks. They are especially used for making sawali. This soil type has an area of 96,336 hectares.

MANTALONGON SERIES

This series is found only on the southern part of Cebu and on the central portion west of Dalaguete. This series like that of the Baguio series is characterized by high, rough mountain with steep slopes. Its altitude reaches up to 1,000 meters or even more above sea level. Because of this elevation, the weather is cool and rainfall is usually abundant. Rainfall in Mantalongon averages 2,353.5 millimeters a year, which is the maximum mean precipitation recorded in Cebu. It has also more rainy days than any other station in the province.

Unlike the Baguio series, Mantalongon series has bedrocks of sandstones and shales. The shale rocks, however, are not limy in contrast with those of Lugo. Deep in the substratum



This is a profile of Baguio clay loam. The brown soils produced from the weathering of the igneous rocks below are fair in fertility but the steep slopes common in this area make this soil type unfit for farming, except under careful management.

General landscape of Baguio clay loam. Note the steep slopes of the mountains, in spite of which, corn and coconuts are planted. Such areas are common along the Talisay-Toledo road.

PLATE 13.

are veins of coal which are being mined. There are also outcrops of limestone in distributed areas but not as common as those of the Faraon series. Some of the lime outcrops are of the calcite forms.

This series is also well drained like the Baguio series. The drainage is purely external so that runoff easily flows into the creeks. Areas dominantly covered by cogon can protect their soils from being washed down but not as good as the forest can hold runoff water. Patches of virgin forest are found in isolated areas. The growing timber belongs mostly to the third group.

Soils of the Mantalongon series are residual materials having been developed from the underlying rocks which are mostly shale, sandstone, and conglomerate. It is brown to light brown, friable and granular. The substratum is made up of reddish brown to grayish brown shale rocks. The shale rocks have platy structure which is arranged in beds lying parallel to the ground surface. The shale is very brittle and soft. The boundaries separating each soil layer are smooth and gradual. There are no other coarse skeleton like stones or boulders imbedded in the profile.

A typical profile characteristics of this series is represented by Mantalongon clay loam as follows (Plate 13, Fig. 1).

Mantalongon clay loam

Depth of soil cm.	Characteristics
0–15	Surface soil, light brown; with a medium coarse granular structure; and a consistency that is slightly friable when wet but just friable when dry. In some areas are outcrops of limestone and calcite. This layer is fairly rich in organic matter.
15–45	Subsoil, yellowish brown to light brown silt loam; with a medium to very coarse granular structure; and a slightly friable consistency when wet and very slightly friable when dry. This layer is separated from the surface soil by a smooth gradual boundary.
45–150	Substratum, reddish brown to grayish brown weathered silty shale. It has a good to very coarse platy structure, and a consistency that is very brittle, either dry or wet. Separating this layer from the subsoil is a smooth gradual boundary. Veins of coal may be found in some cuts along the road.

Mantalongon clay loam (160).—This soil type is found on the south central portion of Cebu occupying the highly elevated and very rugged mountains between Dalaguete and Badian. The

topography of this soil type, although very irregular, has rather smooth surface unlike that of the Baguio clay loam which has sharp-edged tops. It, however, has also steep slopes. In between the slopes are little valleys which are cultivated. The external drainage is excessive, but internal drainage is slow in some of the valleys, especially where lowland rice is planted.

Mantalongon clay loam is dominantly covered by cogon. There are very few and small patches of forest. The remaining areas are planted to coconut, corn, bananas, abaca, sweet potatoes, and some lowland rice. The lowland rice is planted in paddies built along the slopes. The area planted to this crop is very limited and occupies small distributed patches. The abaca plants do not seem to be adapted to this type as shown by their thin and low growth. Coconuts therefore are planted on small scale intended for home use only.

Mantalongon soils which range from 10 to 25 centimeters deep are light to dark brown in color. It is fairly friable and can be easily worked. However, because of its steep slopes only small patches can be cultivated.

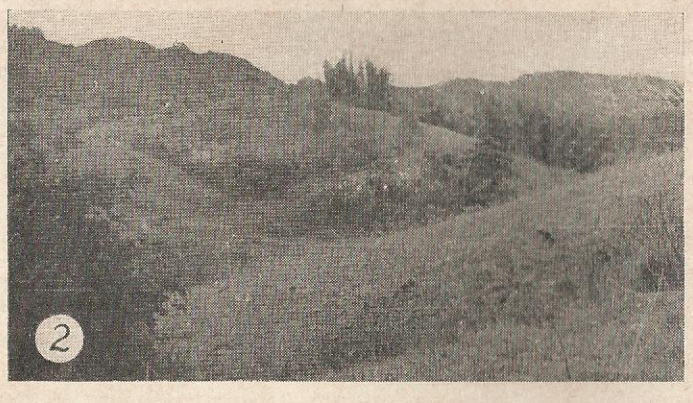
This is the only soil type in the Province of Cebu that is slightly acidic with a pH of 6.13. This soil reaction, fortunately, is within the range required by most cultivated crops. Lime may be applied not to correct soil acidity in this particular case but as a plant food supplement.

Mantalongon clay loam is well adapted to the growing of semitemperate crops. The area is noted for the production of cabbage, lettuce, cauliflower, everlasting, and some trees like pines. On account of the high altitude which is over 1,000 meters above sea level, the climate is cool, and rainfall is abundant and well-distributed throughout the year.

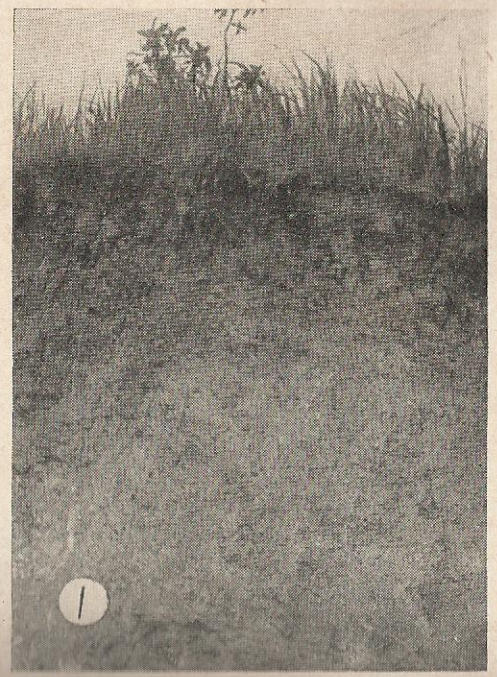
It would be better that this soil type, being mountainous, should be reforested than cultivated. Cultivation may be allowed only in areas of low gradients and should be done under a system that will not induce soil erosion. This soil type has an area of 20,225 hectares.

GENESIS AND MORPHOLOGY OF CEBU SOILS

The soil is a complex of mineral and organic substances whose composition varies in different places and at different times. The original soil formed at the beginning is not exactly the soil existing now, but rather the product of continuous development with time. For this reason, the definition of soil is not fixed or well-defined but rather varies in its concept to be



A profile of Mantalongon clay loam. The brown soil of this type had been developed from weathered non-calcareous shale.



A typical landscape of Mantalongon clay loan. The high and rugged mountains between Dalaguete and Badian are under this soil type. Vegetation consists mostly of cogon and some second-growth forest.

PLATE 14.

suited for a particular purpose. While the general definition for farmers is that soil is a natural medium for the growth of plants, such view is broad and hardly gives a clear idea of what a true soil is. The recent concept of soil as a natural and independent body had paved the way to more enlightenment and a further critical study of the subject. To the Russians goes the credit of having first considered soil as a product of the environment which led to the definition of soil as a mixture of fragmented and partly or wholly weathered rocks and minerals, organic matter, water, and air, in greatly varying proportions, and has more or less distinct layers or horizons developed under the influence of climate and living organisms. In America, while soil scientists somehow followed the Russians' school of thought, they further studied the soil according to their conditions.

This led to the modern definition of soil by Marbut as follows: "The soil consists of the outer layer of the earth's crust usually unconsolidated ranging in thickness from a mere film to a maximum of somewhat more than ten feet which differs from the material beneath it, also usually unconsolidated, in color, structure, texture, physical constitution, chemical composition, biological characteristics, probably chemical processes, in reaction and morphology." This definition which tends to define soils in terms of soil characteristics is slightly different from that of the Russians which is more of soil forming processes.

True soil is the product of action of climate and living organisms upon the parent material, as conditioned by the local relief. There are five principal factors in soil formation and the predominance or length of time any of each or a combination of two or more factors act on the parent material determines the nature of the resulting product—the soil. These factors are: (1) Parent material; (2) climate; (3) biological activity; (4) relief; and (5) time.

A mature soil is in equilibrium with its environment. It will only change when the environment, such as climate, erosion of land, agricultural practices of man, etc. is changed.

A comprehensive study of soil involves at least four fundamental problems. It must answer four questions, namely, what, how much, how and why. Soil chemistry will deal with *what* and *how much* and soil physics will handle the *how* and *why*.

Soil morphology which is closely related to soil physics deals with the soils as finished products and measures, describes, correlates and classifies them.

Soil morphology as discussed here will deal with soil as a finished product and that its study would mean the measurement and description of this product.

Soil genesis on the other hand implies a process of gradual transformation of the inert parent material into a definitely organized dynamic soil. In other words, it describes the various steps involved in the transformation of parent material into a true soil.

There are eight soil series classified in the Province of Cebu of which only four are established in the province and the rest are soil series formerly identified in other provinces such as Bolinao in La Union, Baguio in Mountain Province, Beach sand, a miscellaneous land type common in many provinces, and Faraon as formerly established in Occidental Negros. The new soil series established in Cebu are Mandawe, Medellin, Lugo, and Mantalongon. However, only Faraon and Lugo series are the most important ones agriculturally and will be discussed in this report.

It is unfortunate that due to the Second World War, the chemical laboratory was unable to make a complete chemical analysis of Cebu soils so that only very limited discussion will be mentioned in the genesis part and much deductions in the chemical properties of the soils will be derived from the morphological characteristics. Cebu Province is predominantly a limestone island which, according to Smith, belongs to the Malumbang Formation having been developed during the Tertiary period. This limestone is characteristically coralline. Smith further described the Malumbang Formation as having been formed during the Pliocene age. This form of limestone is sandy and could not be distinguished from the sandstone which is usually calcareous. It is brownish yellow to white and generally massive or in thin poorly defined beds. The lime deposit is usually divided into horizons. The upper horizon is generally coralline and attains a thickness of 30 meters. The transition between the upper and lower horizon is very gradual and its boundary cannot be delimited. This bed of transition, which is estimated from 40 to 135 meters thick is more resistant to weathering than the upper bed. The lower horizon is generally less than 20 meters thick and is harder and more compact than the upper limestone. The present classification of this limestone has made the Malumbang Formation obsolete and instead has divided it into five groups, namely: Carcar Lime-

stone, Barili Limestone, Maingit Formation, Mount Uling Limestone, and Cebu Orbitoid Limestone.

Another sedimentary rock of importance in Cebu is shale, which according to Smith, belongs to the Vigo Formation having been formed during the Tertiary period. According to Pratt, the Vigo Formation has three layers too. The lowest consists of gray shale, black shale, yellow and brown shale and sandstone interbedded. The middle stratum consists of massive, bluish to black shale with minor sandy zones (usually the stratum of oil deposits) and the third layer or uppermost stratum consists of sandstone and fine sandy conglomerate in alternate layers. The shale consists of fine-grained shales and sandy shales interstratified in thin regular beds from 5 to 10 centimeters in thickness. This shale is gray, blue or black and made entirely of clay. The sandy shale is yellow or brown and of intermediate composition. As a whole the shale is highly calcareous and reacts violently with hydrochloric acid solution. The thickness of the Vigo shale is unknown. Lately, the classification of this shale was changed to Barili limy clay.

As a whole, all the soil series classified in Cebu can be conveniently separated into most of the profile groups set by Storie and Weir as follows:

Profile group I.—Soils of recent alluvial fans, flood plains, and other secondary soils having undeveloped profiles underlain by unconsolidated materials. There are several and recently deposited soils along the rivers in Central Cebu. Their areas, however, are so small that they are not delineated in the map.

Profile group II.—This group consists of young alluvial soils with slightly developed profiles and with slightly compact subsoil. There is no soil under this group classified in the Province of Cebu.

Profile group III.—Also alluvial soil with moderately developed profiles, deep soils with no claypan or hardpan. To this group belongs the Mandawe series. In this series are the alluvial soils of Cebu with slightly compact horizons throughout the whole depth of the profile. This series is different from the Umingan soils in color, structure, and consistency of the horizons. Umingan soils have darker color and looser consistency than the Mandawe series. The pH value of Umingan soils is 6.26 while that of the Mandawe soils is 7.96. The San Manuel soils are similar to the Umingan soils, except for the presence of river-washed pebbles and cobblestones in the layer of the latter. Although Mandawe soils have some gravels and

stones in the deeper layer of the substratum, the two soils Umingan and San Manuel, are very much different from each other.

Profile group IV.—Soils of older plains or terraces having strongly developed profiles with dense clay subsoil (claypan). No soil series of this group was mapped in Cebu.

Profile group V.—Soils of older plains or terraces having hard pan subsoil that does not soften with water. Likewise no soil of this group was classified in Cebu.

Profile group VI.—Soils of older terraces and upland areas having dense clay subsoil resting on moderately consolidated material. The Medellin soil is classified under this group. Medellin soils are of heavy clay from the surface to the lower subsoil resting on highly weathered limestones and shales.

Profile VII.—Soils of upland areas developed on hard igneous bedrock with a rolling to steep topography. Under this group is the Baguio series found on the central portion of Cebu. Baguio series has a parent material developed from andesite, diorite, and quartz diorite. Metamorphic rocks like greenstones and slates are also present. This series was first established by Pendleton in Mountain Province.

Profile group VIII.—Soils of upland areas developed on consolidated sedimentary rocks like limestones, sandstones, and shales. Under this group are the Lugo series and the Mantalongon series. The Lugo series will be discussed in detail in the latter part of this report. Mantalongon soils on the other hand are clay loam soils developed from noncalcareous shale with a very rugged topography representing the most elevated area of the central part of the province.

Profile group IX.—Soils of upland area developed from soft consolidated materials. The Faraon series is classified under this group.

LUGO SERIES

This series was first described on the northern part of Cebu in a barrio bearing the name. It was later found to be present on the southern part of Cebu between Carcar and Barili and still in another part between Boljoon and Malabuyoc. Lugo series are upland soils with a characteristically rolling to roughly rolling hilly areas dissected by many gullies, creeks, and rivers. This area must have been once an upland and level plain which Abella referred to as "mesetas" meaning table land. However, accelerated erosion has greatly scoured the

land into its present condition and indications are that if this rate of erosion is prolonged unabated, the relief will be restored to its former "mesetas".

The altitude around Lugo ranges from 300 to 700 feet above sea level and between Carcar and Barili, varies from 250 to 580 feet.

The area in general is well drained. External drainage is, however, more excessive than the internal drainage which is but moderate. The creeks in almost all cases are intermittent. They, however, swell and oftentimes overflow after heavy rains. The drainage water is heavily laden with washed materials. None of the rivers present in this series is navigable.

Lugo soils had developed from the underlying bedrocks of shale referred to by the geologist as the Barili limy clay. This shale rock is highly calcareous and reacts violently with hydrochloric acid solution. The shale rock is soft and brittle, grayish white, and laid on thin horizontal beds that range in thickness from 5 to 10 centimeters. No other kind of rock is present in this area either on the surface or underneath.

There is no virgin forest in this area, but it is likely that the area was once covered by a thick forest which was later cut for the economic existence of man. Second-growth trees occasionally line the banks of creeks and gullies. In such areas thick shrubs and vines constitute the undergrowth vegetation. The open uncultivated cogonal area whose growth is scanty with short and narrow leaves were formerly farms, but were later abandoned because of their decreased productivity. Scattered in widely distributed areas on the hillsides, as well as along banks of creeks, are bamboo groves.

The water table is extremely deep. Artesian wells on this area have a depth of from 300 to 400 feet.

Among the upland soils of Cebu, Lugo series is one of the most widely cultivated and inhabited soils. Crops are widely diversified. Although corn is the principal crop, other portions of the field are grown to tobacco, sugar cane, bananas, coconut, and some vegetables. Some sections of the field are fallowed but the larger portions of the whole field are always planted. Tobacco is the only seasonal crop planted in November. All the other crops are usually planted any season. Most houses are located right on the farm and seldom are they situated in barrios.

Lugo clay is the only type under this series and has the following characteristics:

Depth of soil cm.	Characteristics
0–20	A dark gray to black surface layer; heavy clay with medium to fine granular structure; very sticky and plastic when wet but slightly friable when dry. Upon drying, soil particles do not clod nor harden like other clays. It is fairly rich in organic matter and devoid of any skeleton.
20–30	A light yellowish brown clay with a good coarse granular structure that is also sticky and plastic when wet but friable when dry. There is no coarse skeleton. Soft concretion-like limestones which are spherical to irregularly shaped forms are present in this layer. This layer is separated from the layer above by a smooth and diffused boundary. Organic matter content is less than that of the surface soil.
30–70	Brownish gray layer speckled with dark orange parent material. Consists of consolidated weathered shales, gritty or powdery in feel. When wet it is also sticky but not plastic. It is brittle when dry. The relative content of organic matter is much less than that of the surface soil.
70–150	This layer extends down to an indefinite depth and consists of calcareous shale that is grayish white speckled with orange. It is slightly sticky when wet but not plastic. It is brittle either dry or wet. Shale are in thin horizontal plates from 5 to 10 centimeters thick.

The whole southern half of the Province of Cebu belongs to the third type of climate characterized by no maximum rain period and a short dry season lasting from one to three months. The average annual rainfall is 1785.7 millimeters or about 73 inches. Under this climatic condition, a humid tropical climate prevails. With such amount of rainfall, it is expected that the leaching of bases will be promoted and soil acidity enhanced. The pH of the surface soil is 7.72; subsoil, 7.67; and the parent material, 8.00. Although the pH of the surface soil is lower than that of the parent material, still it is of medium alkalinity. This shows very little migration of bases has taken place in spite of the heavy precipitation in the area.

The surface soil of Lugo series is characteristically black, indicating that the soil is rich in organic matter. Roberts and others in their survey of Puerto Rico soils pointed out that soils that have developed from soft calcareous material under any set of climatic conditions are black. The tendency of the calcium ions in calcareous soils is to coagulate the humus colloids

and thus prevent their dispersion and subsequent removal. The dark colored A horizon is more pronounced in soils under grassland than in soils under forest area. In this respect, the humus under grassland is more concentrated in the upper horizon whereas in the forest area, the humus is relatively well distributed in the different layers of the profile.

Alkaline earth carbonates retard the soil forming processes. This is especially noticeable in humid regions like Cebu. Jenny (1941) reports that the colloidal sols of aluminum hydroxide and ferric hydroxide when unprotected by colloidal humus are readily flocculated by calcium carbonate solution. The migration of clay particles within the profile is reduced. Hence, the formation of eluvial and illuvial horizons is impeded. It is only after the removal of the carbonates that the characteristic regional profile differentiation is instigated.

Shrinking, hardening, and cracking are characteristics of most clay soils. Lugo clay, however, does not exhibit such properties. On the contrary, the surface soil is friable and does not crack nor shrink upon drying. The soil may become hard only if puddled well but not otherwise. Upon drying the soil retains its fine granular structure and mellow consistency. In the absence of chemical analysis it may be inferred that this soil is rich in carbonates of some bases. As has been pointed out by Roberts and others in their study of Puerto Rico soils, sodium carbonates when concentrated on the surface make the soil mellow, fluffy, and vesicular, which favor both wind and water soil erosions. As a matter of fact, Lugo clay soils are very severely eroded in the form of sheet and gully types. Erosion is so common that at a distance the color of the land surface appears whitish. The light colors represent colors of the lower part of the profile after the soils above it have been eroded. It is white or grayish white on the summit, yellowish brown on the slopes, and dark gray in the valleys or lower slopes. The same authorities also reported that soils rich in carbonates with tropical shower promote chemical activity and the sodium aluminum silicates leach to the lower depths. The leaching is assisted by the solvent action of alkali on the humus coated clay, thus dispersing the colloids. As a result, the topmost soil produces a composition of sand with a low concentration of sodium and potassium but high in calcium. After the rain, the soil is devoid of visible cracks, but on drying tiny thread-like cracks appear. These characteristics of Lugo clay are also found in Faraon clay.

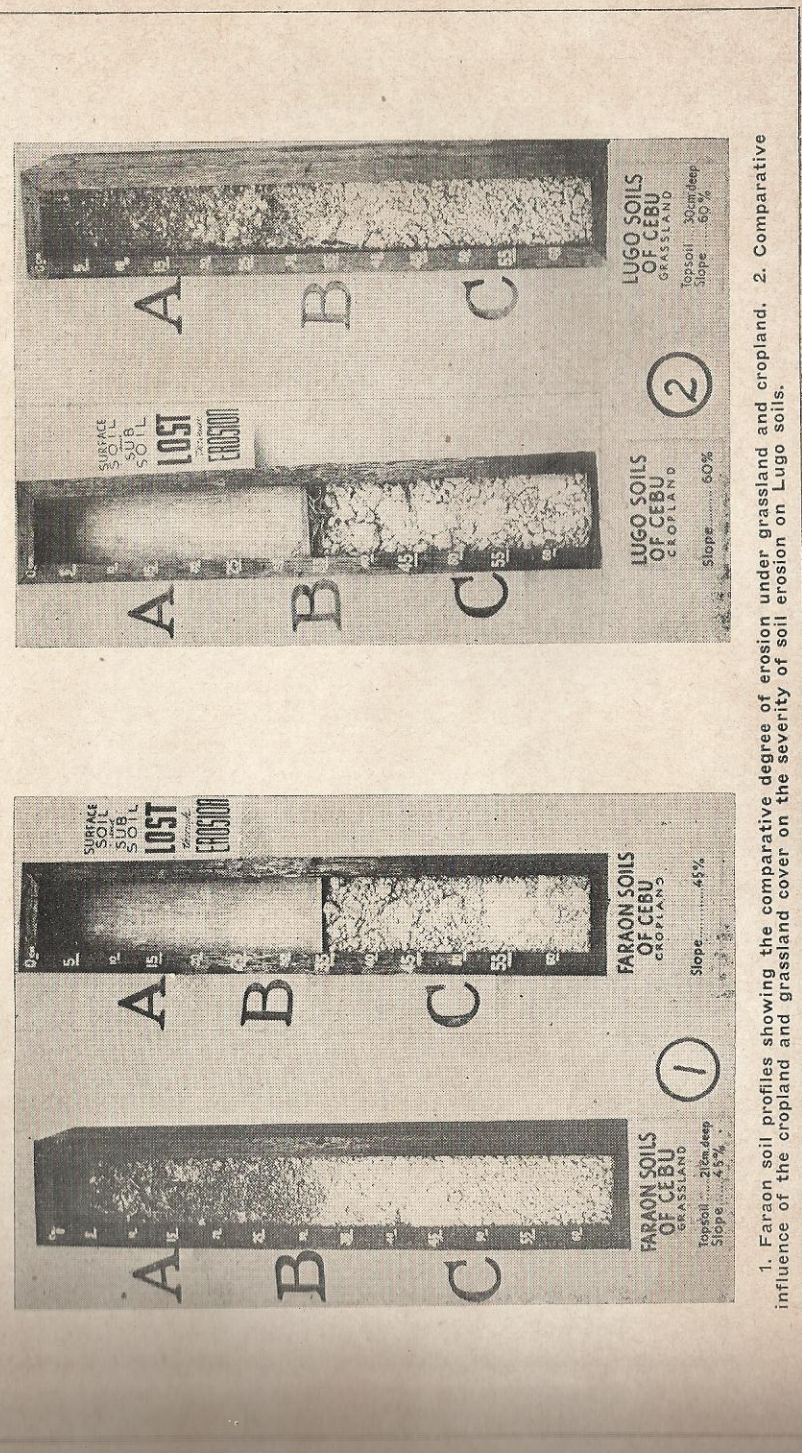
Plasticity and cracking of soils depend upon the calcium-magnesium ratio. A soil with more magnesium than calcium will tend to be plastic when wet and cake when dried. On the other hand, if calcium is more than magnesium the soil will be granular and fluffy. Inasmuch as Lugo clay does not cake upon drying, it is evident that the ratio of calcium over magnesium is more than three.

FARAON SERIES

This soil series was first found and described on the northeastern part of Negros Occidental. This same series was found to be the dominant soil in the Province of Cebu. Faraon soils practically cover the whole area surrounding the hilly coast of Cebu. The soils on the extreme northern part of Cebu, however, although of limestone formation, are classified under the Bolinao series.

The general topography of Faraon clay is hilly with roughly rolling slopes. The slopes of the land are usually as high as 25 per cent. The steep phase of this type has slope that is more than 100 per cent. The elevation of this type varies from a few feet above sea level to as high as 1,000 feet. The principal distinguishing characteristic of this series from the other soil series of limestone formation is the black, heavy clay soils, with outcrops of gray coralline and porous limestone. The surface is littered with pebbles and cobbles of limestone. Such materials are referred to as erosion pavement or the coarse skeleton left after the soil had been washed by erosion.

The drainage condition in general is excellent. Some authors attribute the generally good health of the people to the good drainage condition of Cebu. The internal drainage is fair. The water easily finds its way through the porous bedrocks. In the rocks are ramifications of pores which gradually coalesce to form big crevices that eventually become caves. All drainage water in these crevices and caves ooze at the base of the hill spring. The external drainage in the form of runoff empties into the numerous gullies and streams that bisect the entire area. With moderate rainfall, the water in the streams slowly percolates and does not reach the sea any more. During heavy rains, however, the drainage water swiftly flows out and after some time the creeks dry out again. This explains why the streams in this Faraon area are oftentimes broken or intermittent. The drainage condition is also influenced by vegetation. In forest lands, the soils readily absorb rain water which feeds the streams slowly throughout the year.



1. Faraon soil profiles showing the comparative degree of erosion under grassland and cropland. 2. Comparative influence of the cropland and grassland cover on the severity of soil erosion on Lugo soils.

PLATE 15.

Vegetation in Faraon series consists of wide mixture of second-growth and primary forest. In the second-growth forest, the trees of the molave type are small, frequently with thin undergrowth. The trees are also thinly crowned.

The root development of crops is limited only to the thin solum spreading horizontally instead of going downward because of the presence of bedrocks. The roots of trees, however, were observed to have penetrated the limerocks. This might have been brought about by the tiny roots which, being able to penetrate the tiny pores of limestone, developed tremendous piercing force.

The water table in this series as measured from the dug wells in the valleys ranges from 3 to 4 meters below the soil surface.

Faraon clay, which is more important agriculturally than the steep phase, has the following profile characteristics:

Depth of soil cm.	Characteristics
0–20	A horizon, black to grayish black heavy clay soil; with a coarse to medium good granular structure. It is fairly rich in organic matter and friable and somewhat loose and crumbly when dry. When wet it is highly sticky, soft and plastic. In this horizon are gravels and pebbles of limestones. Outcrops of rough-edged coralline limestone are generally present on the surface.
20–35	Subsoil, grayish black; also heavy clay and a structure that is coarse to medium granular. When wet, it is also highly sticky, soft and plastic. Some gravels of limestone are present in this layer. This horizon is separated from the surface layer by irregular and gradual boundary. In certain soil profiles this layer is absent and the surface layer is immediately followed by the bedrock.
35–150	The bedrock, grayish white to yellowish gray, partly weathered limestone. When this layer is highly weathered and soft, a very gradual transition from unweathered rock to surface soil is exhibited. When the bedrock is hard, the surface soil immediately rest on the parent rock. An irregular abrupt boundary separates this layer from the layer immediately above. This layer has indefinite depth.

As has been previously pointed out, the whole Province of Cebu falls under a humid tropical climate with an average yearly rainfall of 1785.7 millimeters or approximately 73 inches.

Under this climatic condition, Roberts points out that leaching and soil weathering are very rapid and on account of this leaching, the surface soil becomes deficient in calcium, magnesium, and phosphorus. Naturally, the food crops grown on such soil

are also deficient in calcium and other base elements essentially needed in sound nutrition. Evidently, ricket and poor teeth development are not uncommon in places with humid tropical climate. The same author expresses views that laterization is the dominant and active soil forming process under such condition. As this soil had developed from limestone, Faraon clay shows a pH of 7.98 as analyzed by our chemical laboratory. This result of the chemical analysis shows that in spite of heavy precipitation, salts of some forms are still present in the surface soil. More so, the soil that has been developed from limestones is black instead of being red which is a characteristic of the laterites. The red soils mapped in Cebu belong to the Bolinao series. This series has hard and almost pure limestones. Such parent rocks yield to weathering under any set of rainfall. It is the soft limestone, a characteristic of Faraon series, which weathers fast and produces plastic, alkaline granular soil under dry or wet condition. The black surface soil like that of Lugo clay may be attributed to the coating of the clay soils with humus.

Faraon clay is friable, fluffy and granular and does not harden nor shrink upon drying. This soil characteristic is true of Lugo clay and at a glance, the soil in the field appears sandy. Unlike other clays, Faraon clay when dry can be easily picked with the hand and poured out in a manner that sand is sown over a seedbed. This property of the soil can be attributed to its high calcium content as mentioned in the case of the Lugo clay. However, due to insufficient data in the chemical analysis of the soils, the explanation why the hard limestone on northern Cebu produces red soils while the relatively soft limestone produces black soils can not be satisfactorily discussed. On the other hand, it is interesting to know that the Binangonan clay as classified in Rizal Province, which has been developed from hard limestones, produces black soils.

MECHANICAL ANALYSIS OF CEBU SOILS

Mechanical analysis has for its purpose the determination of the composition of the different grades or sizes of the minerals that compose the soil. These mineral particles are the sand, silt, and clay. The sand includes particles from 2.0 to .05 mm. in diameter, silt particles, 0.05 to 0.002 mm.. and clay, 0.002 mm. or less. Depending upon the amount of sand, silt, and clay fractions that make up the soil, the class name can be determined like sandy soil, sandy clay, clay loam, silt loam, clays, etc.

The textural grades of the different soil types of Cebu were first determined in the field by the usual feel-method. Then composite samples of each of the important soil types were collected in the field and analyzed in the laboratory to check the result of the field feel-method. The method of mechanical analysis followed in the laboratory was the modified Bouyoucos process using the conventional cylinder, thermometer and hydrometer. The samples, with the organic matter, were oven-dried before weighing. The result of the analysis is shown in table 10. Where the class name as determined by the mechanical analysis does not differ much from the class name given in the field, the latter class name is preferred.

It will be noted in table 9, that of the 11 soil types and phases classified in the province, 6 of them belong to clay class; 3, clay loam class; 1, loam class; and 1, sand class. The area of the clay class aggregates to 316,057 hectares representing 64.91 per cent of the land area of Cebu; clay loam class, 144,781 hectares or 29.74 per cent; silt loam class, 13,705 hectares or 2.82 per cent; and the sand class 1,660 hectares or 0.34 per cent. These figures show how extensive the clay soils in Cebu are distributed. The result of the mechanical analysis in table 10 further shows that all the soil types under class clay, except that of the Faraon clay, steep phase, has over 50.00 per cent of the clay fraction. The clay soils of Cebu have very high per cent of the clay fraction. The Faraon clay, steep phase has a relatively low percentage of clay and more of the sand fraction because this type being severely eroded had lost its finer fractions like the silt and clay.

TABLE 10.—*Showing the average mechanical analyses of some of the important soil types of Cebu Province* [a]

Type No.	Soil type	Sand 2.0–0.05 mm.	Silt 0.05–0.002 mm.	Clay 0.002–0.0 mm.
		Per cent	*Per cent*	*Per cent*
132	Faraon clay	27.32	21.50	51.28
153	Bolinao clay	23.47	19.73	56.80
155	Faraon clay, steep phase	43.02	19.12	37.86
156	Lugo clay	26.84	19.30	53.86
157	Mandawe clay loan	32.94	32.17	34.89
158	Mandawe silt loam	30.75	52.23	17.02
159	Medellin clay	18.55	14.81	66.64
160	Mantalongon clay loam	42.83	31.43	25.74
169	Baguio clay loam	50.98	22.85	26.17

[a] The modified Bouyoucos method of analysis was followed. Data represent analysis of the surface soils only. Analyzed by Isaac Aristorenas and Francisco Salazar of the Soil Surveys Section.

Usually soil with 40 per cent or more of the clay fraction is considered as clay soil. The high content of the clay fraction can be partly attributed to the organic colloids present in the soil sample.

FERTILIZER AND LIME REQUIREMENTS OF CEBU SOILS [1]

The most important consideration for conserving the soils of Cebu is its restoration and protection and building up of the lost fertility. Practically, the whole upland area is under certain degree of erosion. Eroded areas are not productive since most of their fertility had been removed. No amount of fertilizer materials could take the place of the lost fertility. Whatever soils are left must be built up through soil building processes before such soil can be made to yield optimum crops. The lowland soils on the other hand are at the mercy of the erosion materials from the uplands. If the eroded materials deposited on the lowlands come from the fertile upland soils, the resulting deposition is beneficial but, if such materials are composed of inert gravels or stones, the deposition is destructive. There are several areas on the lowlands of Cebu which originally have high productivity level, but are now abandoned because of the deposition of gravels from the upland.

In general, the soils of Cebu need no liming since most of the soils had been formed from calcareous materials. There are exceptional areas, however, which are slightly acidic. These are the Mantalongon and Baguio soils.

Soil fertility can be significantly improved by the incorporation of organic materials into the soil in the form of crop residues, farm manure, compost, and green manure crops. The addition of organic matter in the soil makes the use of commercial fertilizers more effective.

PRODUCTIVITY RATINGS OF CEBU SOILS

The productivity rating of the soil types is one of the latest contributions to the soil survey reports in supplementing the soil type description. This is considered as one of the promising developments in soil science today. The rating of the soil types is made during and after the field operation. Its aim is to assess each of the soil types and phases by assigning them index numbers which represent their productivity to be compared with standard productivity of 100. These ratings will show the productive association between a specific soil type and a given crop or the comparative productivity of the individual soil types.

[1] A more detailed information on this subject is treated in a supplement soon to be published.

The productivity ratings can be calculated by two general methods, namely, the inductive and the deductive methods.

The inductive method weighs the profile characteristics with the other soil conditions in relation to the production of any particular crop. Conditions and properties, such as depth of the soil layer, structure, texture, slope, erosion, organic matter, drainage, plant nutrient, etc., are considered in giving the index numbers. The total product of the individual index figure is the combined effect on productivity of the different soil characteristics. An example of this inductive method of rating was designed by Storie of the University of California. In this method, the value of the four factors, A, B, C, and X are multiplied to obtain the final productivity index. The explanation of Mr. Storie with reference to this inductive method of rating is hereunder quoted:

> This method of soil rating, known as the Storie Index is based on soil characteristics that govern lands, potential utilization and productive capacity. It is independent of other physical or economic factors that might determine the desirability of growing certain plants in a given location.
>
> Percentage values are assigned to the characteristics of the soil itself including the soil profile (Factor A); the texture of the surface soil (Factor B); the slope factor (Factor C); and the conditions of the soil exclusive of profile, surface texture, and slope—for example of drainage, alkali content, nutrient level, erosion and micro relief (Factor X). The most favorable and ideal conditions with respect to each factor are rated as 100 per cent. The percentage values or ratings for the four factors are then multiplied, the result brings the Storie Index rating of the soil.

This method of rating has advantages and disadvantages. One disadvantage is that any one of the above-mentioned four factors is enough to make the rating significantly low even if the other three factors are rated 100 per cent. In addition, the determination of the percentages of the factors A, B, C, and X is purely an estimate and is based on personal judgment. On the other hand, the Storie Index has been standardized for California soils where a wide variety of crops are grown and, therefore, its application elsewhere seems feasible.

The other method of rating the soil productivity is the deductive process where the rating is based upon the representative yield of a specific crop on the particular soil type. The

productivity rating of the soils of Cebu was based on this method. The standard yields are obtained by arbitrary selection on the basis of information relative to the average yield obtained for the different crops on different soils of the province where practices do not include the addition of commercial fertilizers or other soil amendments. Such information is gathered in the field, in census reports, statistical bulletins, and reports of the provincial Agricultural Supervisor. This method can only be applied with accuracy in a country where the yield per unit area are recorded and customary agricultural practices well established.

The productivity ratings of the various soil types of Cebu for the different crops are shown in Table 11. However, the total quantitative production of crops under each soil type cannot be figured until additional information on the hectarage of the individual soil types devoted to such crops are made available. In the determination of these ratings it should be stated that such factors as distance to markets, kind of roads, relative prices of farm products, cost of production, and other factors were not taken into consideration and, therefore, such ratings should not be interpreted entirely as a basic criterion for land valuation.

TABLE 11.—*Productivity ratings of soils in Cebu Province*

Soil types	Productivity ratings for[c]							
	Corn	Lowland rice	Sugar cane	Coconut	Tobacco	Cassava	Mungo	Maguey
Mandawe clay loam	59	30	75	80	67	53	85	80
Mandawe silt loam	59	55	75	(b)	75	66	100	80
Medellin clay	70	(a)	100	80	67	63	85	80
Beach sand	(a)	(a)	(a)	100	(a)	(a)	(a)	(b)
Faraon clay	35	(a)	(b)	80	60	20	71	66
Faraon clay, steep phase	24	(a)	(a)	60	(a)	7	(b)	(a)
Bolinao clay	35	(a)	(b)	80	60	20	71	70
Bolinao clay, steep phase	24	(a)	(a)	60	(a)	7	(b)	(a)
Lugo clay	41	(a)	75	60	100	33	71	76
Baguio clay loam	35	(a)	75	60	(a)	44	71	(a)
Mantalongon clay loam	47	66	75	60	(a)	44	71	(a)

[a] Not planted to this crop.

[b] Not planted on commercial scale.

[c] Under present system of management the average yields per hectare of the following crops have been established as standards of 100:

Lowland palay	60 cavans per hectare.
Tobacco	1,475 Kg. per hectare.
Corn	17 cavans per hectare.
Coconuts	3,750 nuts per hectare.
Sugar cane	80 piculs sugar per hectare.
Cassava	15 tons of roots per hectare.
Mungo	8 cavans per hectare.
Maguey	463 kilos per hectare.

It can be seen in the table that corn on Medellin soil has a rating of 70 per cent and, therefore, 30 per cent behind the standard, yet this soil is extensively planted to corn. For sugar cane, Medellin has a rating of 100 per cent. In general, Cebu soil is not adapted to rice growing and the area planted to rice is very insignificant. Coconut trees growing along the shore are more productive than those growing in the interior area. Lugo soil is suitable for tobacco culture so that most of the tobacco in Cebu are grown on this soil. The deep fertile soil of the province is good for cassava, yet most of the cassava are found on Bolinao clay soil and partly on Faraon clay soil. Bolinao and Faraon soils are extensively planted to maguey.

Agricultural crops in Cebu are not commonly fertilized. Only the sugar cane grown in Bogo-Medellin area receives commercial fertilizers. All the sugar cane grown in Cebu are milled in the sugar central established in the Bogo-Medellin area. Despite the fact that corn is the staple crop of Cebu and the yield of this cereal crop is not sufficient to meet the domestic need of the Cebuanos, yet no attention is directed towards the use of fertilizer to bring up the level of production of this major crop.

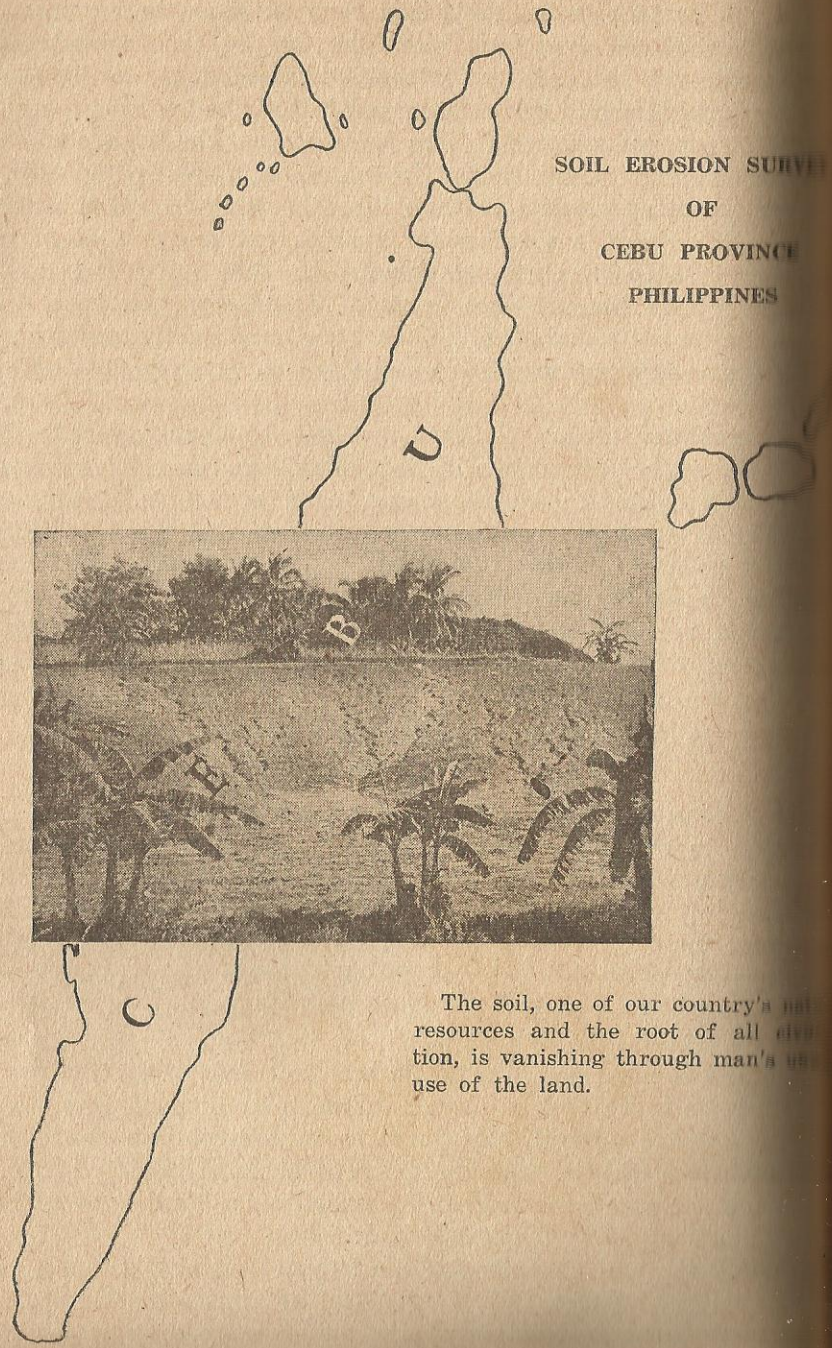
II. SOIL EROSION SURVEY OF CEBU PROVINCE

INTRODUCTION

Soil erosion began when man ceased to be nomadic and started to cultivate the land in order to satisfy his wants. "It began when the first heavy rain struck the first furrow turned by a crude implement of tillage in the hands of prehistoric man. It has been going on ever since, where man's culture of the earth has bared the soil to rain and wind."(39).

Soil erosion is one of the most dreaded factors in causing the depletion and deterioration of the land surface. Man generally induces soil erosion on the land and as such, he has the power to control it. And, unless man himself who uses the soil takes appropriate measures to control this abnormal phenomenon of soil wastage, our present farm lands will continue to be washed away at an exceedingly high rate to be uneconomical for agricultural cultivation later.

Man lives and depends for his support on the products of the soil; yet unknowingly, very often, he abuses his land with the consequent destruction of the soil resources on which he is dependent. According to Bennett,(39) "abuse or neglect of



The soil, one of our country's nat resources and the root of all civi tion, is vanishing through man's us use of the land.

the lands that sustained their populace and their commerce is believed to have played a major part in the decline of civilization now extinct." "In the decline of these civilizations, many factors other than erosion played a part. War and pestilence, for example, were common in the ancient world. But civilizations are rooted in the soil. Cities are fed on the produce of the land; much of their commerce depends on it. The very fact that regions scarcely habitable today once supported rich cultures is evidence in itself of the decline of the land. Parts of the west coast of South America, where the oldest known civilization in the Western Hemisphere existed are treeless and barren."

Soil erosion was noticed and reported in many countries like the United States, China, Japan, Java and Sumatra.

Whiteford, et al., (41) reported that in 1878 an American geologist, Stevenson, writing on the geology of Guernsey country, Ohio, U. S. A., called attention to the formation of deep gullies and to the wasteful operation of planting corn on steep hillsides and thin soils. Thorp(7) who spent some of his time in the study of soils of China, stated that "much of the soil erosion in that country is essentially a form of modification by man with the help of nature; that the population has made repeated assaults on the hill lands clearing away the trees or plowing up the sods only to be driven back to valleys again by soil erosion. The deforestation of the hills and the mountains of the rice region, not only has failed to furnish permanent farms for land hungry people but it is causing the good valley lands to be covered by sterile clay from the hills."

In Japan, Detwiler(37) stated that much of the soil erosion losses are controlled by regulating the tillage, intelligent farm management, reclamation practices, and care for the steeper land.

In Java and Sumatra according to Stewart(37), the system of wet land rice agriculture "sawah" was mainly responsible for the prevention of the loss of soil due to erosion. "In no place of the country where terraces are not found and it is not unusual to see individual terraces for each separate tree on the rubber plantation", he said.

Erosion had adversely affected almost every cultivated farm of the country, but up to the present time our farmers have failed to notice and realize the importance of soil erosion affecting crop yields.

In an agricultural country like the Philippines, in which the land is the basic means of livelihood and farming the main industry of the people, a study of soil erosion primarily to ascertain the extent of damage to the land is of paramount importance.

Cebu Province, whose land surface in general is predominantly rugged, hilly, and mountainous was selected for the present erosion survey study. It has an area of 486,850 hectares and a population estimated at 1,174,700 souls in 1946; its principal staple crop is corn, a soil-erosion-promoting crop.

It is the purpose of this survey to present in brief the character and extent of soil erosion in Cebu; to determine the factors that have contributed to soil losses by erosion; and to suggest possible means by which such soil waste may be minimized, if not totally eliminated.

SOIL EROSION DEFINED

Soil erosion is the removal of the soil particles from their original location through the agency of water, wind or ice. Erosion may be classified into two main groups—normal (geologic) and accelerated.

Normal or geologic erosion.—Normal or geologic erosion is the removal of soil particles under natural conditions operating through long periods of time. Since normal erosion is a geologic process going on at an exceedingly slow rate, this kind of erosion is not dealt with in the present report.

Accelerated erosion.—Accelerated erosion is the removal of soil material brought about by certain unusual natural conditions or as a result of man's use of the soil for his immediate needs or both. In early geological times when Cebu was under forest or natural vegetative cover, there was but very little accelerated erosion caused by fire, or by wild animals where these made their path, thus exposing the soil directly to the action of the beating rain. As a result of the increase in the population of the province, there was a corresponding increase in the land area opened and cultivated and subsequently, the removal of the soil particles was speeded up. The present paper is primarily concerned with this kind of erosion.

Accelerated erosion is caused principally by wind and running water. Although wind erosion may be active in some parts of the country, it is not so in Cebu, hence this kind of erosion will not be discussed in this report.

Water erosion can be divided further into three forms: sheet erosion, gully erosion, and stream-bank erosion. Sheet erosion is the uniform removal of a thin surface soil layer from a sloping land of considerably large area at approximately the same rate. Sometimes sheet erosion may be accomplished by the formation of little shallow channels called rills which, however, does not interfere with the normal cultivation.

Gully erosion.—Gully erosion is a process by which running water produces definite channels on the land surface too deep to be removed by normal tillage.

Stream-bank erosion.—It is the shifting of stream channels either by gradual cutting at the unprotected bends or by the formation of an entirely new channel during overflow stage.

METHODS USED IN MAKING SOIL EROSION SURVEY

The United States Department of Agriculture soil conservation handbook system of classification was followed in the reconnaissance erosion survey of Cebu(22). The degree of sheet erosion was determined by the extent to which the original surface soil has been washed away. This was accomplished by determining the depth of the original surface soil of a virgin woodland or grassland, which has never been cultivated and then comparing this depth with that of the cultivated fields. The difference in the depth was taken as the extent to which the original surface soil has been washed. This measurement was done for every soil type and erosion class established. For example, Plate 15 shows the differences of erosion that have taken place on Faraon and Lugo soils in Cebu Province.

The surface soil, originally of the Faraon clay type under grassland is 21 centimeters while that on the adjacent cultivated fields of the same soil type the surface soil and subsoil have already been lost through erosion. The Lugo soil under grasslands has surface soil 30 centimeters deep. On the cultivated fields adjacent to it with the same 60 per cent grade of slope, the surface soil and subsoil have already been washed away. Sheet erosion has removed all the fertile surface soils and subsoils of the uplands in Cebu so that in many parts, at present, farmers are practically farming on the infertile substrata or highly weathered limestone rocks. The degree of gullying was determined by the frequency and size of the gullies occurring in certain areas or soil types.

The total mean annual precipitation of Cebu as reported by the Philippine Weather Bureau(25) is 1,552.9 mm. The period of heaviest rainfall occurs during the months of June to November, with October having the heaviest downpour. The data on the intensity of rainfall of the province is very limited, as the records were all destroyed during the liberation of Manila in February, 1945. During the typhoon and flood of November 13, 1946, the local weather office in the province recorded a total precipitation of 97.9 mm. in 20 hours of rainfall. During the flood both gully and sheet erosion were severest on the unprotected fields. This is evidenced by the great amount of soil materials and rock fragments brought down from the uplands (Plate 22).

Slope.—The power of water to scour or erode the soil depends largely on its velocity and volume. Velocity is determined by the slope of the land and the volume is directly influenced by the size of the drainage canal. In general, the greater the per cent of slope the greater will be the speed of surface runoff; and a rapidly moving water has more eroding power and greater carrying capacity than the water moving slowly.

In the Philippines no soil erosion study has so far been made on the influence of the slope on soil erosion. Slope affects greatly soil erosion. At Bethany, Missouri, U. S. A., Conrey, et al.(13) stated that on an 8 per cent slope in continuous corn the soil loss was 61 tons per acre per year. At Columbia, Missouri, a similar soil under similar conditions with a slope of 3.7 per cent lost but 20 tons of soil. In Cebu where a considerably large percentage of the land under cultivation is rolling and rugged, with slopes varying from 10 per cent to 180 per cent, erosion is generally serious ranging usually from moderate to severe type (Plate 16).

Soil.—Soil is a factor that affects soil erosion. Different soils have different resistibilities to the action of water. Soils that have good permeability and contain plenty of organic matter absorb and hold water readily. Soils with these characteristics are generally resistant to erosion. The capacity of the soil, therefore, to absorb water depends entirely on its physical characteristics, the most important of which are the texture, structure and the organic matter content. In coarse-textured soils, permeability is high and absorption of water is quite fast. This condition is, generally, unfavorable for the surface runoff to develop and cause erosion. In fine-textured soils, however, structure plays an important part in the absorption of water. A clay soil for example with a granular structure absorbs water readily and is, therefore, fairly resistant to erosion. As organic matter in the soil has the property to increase the water-holding capacity, it also promotes granulation which influences the absorptive capacity of the soil for water subsequently reducing greatly the surface runoff. The decrease in the organic matter content of the soil as a result of the continuous cropping of the land apparently would increase the susceptibility of the soil to erosion. Many of the upland soils of Cebu have already lost their surface soil, and only the infertile subsoil which is relatively deficient in organic matter is left exposed on top.

Vegetative Cover.—The kind and density of the vegetative cover is very important in determining the type of erosion that will take place on a land. For example, different soil covers such as forest cover, grass cover, pasture grass cover and cultivated crop cover, will give rise to different soil erosion conditions. Land covered with undisturbed forest naturally will not be much affected by erosion, primarily because most of the rain reaching the ground is absorbed by the leaf litter and the underlying porous soils. Grass may be nearly as effective as the forest cover in minimizing surface runoff. Permanent pasture will exhibit different conditions of soil erosion as grazing destroys the leaf litter and compacts the soil. The trampling of the land by animals will destroy the protective cover thereof and tends to increase soil erosion.

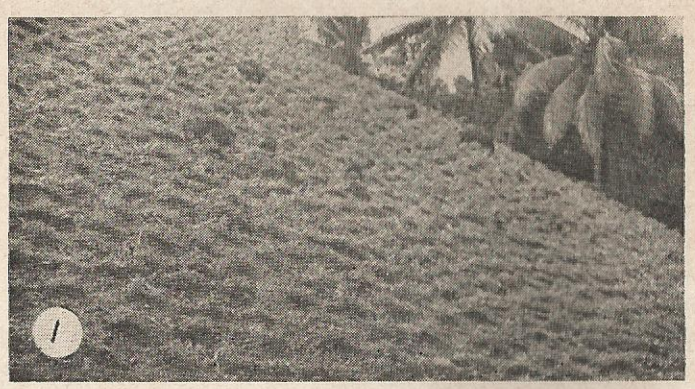
Land under constant cultivation suffers the most from severe erosion. This is especially true in Cebu Province where the land is plowed or cleared for planting just before the rainy season begins. At this state when the soil is cultivated and totally bare of its protective cover, even light rains will invariably induce soil erosion on the land, especially so on lands with steep slopes.

In the foregoing discussion, the factors affecting soil erosion have been enumerated in a general way. Before discussing the character and severity of erosion in the different soils of Cebu and the various possible control measures in relation to the properties of the soil, the main causes of the present soil erosion conditions should be evaluated. Careful observation in the field, coupled with the information obtained from the farmers during the progress of the survey has revealed several important facts to which may be traceable the serious condition of soil erosion of the province, namely:

1. *The farmers are misusing the land by cultivating many steep slopes to clean-culture crops like corn, tobacco, camote etc.*—The cultivation of steep mountain and hill slopes, owing to the limited agricultural land areas in the valley as a result of the increase in population of the province, has brought about this serious condition of soil erosion. The farmers in many instances, planted corn and tobacco on land having 90 to 180 per cent slopes, a practice which is virtually detrimental to the land. Steep slopes such as these, whenever planted to clean-tilled crops are bound to be adversely affected by soil erosion. In many of these slopes, the farmers build simple terraces by piling up logs and debris along the contour to minimize the washing down of the surface soil (Plate 10, Fig. 2, and Plate 4, Fig. 2). Although soil erosion is to a certain extent minimized, this practice of terracing is certainly not economical nor practical. It has been found that most of the severely eroded areas of the province occur where the lands have slopes greater than 25 per cent. In cultivated areas where the slopes are from 5 to less than 25 per cent, the degree of erosion generally varies from slight to moderate types. However, areas where the slope of the land is 3 per cent or less show apparently no sign of soil erosion.

The deplorable condition of soil wastage in Cebu is primarily attributed to the past and present misuse of the land, the evil consequences of which the farmers have apparently failed to realize.

2. *Improper soil-and-crop-management practices used by the farmers of the province.*—The present soil-and-crop-management practices employed by the farmers are improper from the standpoint of soil conservation farming. Owing to the limited lowland area of the province, farming is most commonly carried out on the uplands. As a result of the extensive and continuous cropping of these uplands, serious erosion has been developed. The farmers do not adopt sound soil-and-crop-management practices, such as contour tillage, strip cropping, crop rotation, cover cropping, green manuring, and application of farm manures and commercial fertilizers, all of which are important measures in minimizing soil erosion and maintaining the fertility of the land. Pressed by the necessity to survive, most farmers are impelled to plant corn after corn on their upland farms only to find themselves in poverty as a result of soil erosion. By the time the farms fail to produce substantial crops because of the worn-out soil, the land is generally abandoned bare at



Cultivation of this steep farm land at Argao is one of the main causes of the fast wearing down of the soils of the province. This soil is Faraon clay on a 60 per cent slope.

This "kaingin" at Carcar is also on Faraon clay with a slope of 160 per cent. Note the man standing in the gully formed as a result of erosion.

PLATE 10.

the mercy of nature. The clearing of other forest areas is again started all over. This century-old "kaiñgin" system of farming is one of the major causes that has brought Cebu to its present deplorable and disastrous condition of soil erosion.

Again, in an attempt to facilitate drainage of the land, the row of crops is being arranged up and down the slope. This practice has considerably increased the loss of surface soil through runoff water that carries tremendous amounts of soil materials in its downward movement through the furrows. Consequently, shallow gullies which increase in size with the years, if not obliterated, are formed on the land. Gully erosion is most commonly found on sloping lands of the Lugo and Faraon soil series.

3. *Failure on the part of the farmers to appreciate and realize fully the ever-decreasing fertility of the land and the damage caused by erosion on their farms.*—It has been observed that most farmers of the province do not seem to realize the adverse effect of erosion on their farms. In several instances, the antiquated ideas of farming still persist among them. In general, most farmers do not adopt modern farming practices to conserve soil and its fertility. Moreover, the lack of record on the effects of erosion on crop yields is undoubtedly the reason why Cebu farmers are not alarmed of the ill-effects of soil erosion.

SOIL EROSION IN THE DIFFERENT SOIL AREAS

In order to picture clearly the different degrees of erosion that have been existing throughout the province, it is obviously necessary to present in brief the conditions of erosion taking place in each soil type and the role this soil type plays in causing soil eroson. For practical purposes, Cebu soils are arranged according to topography into several groups which, apparently, have somewhat similar erosion conditions. These groups are as follows:

I. Soils of the lowland:
  1. Alluvial soils
    a. Beach sand—well-drained soil
    b. Hydrosol—poorly-drained soils
    c. Mandawe soils—imperfectly drained soils
  2. Deep soils developed on highly weathered limestone
    a. Medellin soils

II. Soils of the upland, hilly and mountainous areas:
  1. Soil developed from coralline limestone formation
    a. Faraon soils
    b. Bolinao soils

ping. In general, these soils suffer more serious sheet erosion than the lowland soils because of the differences in topography, vegetative cover, cropping system, and the character of the soils, which, invariably, are important factors in soil erosion.

Faraon soils.—The soils of the Faraon series are primary soils having been developed from almost purely coralline limestone formations of the province. The topography of the area varies from undulating to rolling, hilly and mountainous. These soils are generally shallow with varying degrees of soil erosion. These series, constituting an area of 127,951 hectares, include the most extensive soils of the province, occupying almost the entire elevated portion from the northern to the southern parts of Cebu. The slope of the land varies considerably ranging from 5 to 160 per cent (Plate 16). Because of these differences in the slope and farming practices, considerable variations exist in the degree of erosion. This series is composed of two soils—the Faraon clay type and the Faraon clay, steep phase.

The Faraon clay, whenever cultivated to crops, is bound to be eroded owing to the sloping topography of the land and the impervious character of the soil which accelerates runoff. The degree of erosion increases with the slope of the land.

The effect of erosion is closely associated with the use of the land. The more intensively a land is used the greater the erosion will be. The presence of large quantities of lime rock fragments and similar erosion pavements left on the surface after erosion, minimizes to some degree the impact of rainfall on the surface and, therefore, prevents further washing of the soils. Intensive cropping as already stated causes erosion ranging in degree from moderate to severe condition (Plate 18). To better insure minimum soil loss, slopes greater than 30 per cent should be retired as cropland and instead grown to crops that will provide permanent cover of the soil.

The Faraon clay, steep phase includes the steeper lands of the Faraon soils. The slope of the land generally ranges from 80 to 160 per cent. Whenever this soil is grown to cultivated crops like corn and tobacco, severe erosion occurs. With the intensified system of farming prevailing in Cebu, especially that carried on steeper slopes, the maximum effect of soil erosion would certainly occur. If this practice is prolonged, the land would totally be ruined with the years. One imperative soil measure that necessitates immediate change to safeguard

A typical class 1 erosion on Bolinao clay in Mactan Island. The slope is only 3 per cent. The white spots on the surface are limestone rocks or erosion pavements.

This is another typical class 1 erosion on Faraon clay, with a slope of 3 to 5 per cent in Mandawe. Note the good growth of bananas.

PLATE 17.

soil wastage is to retire steep slopes from cropping and devote them to the growing of perennial plants.

Bolinao soils.—This soil, like the Faraon soils, is a primary soil that has developed from the limestone rock formation of the province. Faraon soils are dark or black soils; Bolinao soils are redish brown in red or brick red in color.

The Bolinao clay type of soil dominates the northern part of Cebu which includes the island of Camotes and Bantayan. This soil, with varying degrees of soil erosion ranging from slight to moderate and severe types, comprises an area of 58,575 hectares. Although soil and climate are general factors affecting soil erosion, under Cebu conditions, the slope and the system of cropping have primarily exerted greater influences on the severity of soil erosion in Cebu. Soil erosion in this area is generally serious to severe, depending on the topography of the land. On undulating areas where the slope ranges from 3 to 10 per cent only, erosion is generally slight to moderate in spite of the intensive cropping of the land.

Lugo soils.—The Lugo soils, like the Faraon and Bolinao series, are primary soils having been developed from the calcareous shales or limy shales of the province. Ordinarily, the surface soil ranges in color from brown to dark brown stiff clay and the clay subsoils vary in color from light brown to light yellowish brown. These soils occur on the northern, southern, and south central part of the province, the latter section representing the largest area. Like the Faraon soils, these soils have varying topography ranging from moderately rolling to strongly rolling and hilly with an area of 98,321 hectares. The slope of the land ranges from 10 to 160 per cent, the steeper portion being on the south central part of the province. Erosion on these soils is generally serious to severe, primarily because of the continuous cropping of the land to corn and tobacco (Plate 18, Fig. 2). The cultivation of the steeper slopes to seasonal crops which otherwise would have been retained as woodland, has contributed a great deal to the present seriousness of soil erosion.

The Lugo series is represented by a type and a phase—the Lugo clay and the Lugo clay, steep phase. Although these soils are both clay in texture, they differ variably in their topography and land-use capability which significantly affect soil erosion. The Lugo clay soil generally occurs on moderately sloping land ranging from 10 to 50 per cent slope, while the Lugo clay, steep phase soil occurs on steeper areas whose slope

generally ranges from 80 to 160 per cent. Owing to the heavy and tight condition of the surface soil and subsoil, water percolates at exceedingly slow rate which, under similar condition on steep slope, runoff water could have excessively formed on the surface, creating excessive velocity and volume destructive to soil management. It is, therefore, to be expected that these two soils, Lugo clay and the Lugo clay, steep phase, if subjected to the same system of cropping would induce more erosion on steeper slope soils than it would on soils of moderately sloping land.

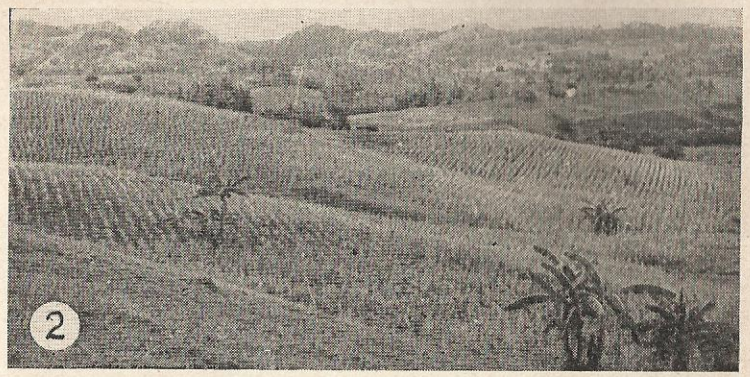
Baguio soils.—This soil has developed from the igneous rocks or "basement complex" formation of Cebu through the ages by the factors of soil formation. The light brown to dark brown clay loam characterizes the physical make up of the solum of this soil. Unlike the Faraon, the Bolinao and the Lugo soils which are characterized by heavy, stiff, tight surface soil and subsoil, the Baguio soil has a somewhat better physical condition, it being a lighter soil. The natural friable condition of this soil makes it easily permeable to water; and when a soil is readily permeable to water the percentage of runoff becomes relatively low because much of the rain water is absorbed by the soil.

The Baguio soil, with an area of 96,336 hectares, has a rough topography and occurs on the central part of the province. The slope ranges from 20 to 180 per cent. Erosion in this soil generally varies from moderate to severe types depending largely on the grade of slope and on the extent the land was used for cropping (Plate 20, Fig. 2). Ordinarily, this kind of soil is not suitable for cultivation, primarily because of the steepness of the slope of the land. There are portions, however, with moderate slopes that may be cultivated with certain limitation. These are the few areas found on depressions and valley-like formations.

Land misuse is responsible for the present serious condition of erosion in the Baguio soil which apparently is true with the other soils of the uplands, like the Faraon, Lugo, Bolinao, and other soils. The farmers have exploited and mined the soil unwisely to their satisfaction only to find themselves among the victims of soil erosion.

Mantalongon soil.—This soil is a primary soil occurring on the upper region of the barrio of Mantalongon, Dalaguete, and has developed largely from a non-calcareous shale. It has an area of 20,225 hectares. The physical conditions of this soil

A typical class 2 erosion (moderate erosion) on Faraon clay, with a slope of 6–8 per cent in Naga.



A typical class 22 erosion on Lugo clay, with a slope of 15–20 per cent in Bogo. Note the rows of corn laid up and down the slope.

A class 22B erosion on Lugo clay on a 20–25 per cent slope also in Lugo. This area was once planted to corn. Note the rills and gully formed.

PLATE 18.

A class 3 erosion (serious to severe erosion) on Faraon clay, with a slope of 35–45 per cent in Carcar. This area was grown to corn for many years. The white spots on the surface are the subsoil layers exposed after the surface layers had been washed off.

A class 3B erosion on Faraon clay with a slope of 35–55 per cent in Naga. Planted to corn, the gully is the result of land misuse.

are very much like those of the Baguio soils which have friable surface soil and subsoil, and with a somewhat similar topography ranging in slope from 40 to 180 per cent, the dominant slope being from 70 to 120 per cent. Erosion in this soil is rather serious to very severe, principally because of the intensive cultivation of the land for the production of row crops like corn, cabbage, pechay and camote. While the character of the soil plays an important factor in soil erosion, steepness of slope, cropping system and rainfall are much more important factors in affecting soil erosion on the land. Though Mantalongon soil is physically good and resistant to erosion, yet with steep topography and intensive cropping of the land under heavy rainfall characteristic, the soil cannot permanently rest in its place because of runoff water.

EFFECTS OF SOIL EROSION

Soil erosion that has heretofore taken place in Cebu due to unwise exploitation of the land and improper cultural practices has resulted in many forms of destruction, namely:

1. *The topsoil or the entire soil mass is lost through erosion.*— Soil erosion is a destructive process to the physical make-up of the land. The loss of the surface soil does not only mean the washing away of the mineral soil particles that compose its mass but also of the nutritive constituents, the biological population, and the organic matter content of the soil, all of which are very essential to grow a normal crop. Bennett(5) reported that as much as 21 times of plant food nutrients are lost from the soil by erosion as are removed by crops. After the topsoil is removed by erosion, the subsoil, which is relatively more deficient in plant nutrients than the surface soil, is exposed on the surface. According to Bennett, the surface soils produce from 2 to 10 times greater yields than the subsoil. In Cebu it is a common scene to see farmers farming on the subsoils. This indicates that the soils of Cebu are badly eroded. If the present rate of erosion in Cebu is not controlled, many of the farm lands of the province would eventually be ruined.

2. *Destruction to crops, cropland, bridges, houses, and lives.*— The destruction of the vegetal cover of the upland starts soil erosion. If soil erosion is too excessive, the scouring effects extend into the inert substratum. Apparently, tremendous amount of soil materials are washed down into the croplands. The standing crops are destroyed and the lands are rendered difficult for cultivation. On November 13, 1946, while the erosion survey

of Cebu was in progress, a torrential rain hit the central part of the province. Many of the farm lands in Naga, Minglanilla, San Fernando, Carcar, Toledo, and Aloguinsan were covered with sediments of silt, sand, and chert fragments from a few inches to 3 feet deep, destroying the crops and rendering some of the farm lands below unfit for cultivation (Plates 21 and 22). Cobblestones and lime rock boulders were brought down causing great destruction on the lowland. As a result many bridges, roads, houses, and even human lives were destroyed or lost during this flood.

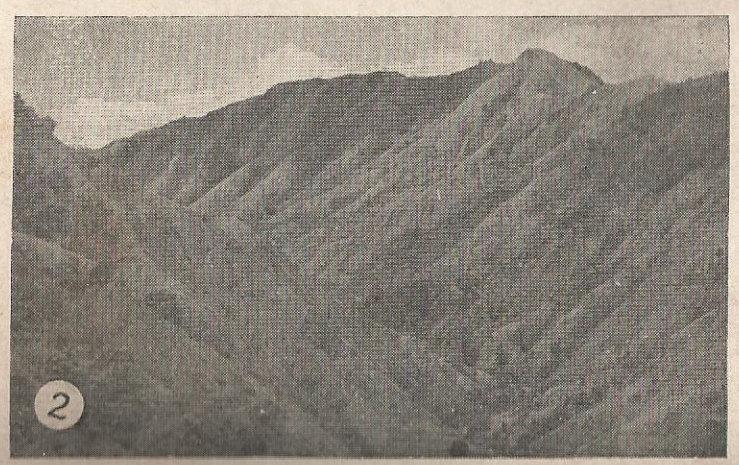
3. *Flood and drought hazards are increased as a result of soil erosion.*—The removal of the topsoil decreases invariably the capacity of the soil to hold water and inversely increases the rate and amount of runoff causing soil erosion and floods. In an experiment conducted under the direction of M. F. Miller in 1917, Enow and Musgrave(39) stated that as much as 11.6 per cent of the rain water that fell on the sod was lost through runoff, while on the cornland the loss was more than 27 per cent. Nearly all the soils of Cebu have compact surface soil and subsoil. Such physical characteristic of the soil naturally would enhance surface runoff. The absence of vegetation on the land that protects the surface from the impact of rainfall further increases excessive runoff which causes soil erosion and flood.

Drought is the opposite of flood. Any decrease in the amount of water infiltration into the soil will materially reduce the supply of ground water. The increase, therefore, of runoff water on the land not only causes flood but drought hazards as well. Thus, in badly-eroded areas in Cebu, plants generally suffer greatly from lack of water during the dry months of February, March and April.

4. *The silting of highways, waterways, channels, reservoirs, and harbors are adverse effects of soil erosion.*—Negligence and misuse of the land that supports humanity, as a rule, open the way to soil erosion. In Cebu the flood that occurred on November 13, 1946, resulted in the destruction of properties and the loss of lives. This flood caused the silting of highways to a depth of few inches to 3 feet in the vicinity of San Fernando, Carcar, Aloguinsan and Toledo. Some of the waterways and river channels of Cebu had been filled up to capacity with silt, sand, and gravel brought down by water from the uplands.

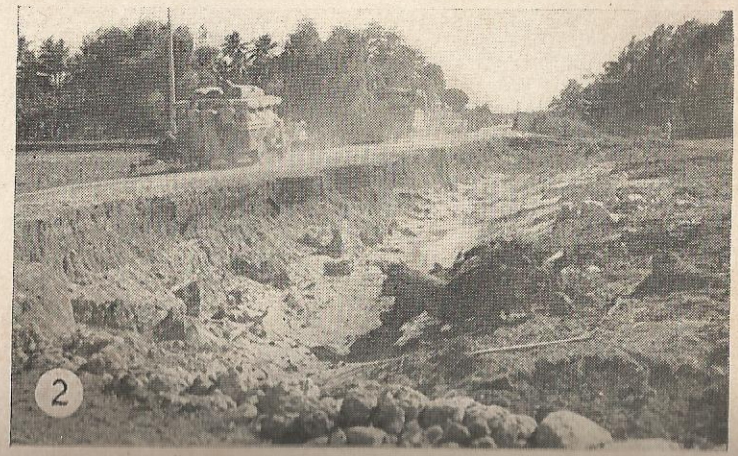
Cebu harbor, which is considered to be the best harbor in the Visayas and is comparable to that of Manila, is becoming shallower with the years due to sedimentation. It is predicted

Severe to excessive erosion takes place on the rolling upland of Lugo clay soil, with a slope of 45–120 per cent. This farm land in Borbon is being continuously planted to corn and tobacco.

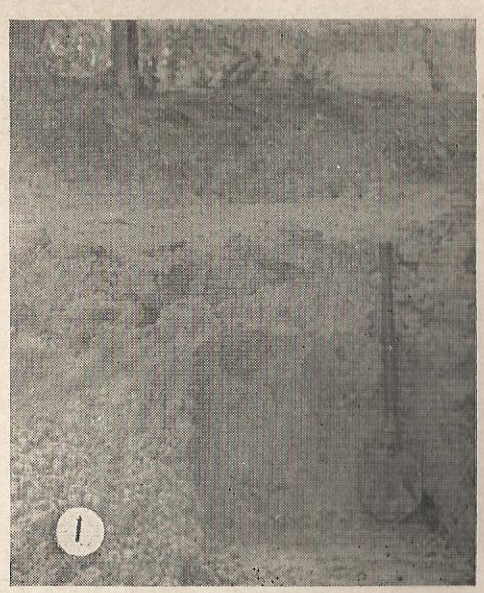


A class 5 erosion on Baguio clay loam with a slope of 80–160 per cent along the Toledo-Minglanilla road. Cultivation on this kind of land has resulted in accelerated erosion.

Destruction due to soil erosion is evidenced on this corn and sugar cane field at Minglanilla, destroyed as a result of the deposition of materials from the uplands.



The side of the highway at Carcar destroyed by flood which occurred after the heavy rains of November 13, 1946.



A portion of the highway at Carcar covered with silty materials washed off from the uplands. This deposit was found to be nearly two feet deep.

A corn field at Carcar was similarly covered by silty materials to a depth of 18 centimeters of sterile soil. Note the corn plants that were washed down by the flood.

that at the rate of soil erosion taking place in the province, in time, the beautiful harbor of Cebu will be filled up with different sediments and its usefulness may be lost in the near future.

EROSION CONTROL MEASURES PRESENTLY EMPLOYED IN CEBU

The control of soil erosion in the Philippines was started long before the coming of the Spaniards. This is evidenced by the super-engineering structures of the Banaue terraces in Mountain Province built by the Ifugaos in the early days. In Cebu, where the topography of the land is similar to that of the Mountain Province, no such magnificent structures have ever been built probably because of lack of sufficient skill of the soil tillers. However, because of the necessity to increase and maintain high crop yields, the farmers adopted soil-erosion control practices as follows:

1. *Terracing the steep slopes and hillsides.*—Although terracing is not a common practice in Cebu, there are a number of conscientious farmers who have terraced their farms to insure sustained crop production. By terracing, the optimum yield of crops is increased or maintained because the soil and its fertility are conserved.

These terraces are made up of gravel and boulder dikes, and occasionally, they are made up of logs, branches and twigs. On very steep slopes, terracing seems impractical.

2. *Planting of ipil-ipil to rejuvenate the soil after the land has been cropped for a year or two.*—After a piece of land has been grown to crops like tobacco, corn, etc., for a year or two, ipil-ipil seeds are broadcast and allowed to cover the land from 3 to 5 years. They are then cut down, and the land is used again for cropping (Plate 23). Although this practice is beneficial to the land because of its rejuvenating effect upon the soil, its use must be limited to less steeper slopes.

3. *Reforestation program of the Bureau of Forestry.*—The object of reforestation of the non-agricultural lands of Cebu is to make this province self-sufficient in timber. The incidental aim of reforestation in the form of soil conservation is equally important. But inasmuch as reforestation is a slow process, it should be supplemented by other soil conservation practices to minimize the fast wearing down of the soil.

SOME SUGGESTED METHODS FOR CEBU SOIL EROSION CONTROL

The intrusion of man into the natural state of soil equilibrium is largely responsible for the present serious soil erosion condition in Cebu. The failure of the farmers to realize the detri-

mental effect of such erosion which has been attributed to the unwise use and poor management of the land has caused the enormous losses of the once relatively fertile soils of the province. In order to minimize soil depletion, the farmers must be acquainted with some methods relative to soil-erosion control measures.

A good approach to the soil erosion control problem of Cebu is to adopt a well-planned system of land-use. Such a system will involve a variety of control measures which may need a thorough and intensive study to suit existing conditions. However, for purposes of general information, soil erosion in Cebu can be controlled by adopting a program of work as follows:

1. *Education of the farmers.*—One of the effective ways of solving the problem of soil erosion in Cebu is to educate the farmers on the methods of soil conservation. This could effectively be done by actual field demonstrations of the accepted practices in soil conservation farming. It should be borne in mind that soil is the greatest natural resource of this country and the failure to conserve it would mean the downfall of our basic industry—farming. Optimistically, the result of field demonstration can easily be absorbed by farmers and thus, the change of the present farming into a better system will not be long.

2. *The need for proper land-use.*—There are at present vast areas of ruined and badly-eroded steep lands in Cebu that are grown to corn in spite of the fact that such lands are submarginal to this crop. These conditions are common in Cebu and, therefore, something must be done to remedy the situation in order to prevent further soil erosion. The steep and badly-eroded lands should be permanently devoted to woodland. Worn-out lands, if further cultivated to crops, would eventually be ruined totally. It will be a constructive program if these steep and badly-eroded areas in Cebu are purchased by the government for reforestation or permanent planting to perennial plants of economic value.

For the sake of farm posterity, one essential conservation practice which needs immediate implementation is the proper land-use planning. Discourage the cultivation of row crops on sloping areas and assign to these areas permanently growing crops like citrus, coconut and other fruit trees adapted to the climatic condition of the place. With this system of planning the inherent capability of the land is not disturbed and the maximum crop yield attainable is derived.

The growing of a thick vegetative cover is a good way to control erosion. Some farmers have learned by experience that growng ipil-ipil on poor soil will make it productive later. A portion of the land was cleared and planted to tobacco.

Another field in Sugod was cleared of ipil-ipil for planting. Ipil-ipil is also used as a cover crop in coconut plantations.

PLATE 33.

3. *Application of conservation measures.*—Slope farming is a destructive practice if the present system of plowing the fields up and down the slope is continued. There are, however, remedies to justify the continuance of farming the slope. Instead of running the furrows up and down the slope, contour furrows are laid across the slope. In other words, all land operations are made along the contour. The object of contour farming is to intercept the runoff water, minimize its velocity and volume and carry it slowly down the slope.

4. *Stop century-old "kaiñgin" method of farming.*—The "shifting" agriculture or the century-old "kaiñgin" system of farming is still a common practice in Cebu. From the early to the present, the kaiñgin system of farming has been carried on in the province and the consequent result is the destruction of the forest and the exposure of the soil to the action of rainfall that causes erosion. The only alternative to check the further loss of soil and to conserve the forest product is to discourage this faulty "kaiñgin" system of farming for the benefit of the farmers themselves and the coming generation.

5. *Adopt efficient soil-management practices.*—Not ignoring the deleterious effects of soil erosion, the farmers in Cebu in another way have been doing injustice when they neglect to put back to the soil the amount of plant food nutrients taken by their crops year after year. Thus fertility depletion joins hand with soil erosion to pull down the yield of crops. The remedy is simple and fast. Application of commercial fertilizers is all that is necessary to correct soil nutrient deficiency. And to get the maximum benefit from this soil corrective, green manuring, addition of farm manure, incorporation of organic matter, proper tillage and irrigation management must all come together to constitute sound soil-management program for increased yield.

ACKNOWLEDGMENT

The authors wish to express their sincere appreciation to Mr. Dominador Z. Rosell, Chief, Division of Soil Conservation Surveys, under whose guidance this work was planned and conducted. Acknowledgment is also extended to Mr. Jesus P. Mamisao, Chief, Division of Soil Conservation Operations, and Mr. Ricardo T. Marfori, Chief, Division of Soil Laboratories. The writers are indebted to Mr. Fernando de los Reyes, Assistant, Office of the Director, for his valuable suggestions and for going over the manuscript.

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GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN CEBU PROVINCE

Common name	Scientific name	Family name
Abaca	*Musa textilis* Nee	Musaceæ.
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceæ.
Amugis	*Koordersiodendron pinnatum* (Blanco) Merr.	Anacardiaceæ.
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceæ.
Api-api	*Avicennia marina* (Forsk.) Vierb. var. *alba* (Bla.) Bakh.	Verbenaceæ.
Anubing	*Artocarpus cumingiana* Trec.	Moraceæ.
Anislag	*Securinega flexuosa* Muell.-Arg.	Euphorbiaceæ.
Arrowroot	*Maranta arundinacea* Linn.	Marantaceæ.
Aroma	*Acacia farnesiana* (Linn.) Willd.	Leguminosae.
Bakauan-lalaki	*Rhizophora candelaria* DC.	Rhizophoraceæ.
Bagi-lumbang	*Aleurites trisperma* Blanco	Euphorbiaceæ.
Balete	*Ficus altissima* Blume Bijdr.	Moraceæ.
Banuyo	*Wallaceodendron celebicum* Koord.	Leguminosae.
Bananas	*Musa sapientum* Linn.	Musaceæ.
Bagalonga	*Melia dubia* Cav.	Meliaceæ.
Bagadna	See Bagalonga	
Bamboo	*Bambusa spinosa* Roxb.	Gramineæ.
Breadfruit	*Artocarpus communis* Forst.	Moraceæ.
Bermuda grass	*Cynodon dactylon* (Linn.) Pers.	Gramineæ.
Buyo	*Piper betle* Linn.	Piperaceæ.
Betel nut	*Areca catechu* Linn.	Palmae.
Buri	*Corypha elata* Roxb.	Palmae.
Bongalon	*Panicum stagninum* Retz.	Gramineæ.
Binunga	*Macaranga tanarius* (Linn.) Muell.-Arg.	Euphorbiaceæ.
Biga	*Alocasia macrorrhiza* (Linn.) Schott	Araceæ.
Cadios	*Cajanus cajan* (Linn.) Millsp.	Leguminosae.
Cauliflower	*Brassica oleracea* Linn. var. *botrytis* Linn.	Cruciferæ.
Cabbage	*Brassica oleracea* Linn. var. *capitata* Linn.	Cruciferae.
Cacao	*Theobroma cacao* Linn.	Sterculiaceæ.
Camote	*Ipomoea batatas* (Linn.) Poir.	Convolvulaceæ.
Cassava	*Manihot esculenta* Crantz	Euphorbiaceæ.
Coconut	*Cocos nucifera* Linn.	Palmae.
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineæ.
Coffee	*Coffea arabica* Linn.	Rubiaceæ.
Cotton	*Gossypium hirsutum* Linn.	Malvaceæ.
Corn	*Zea mays* Linn.	Gramineæ.
Coronitas	*Lantana camara* Linn.	Verbenaceæ.
Cowpeas	*Vigna sinensis* (Linn.) Savi	Leguminosae.
Derris	*Derris elliptica* (Roxb.) Benth.	Leguminosae.
Dita	*Alstonia scholaris* (Linn.) R. Br.	Apocynaceæ.
Eggplant	*Solanum melongena* Linn.	Solanaceæ.
Everlasting	*Anaphalis* sp.	Compositae.
Gabi	*Colocasia esculenta* (Linn.) Schott.	Araceæ.

Garlic	*Allium sativum* Linn.	Liliaceæ.
Ginger	*Zingiber officinale* Rosc.	Zingiberaceæ.
Indigo	*Indigofera suffruticosa* Mill.	Leguminosae.
Ipil	*Instia bijuga* (Colebr.) O. Kuntze	Leguminosae.
Ipil-ipil	*Leucaena glauca* (Linn.) Benth.	Leguminosae.
Jackfruit	*Artocarpus heterophyllus* Lam.	Moraceæ.
Kalamansi	*Citrus microcarpa* Bunge	Rutaceæ.
Kalantas	*Toona calantas* Merr. & Rolfe	Meliaceæ.
Kapok	*Ceiba pentandra* (Linn.) Gaertn.	Bombacaceæ.
Lagolo	*Acrostichum auereum* Linn.	Polipodiaceæ.
Lauan (white)	*Pentacme contorta* (Vidal) Merr. and Rolfe	Dipterocarpaceæ.
Langaray	*Bruguiera parviflora* (Roxb.) W. and A.	Rhizophoraceæ.
Lanzones	*Lansium domesticum* Correa	Meliaceæ.
Lemon	*Citrus limonia* Osbeck	Rutaceæ.
Lemon grass	*Andropogan citratus* DC.	Gramineæ.
Lettuce	*Lactuca sativa* Roxb.	Compositae.
Maguey	*Agave cantala* Roxb.	Amaryllidaceæ.
Makaasim	*Eugenia aherniana* C.B. Rob.	Myrtaceæ.
Malugai	*Pometia pinnata* Forst.	Sapindaceæ.
Malungay	*Moringa oleifera* Lam.	Moringaceæ.
Mango	*Mangifera indica* Linn.	Anacardiaceæ.
Marig	*Eugenia glaucicalyx* Merr.	Myrtaceæ.
Millet	*Panicum miliaceum* Linn.	Gramineæ.
Molave	*Vitex parviflora* Juss.	Verbenaceæ.
Mungo	*Phaseolus aureus* Roxb.	Leguminosae.
Nato	*Palaguium luzoniense* (F.-Vill) Vidal	Sapotaceæ.
Narra	*Pterocarpus indicus* Willd.	Leguminosae.
Nipa palm	*Nypa fructicans* Wurmb.	Palmae.
Onion	*Allium cepa* Linn.	Liliaceæ.
Oranges	*Citrus aurantium* Linn.	Rutaceæ.
Pagatpat	*Sonneratia caseolaris* (Linn.) Engl.	Sonneratiaceæ.
Papaya	*Carica papaya* Linn.	Caricaceæ.
Patani	*Phaseolus lunatus* Linn.	Leguminosae.
Peanut	*Arachis hypogaea* Linn.	Leguminosae.
Pechay	*Brassica chinensis* Linn.	Cruciferae.
Pepper	*Capsicum frutescens* Linn.	Solanaceæ.
Piagao	*Xylocarpus moluccensis* (Lam.) M. Roem.	Meliaceæ.
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceæ.
Pummelo	*Citrus maxima* (Burm.) Merr.	Rutaceæ.
Radish	*Raphanus sativus* Linn.	Cruciferae.
Rattan	*Calamus blancoi* Kunth	Palmae.
Rice	*Oryza sativa* Linn.	Gramineæ.
Sakat	*Terminalia calamansanai* (Blco.) Rolfe	Combretaceæ.
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae.
Sorgo	*Andropogon sorghum* (Linn.) Brot.	Gramineæ.
Soybean	*Glycine max* (Linn.) Merr.	Leguminosae.
Siniguelas	*Spondias purpurea* Linn.	Anacardiaceæ.
Sugar cane	*Saccharum officinarum* Linn.	Gramineæ.

Squash	*Cucurbita maxima* Duchesne	Cucurbitaceæ.
Tobacco	*Nicotiana tabacum* Linn.	Solanaceæ.
Tabigui	*Xylocarpus granatum* Koenig	Meliaceæ.
Tangal	*Ceriops tagal* (Perr.) C. B. Rob.	Rhizophoraceæ.
Talahib	*Saccharum spontaneum* Linn. Subsp. *indicum* Hack	Gramineæ.
Tindalo	*Pahudia rhomboidea* (Blanco) Prain	Leguminosæ.
Tugue	*Dioscorea esculenta* (Lour.) Burkill	Dioscoreaceæ.
Ubi	*Dioscorea alata* Linn.	Dioscoreaceæ.
Upo	*Lagenaria leucantha* (Duch) Rusby	Cucurbitaceæ.
Watermelon	*Citrullus vulgaris* Schard.	Cucurbitaceæ.
Yakal	*Shorea gisok* Foxw.	Dipterocahpaceæ.

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