REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
MANILA

Soil Report 14

SOIL SURVEY OF NEGROS OCCIDENTAL PROVINCE PHILIPPINES

BY

M. M. ALICANTE, D. Z. ROSELL, A. BARRERA
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WITH A DISCUSSION ON THE CHEMICAL CHARACTERISTICS OF THE SOILS OF NEGROS OCCIDENTAL PROVINCE

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ILLUSTRATIONS

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INTRODUCTION

The soil is one of the most important natural resources of the world. We obtain our food, clothing, and most of our materials for shelter from the soil. To many a man, the vital role of the soil in his livelihood had for centuries been taken for granted. In recent times, however, led by our desire to increase farm production to meet the needs of increased population, the soil has been the object of close study and investigation.

In the hope of making available basic data on the soils of Negros Occidental, which are necessary for the formulation of a suitable land-use program to the end of increasing the yield per hectare of sugar cane and other crops, the Division of Soil Survey and Conservation, of the Department of Agriculture and Natural Resources, conducted a reconnaissance survey of the soils of this province from April 16 to August 30, 1948, inclusive. This report provides a basis for classifying the experiences and results of studies on the characteristics and use-capabilities of the different soil types of the province.

DESCRIPTION OF THE AREA

Location and extent.—Negros Occidental (fig. 1) is a regularly shaped province located between 9° and 11° north latitudes and 122°–15′ and 123°–30′ east longitudes. The province is a part of the Western Visayan Group and is southeast of Panay, separated from this island by the Guimaras Strait.

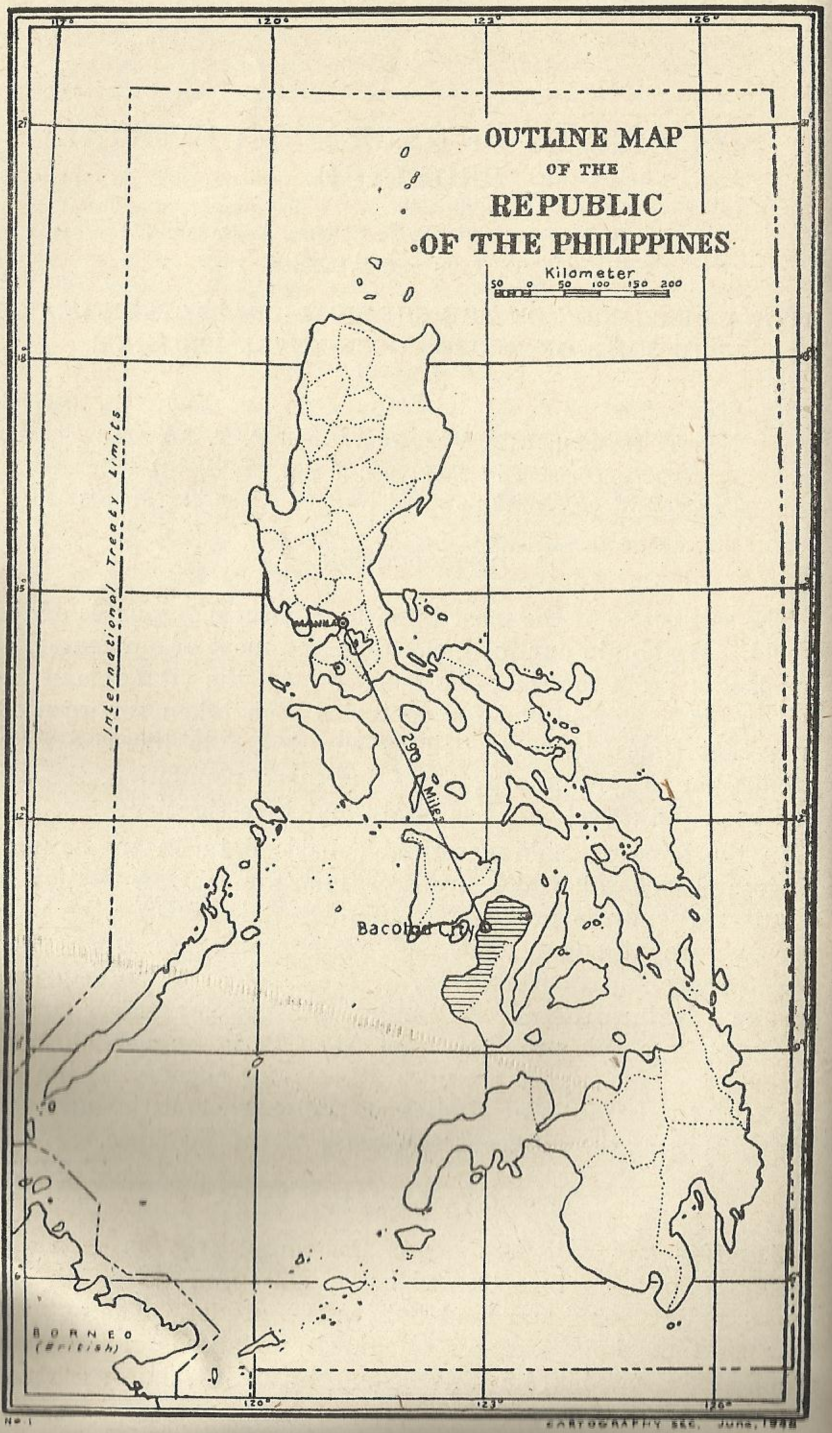


FIG. 1. Outline map of the Republic of the Philippines showing the location of Negros Occidental Province.

North of the province is the Visayan Sea and in the south is the Sulu Sea. On the eastern side is the Province of Negros Oriental.

The province measures approximately 200 kilometers long and is 69 kilometers wide between Bago and San Carlos, which is about the widest distance. It is 23 kilometers between Himamaylan and the eastern boundary, the narrowest part. It has a total area of 774,064 hectares. The chartered city of Bacolod is also the capital of the province and is 290 statute miles southeast of Manila (fig. 1).

Geology.—The volcanic regions of the northwestern part, the alluvial fans in the western central plain, and the undulating and rolling lands which include Mounts Silay, Mandalagan, and Canlaon, are geologically young. The older regions are those in the eastern part of the province and some distance south of Isabela and Kabankalan towns.

The geology and topography of Negros Occidental are characterized by volcanic activity and changes in the elevation of the land. As far as volcanic activity is concerned, Mount Canlaon had undoubtedly played a leading role with other volcanoes contributing. The work of erosion as an agency in the rapid formation of any land mass should be given due recognition in this particular instance. The erosion of sediments from the higher lands and the violent erruptions which occurred during periods of volcanic activity had decidedly filled up with mud flow that portion on the western and southern part of the province, bringing much soil material into the Guimaras Strait.

The present hills in the vicinity of the Antipolo–La Castellana–San Isidro region are remnants of another major activity of some secondary craters. The short but steep hills which extend southwest and south of the volcano have also been formed in like manner, having been caused by the rolling of heavy and coarse angular stones and big rocks mixed with volcanic ash.

The water that flowed across the alluvial fans carried with it some big materials which had earlier been deposited to form more land mass.

The south central part of the province presents a striking peculiar characteristic of the soil. The presence of marine shells in the subsoil around this region speaks of the nature, manner, and time when this region was raised from the sea level. The elevation of the western portion of Negros Occidental within recent times is indicated by the raised beaches near Pontevedra, the bluffs of Bacolod, and the incised meanders in the streams of the volcanic and littoral plains.

In some sections of Negros Occidental are to be found the remains of limestone formations, which are well established at the summits and slopes of hills and mountains. At first there were upturned Tertiary strata through which a great mantle of coral limestone was laid down over it. Subsequently, mountain-making movements of tremendous force raised the rocks to great heights. When life began to settle on this hoisted rock the weathering of its soil, characteristic of what is found today in this section, also started.

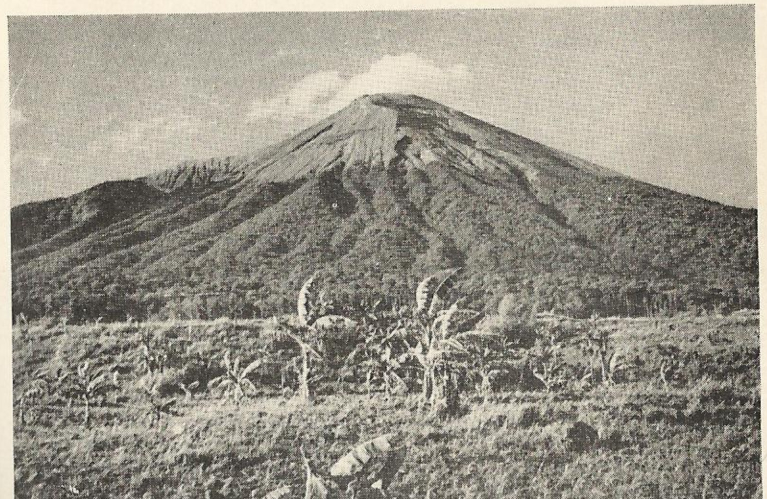
Physiography, relief and drainage.—The wide level land on the western side of the province, the rolling areas in the northern and southern parts, and the range of mountains in the central portion, mark the general feature of the landform of Negros Occidental (fig. 2).

The coast fronting the Visayan Sea has numerous coral reefs and shoals. From Sagay Point extending northeast for 37 kilometers is found a chain of 36 islands. From this point to Tomonton Point are also reefs and shoals which are dangerous to navigation. However, there are occasional sandy beaches and mangroves between these points. Beginning at Tomonton Point to Pandan Point on the west coast is a bay with some mangrove swamps, mudflats, and hard beaches. This coastal line which faces Guimaras Islands and where the Port of Pulupandan is located affords a good protection from the southwest monsoon. The coast flanking Panay Gulf in the southwestern part of the province, which includes the area from Pandan Point to Sojoton Point, is free from coral reefs besides being comparatively deep. The region south of Sojoton Point is characterized by an irregular coastal line and a rugged countryside. The coast line facing Tañon Strait in the eastern side of the province is quite regular and does not have a good harbor, except San Carlos Port which is protected by Refugio Island.

A number of big and small rivers (fig. 2) afford good and natural drainage for the whole province. In general the wide plain in the western part of Negros has poor drainage. Where sugar cane is grown, ditches have to be constructed in order to facilitate drainage. Elsewhere drainage is excessive and oftentimes causes severe erosion of the land whenever cultivated to crops. The Himugaan River and its tributaries rise between the eastern slopes of the volcanic chain and the moun-

By M. Ramos

Fig. 2. Physiographic map of Negros Island.



A. Mount Canlaon viewed from the southwest. This extinct volcano is the most prominent mountain peak in the central range.

B. The northeastern side of the province is rugged with a narrow coastal plain. The hills and mountains are of limestone formation and had been unwisely cultivated to corn. The soil is practically gone as a result of erosion.

tain range. It drains into the Visayan Sea at the north through Barrio Himugaan. This river is navigable to a certain extent. It is principally used in transporting lumber and sugar of the Insular Lumber Company and Lopez Central, respectively, from their mills to the coast.

The Danao River which empties into Tañon Strait in the northeastern part of the province by way of Escalante is swampy near its mouth. It rises at the saddle of the northeastern Cordillera.

Around Victorias town is the Malogo River. This river is comparatively wide although a little shallow. It originates at the southwestern slope of Mount Silay near Guintabuan and flows in a northwesterly direction towards Guimaras Strait passing Barrio Malogo, Victorias.

The headwater of the Bago River rises between the northeastern slopes of Mount Canlaon and the western slopes of the mountain range near the boundary of Negros Oriental. It has several tributaries. Were it not for the rugged mountain range in the east, it would probably drain into the Tañon Strait at some point near the provincial boundary. It almost bisects the province from Bago to the eastern boundary. This river, however, drains into the west at Guimaras Strait through Bago town. It is navigable by medium-sized barges and small bancas to a certain extent in the interior. It is one of the biggest rivers in the west coast.

The longest river in the Province of Negros Occidental is the Binalbagan River. Its headwater rises in the same vicinity as that of the Bago River, between the eastern slopes of Mount Canlaon and the western slopes of the mountain range near the northern boundary of Negros Oriental. A considerable number of tributaries of this river rise from the southwestern slopes of Canlaon volcano. One of these tributaries is the Bungahin River which merges with the main body of the Binalbagan River near the vicinity of Bungahin. This river swells during heavy rains in October, but never dries up during summer. It is navigable by small-sized barges to a distance of about 3 kilometers and perhaps longer for bancas.

The Ilog River is a union of several small rivers and tributaries. Its headwater is the rugged terrain northwest of Bais, Negros Oriental. It flows northwest and empties into the sea through Ilog. The Ilog River is the largest in Negros Occidental and overflows its banks during periods of heavy rain, causing considerable destruction to lives and properties. It is navigable by light draft vessels to as far as 8 kilometers, and 25 kilometers by bancas. The region along the course of the river is enriched by the yearly flood.

The main body of the Sipalay River which drains the Sipalay District in the southwestern part of Negros Occidental has several branches, one of which flows from Cabadiangan Plateau; another is near the boundary of Negros Occidental and Negros Oriental; and a third rises from the northeastern slope of Mount Malapantao. It is a perennial stream.

Water supply.—Water abounds freely in the province. Every town and barrio has either an artesian or fresh-water well. Bacolod City and other big towns have water systems, while all the sugar mills and centrals have water pumps and storage tanks. There are numerous rivers, streams, and springs.

In towns like Victorias, Sagay, and Cadiz the water is pumped into concrete reservoirs built on elevated places.

In barrios where there is no water system of either the gravity or pump type, dug wells are found. The depth of the wells depends upon the depth of the water table. At times drinking water can be dugged at a depth of from 3 to 6 meters.

Vegetation.—Primary rainforests abound throughout the central mountainous region from the northern to the southern part of the province. The timber logged include such species as ipil, molave, apitong, narra, yakal, and lauan. According to the local office of the Bureau of Forestry at Fabrica, there are 27,472 hectares reserved for commercial forest.

Secondary forest occupies a minor position in the vegetative cover of the province. Parangs and wide grasslands are found in Himamaylan and in the Tablas Plateau.

The vast alluvial plain in the western portion as well as the undulating and rolling lands in the central and northern parts are cultivated to crops.

The hydrosol areas are covered with halophytic flora which include nipa palm, bangkal, api-api, bakawan, and bongalon. Along the banks of creeks and rivers are clumps of bamboo species. Bamboos are also abundant in the southern areas of the province.

Organization and population of the area.—Buglas was the old name of Negros before the Spaniards came. It was Fray Andres de Urdaneta who named the island "Negros" because of the presence of many tribes called Negritos. He landed at the present town of Escalante in 1569. In the early years of the history of Negros Occidental, Ilog and Binalbagan were the only native settlements, and became regularly organized municipalities in 1584 and 1575, respectively.

A. The wide plains on the western side of Negros Occidental are cultivated mostly to sugar cane.

B. Tablas Plateau in the south central part of the province has a rolling topography. Vegetation consists mostly of grasses and a few scattered trees of *Binayuyo*.

PLATE 2

Table 1.—*Showing kinds and capacity of water system, including population served in different municipalities* [a]

Municipality	Population served	System	Capacity in gallon per days [b]
Bacolod City	20,000	Gravity	1,696,800
Calatrava	1,500	Gravity	201,600
Cadiz	6,000	Pumping	120,000
Toboso, Escalante	800	Gravity	36,000
Army Cadre, Fab.	300	Pumping	21,600
Himamaylan	3,000	Gravity	72,000
Isabela	4,000	Pumping	432,000
Murcia	1,500	Gravity	144,000
San Carlos	5,500	Gravity	144,600
Silay	5,000	Pumping	129,000
Concepcion, Talisay	600	Gravity	43,200
Victorias	4,000	Pumping	144,000
Total	52,200		3,184,800

[a] Taken from Terrain Study No. 99 Allied Geographical Section Southwest Pacific Area. Negros Island and Sequijor Island.

[b] These figures do not include the water system of the sugar centrals, or sawmills, which are of the pump and storage tank.

Upon the separation of Negros Occidental from the Province of Iloilo in 1734, the Island was made a military district by itself with Himamaylan as the center. The center of the district was subsequently moved to the present provincial capital in Bacolod in 1849. In 1856, however, Negros Island was under a politico-military government. At this time, new towns like San Carlos, San Isidro, and Calatrava were established.

In 1890 the island was divided into two provinces, namely, Negros Occidental and Negros Oriental. In 1898, the two provinces were fused. This year witnessed the Island's struggle for freedom from the Spaniards which was finally achieved. This time, however, the Island of Negros established a government entirely independent from the rest of the archipelago, which lasted from November, 1898 to February, 1899, after which the Americans took possession of the Island. Three years later the two provinces were again separated and civil government was established in Negros Occidental on April 20, 1901.

During the American administration, progress was rapid socially, economically, and politically. Schoolhouses were built and compulsory primary education was established. The opening of roads received due attention. Public and private hospitals were established to ameliorate the health conditions of the masses.

In 1850, the population of Negros Occidental was 18,000. It rose to 148,137 in 1887, and in 1948, this number increased to 1,038,758.[c]

[c] Journal of Philippine Statistics. Vol. IV, No. 1-6.

Transportation and market.—Prior to the outbreak of World War II, Negros Occidental rated as one of the few provinces in the Philippines with a well-established transportation system. Busses and trucks ply between most of the towns and barrios.

The Bacolod–Linaon National Highway is 141 kilometers long with concrete paving from Bacolod City to as far as Hinigaran. The rest of the distance is gravel-surfaced. From this highway interior towns and barrios are connected, either with first or second-class roads.

The 146-kilometer Bacolod–San Carlos National Highway links all the northern towns and barrios of Negros Occidental. It has several branches leading to the interior, sugar centrals, and off-the-way towns, such as Manapla, Cadiz, Toboso, etc. This highway extends down to Dumaguete, Oriental Negros. A one-lane interprovincial highway connects La Castellana and Vallehermoso in Negros Oriental. Aside from the public roads, there are a number of privately maintained roads connecting the sugar centrals with the different sugar cane plantations or haciendas. Similarly, the sugar centrals also have their own locomotives for transporting sugar cane, fertilizers, etc., from the central to the different haciendas.

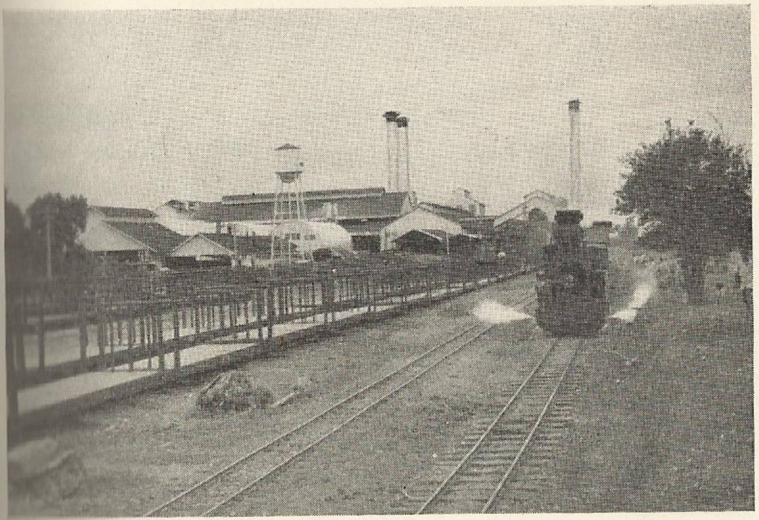
The presence of navigable rivers in the province is a blessing for the sugar central owners, because they provide relatively cheap means of transportation for their sugar. Barges or lighters of from 250 to 500 tons capacity are used to transport the sugar to the ocean-going steamers and to the port of Iloilo.

Interisland ships plying between the ports of Iloilo and Manila usually call at Pulupandan, the most important port in the west coast. However, ocean-going steamers also call at Pulupandan, San Carlos, and Escalante to load sugar. At Sagay, foreign ships load lumber coming from Fabrica. Medium-sized inter-island steamers dock at Banago pier in Bacolod.

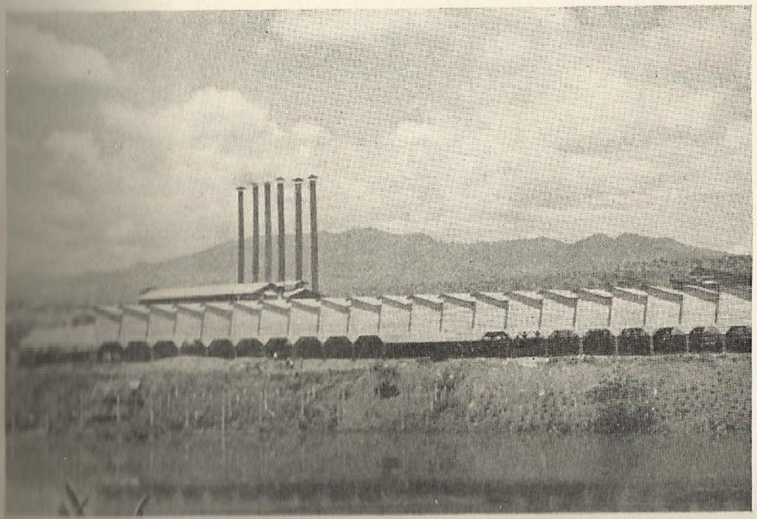
Native bancas or sailboats are the most common and cheapest means of sea communication in the southern coast of the province. The port of San Carlos is used by vessels plying between Negros and the Cebu coast.

Industries.—Like most of the provinces of the Philippines, Negros Occidental is mainly an agricultural province. In 1939, the area of cultivated land was 198,578.36 hectares, representing 25.6 per cent of the total land area of the province. The gross income derived from agriculture in that year, including livestock and livestock products, was ₱12,461,408.[a]

[a] Census of the Philippines, 1939. Data exclude the value of centrifugal sugar produced by the different centrals.



A. Sugar manufacturing is the principal industry of Negros Occidental. There are at present eleven sugar centrals in operation which produced a total of 7,087,936 piculs of sugar in 1949.



B. The Insular Lumber Mill located in Fabrica is the largest hardwood company in the world. It cuts an average of 144 logs a day.

The manufacture of sugar is the most important industry of Negros Occidental. There were 17 sugar centrals before the war which in 1941 produced 9,193,620 piculs of sugar, valued at ₱45,968,100. As a result of the war, nine of these centrals were destroyed. Later, with the rehabilitation and merging of some centrals, like Manapla and Victorias and the centrals Palma, San Isidro, Binalbagan, and Isabela, only eleven were in actual operation, which in 1948 produced 7,087,936 piculs of sugar grown on 67,272 hectares.

The manufacture of commercial alcohol from molasses is done in some centrals like Binalbagan-Isabela, La Carlota, and Talisay–Silay.

Fishing is an industry of the people who live along the coast. The waters in the northern part of the province are considered one of the best fishing grounds for herrings and mackerels; the western waters of Bacolod for snappers and groupers; and the southwestern coast for milkfish.

Most of the fish caught is sold in the local markets, while some are shipped by plane every day to Cebu. The rest are either salted or dried and sent to Manila.

The Insular Lumber Company which is located at Fabrica, a progressive and modern barrio of Sagay, Negros Occidental, is the world's biggest hardwood lumber mill. Lumbering in Negros Occidental is one of the most important industries.

For the year 1947–48, there were 39 license agreement and ordinary timber license granted by the local Bureau of Forestry at Fabrica, totalling 298,260 cubic meters of timber cut on an area of 102,884 hectares.[a]

[a] Data supplied by the office of the Provincial Forester, Fabrica, Negros Occidental.

TABLE 2.—*Showing the location and capacities of the different lumber mills in Negros Occidental*[b]

Lumber mill	Location	Capacity board (super) feet per day
1. Insular Lumber Co.	Fabrica, Occ. Negros	125,000
2. Valderrama Lumber Manufacturing	Cansilayan, Victorias, Neg. Occ.	12,000
3. NID Lumber Co.	Carabalan, Himamaylan	20,000
4. William C. Pfleider (Pfleider & Co.)	Asia, Cauayan, Negros Occidental	8,000
5. Pioneer Lumber Manufacturing	Lucap, Quezon, San Carlos	8,000
6. Inayaian Lumber Co.	Inayauan, Cauayan	4,000

[b] Data taken from the Allied Geographical Section, Southwest Pacific Area. Terrain Study No. 99. Negros Island and Sequijor Island. Phil. Series. 15th November 1944. Copy No. 798, paragraph 5, page 92.

Pot making is another industry of the province. It is concentrated in regions where clay soil of fine-finish grade is found. These regions are situated in the southern part of Bacolod City, North of Talisay, San Carlos, and Hinigaran. Drinking jars, cooking pots, and flowerpots are manufactured from clay.

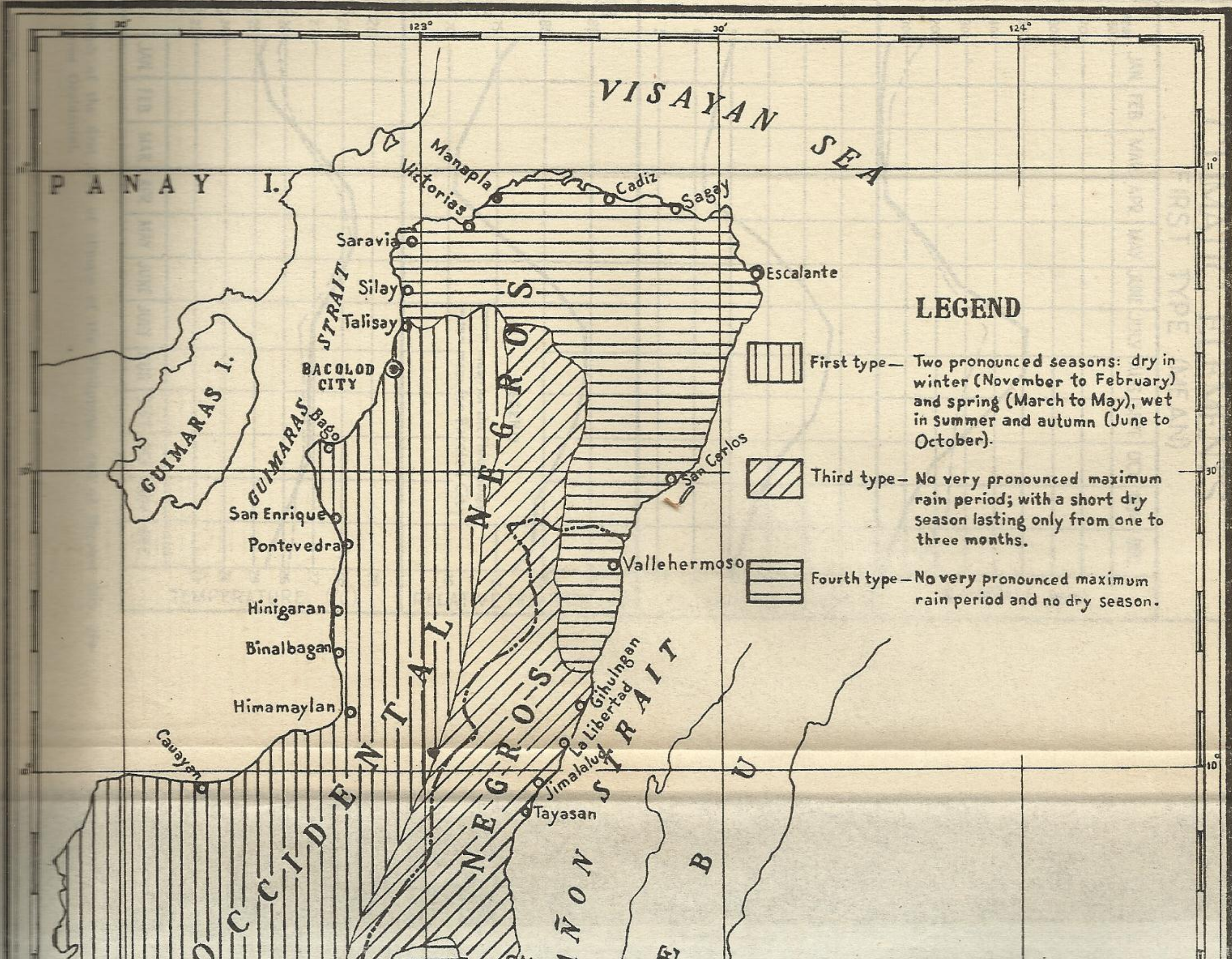
The mining industry is unheard of in Negros Occidental, although coal seams exposed in river channels and pieces of float coal in the rivers of Talabe, Calatrava, and Luzon in the northeastern part of the province, have been reported (Smith 1924). The same investigator, however, found nothing of value as to warrant exploitation of these deposits.

CLIMATE

The economic activity of the people living in a given district is decidedly affected by the climatic conditions prevailing therein. In view of this, the climate of a place should be studied in planning a farm project. To some extent the detrimental effects of climate can be overcome through the planting of a certain variety of crop, the adoption of cultural requirements other than those normally practiced, and the use of irrigation system. Incidentally, the classification of climate in the Philippines is based upon the amount of yearly precipitation, as a result of which we have four types.

There are three types of rainfall in Negros Occidental. The first type is characterized by distinct dry and wet seasons. The dry season commences in December and ends in April, while the wet season starts in May and ends in November. Western and southern Negros Occidental fall under this type. The third type is characterized by no very pronounced maximum rain period, with a short dry season lasting from one to three months (February to April). Eastern Negros Occidental belongs to this type. The fourth type covers the smaller portion of northern Negros Occidental whose climate is characterized by no dry season and no very pronounced maximum rain period. This rainfall distribution is shown in fig. 3.

Precipitation is a component part of climate. The difference in the amount of precipitation gives rise to four types of climatic regions. Weir (1936), has divided climatic regions into four types based on the quantity of precipitation. Thus, in a region of less than 10 inches of rainfall the climate is called arid or desert; between 10 to 20 inches, semi-arid; between 20 and 30 inches, sub-humid; and 30 or more inches, humid climate. These conditions hold true in low altitudes. He further states that



By M. Ramos

Fig 3. Climate map of Negros Island.

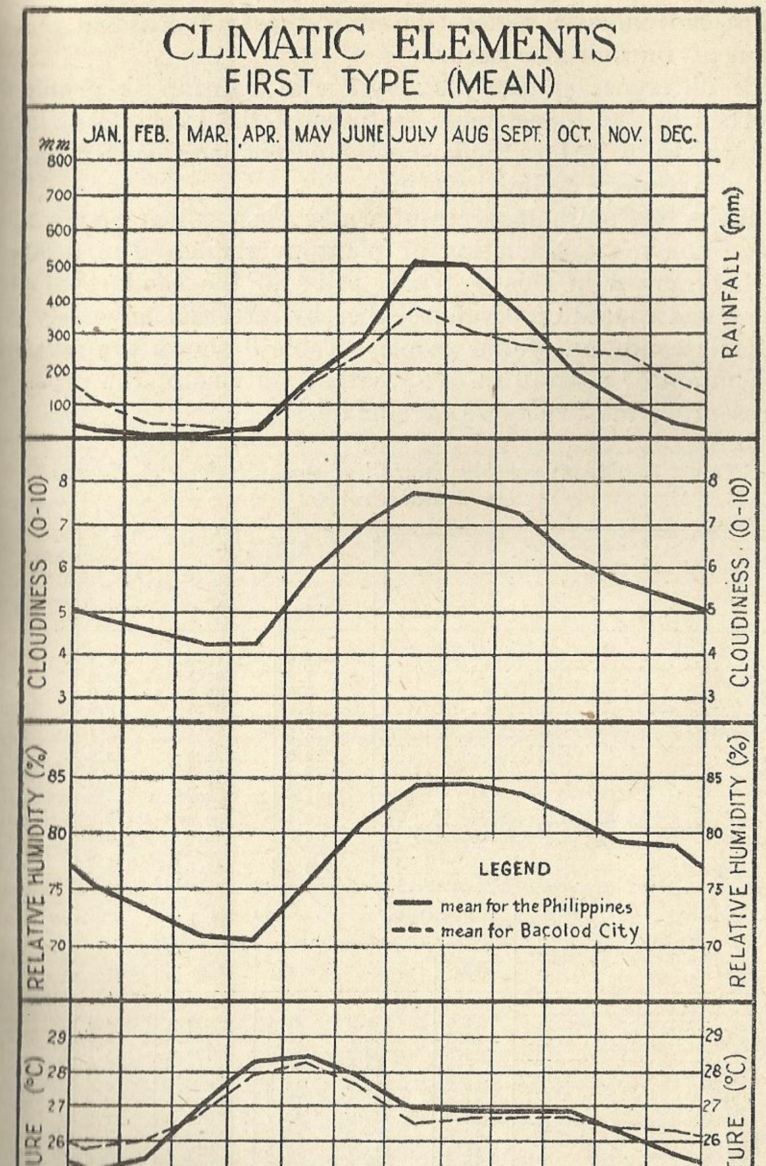


Fig. 4. Graph of the first type of climate of the Philippines, and of Bacolod City, Negros Occidental.

within the climatic region, different types of seasonal distribution of rainfall also occur.

The difference in the distribution of rainfall is primarily governed by the topographic features of the land, its distance from bodies of waters, and whether or not it is located on the path of frequent cyclonic storms.

Rain is one of the sources of water upon which plants may depend for the assimilation of plant nutrients. The drought which occurred in this province prior to the conduct of this survey had caused crop failure, thereby affecting adversely the economic condition of the people. Table 3 shows the monthly distribution of rainfall in five weather stations of the province representing the two types of climate.

TABLE 3.—*Mean monthly rainfall of some stations in Negros Occidental Province* [a]

Months	Bacolod		La Carlota	
	Days	mm.	Days	mm.
January	12.6	111.70	9.1	81.0
February	7.8	58.20	8.0	57.1
March	5.8	35.2	6.0	50.9
April	5.3	37.6	8.5	93.9
May	13.6	184.3	17.9	282.8
June	18.6	237.3	20.4	262.8
July	20.9	391.6	23.9	506.3
August	18.4	315.8	21.5	390.2
September	18.3	281.8	21.5	402.1
October	18.4	262.4	22.0	369.7
November	16.1	234.8	17.3	281.4
December	14.6	173.8	12.3	130.4
Annual	170.4	2,324.5	188.4	2,908.6

Months	San Carlos		Victorias		Asia	
	Days	mm.	Days	mm.	Days	mm.
January	14.6	151.9	21.4	213.0	6.4	68.7
February	10.2	85.1	15.8	146.7	5.4	57.5
March	8.5	65.2	13.0	121.4	4.8	31.6
April	5.9	46.0	10.2	95.0	5.2	38.2
May	10.2	144.8	13.8	205.6	16.5	298.8
June	11.5	147.4	17.0	199.0	17.8	358.8
July	13.3	142.9	20.7	313.8	21.8	608.2
August	12.6	129.3	16.0	264.4	17.5	472.1
September	13.4	128.7	17.5	217.9	19.2	452.6
October	16.5	237.9	21.5	374.2	19.8	591.0
November	14.8	254.0	23.0	567.6	16.5	264.6
December	16.9	213.5	22.8	324.3	8.8	148.7
Annual	148.4	1,746.7	212.7	3,042.9	159.7	3,390.8

[a] Rainfall in the Philippines. Weather Bureau, Manila.

Temperature, one of the elements of climate, affects the metabolic activities of both plants and animals. It is said that between noon and three o'clock in the afternoon, the output of manual as well and mental activities of man is at the mini-

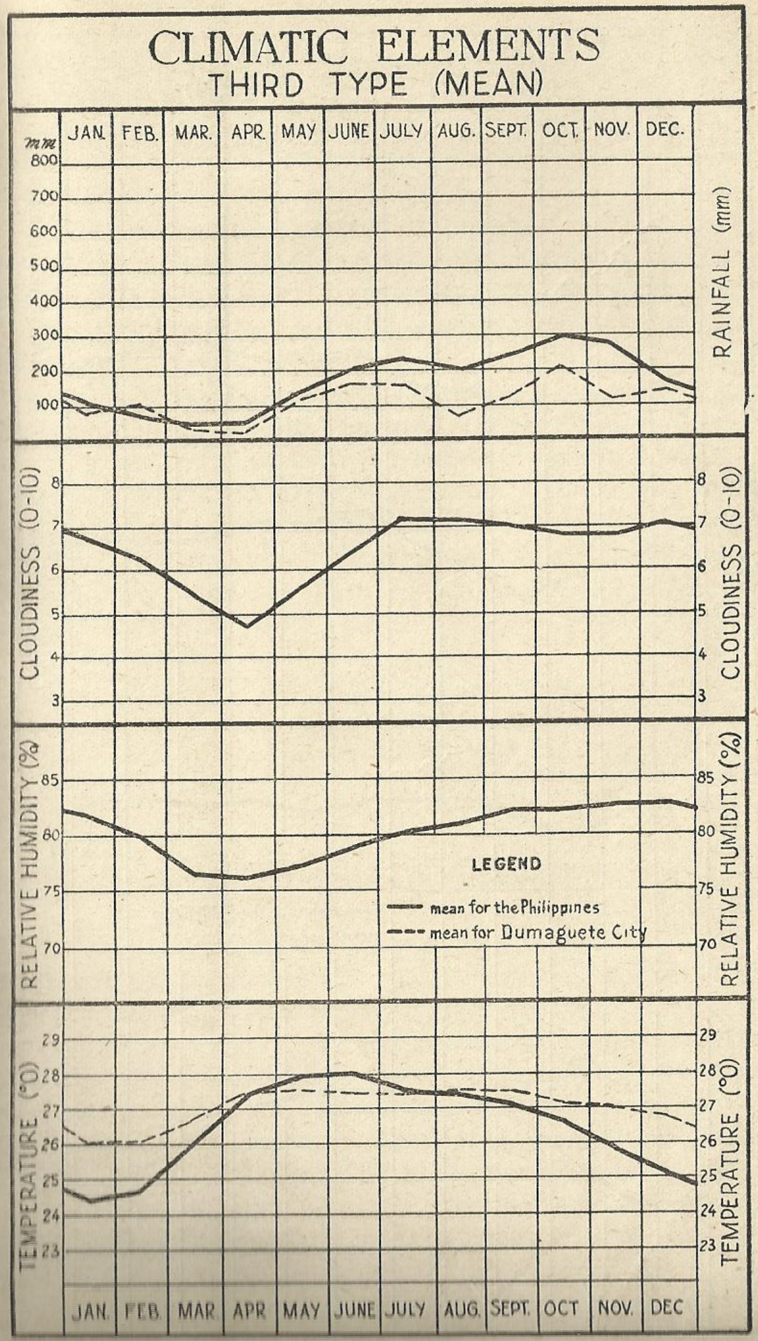


FIG. 6. Graph of the third type of climate of the Philippines, and of Dumaguete City, Negros Oriental.

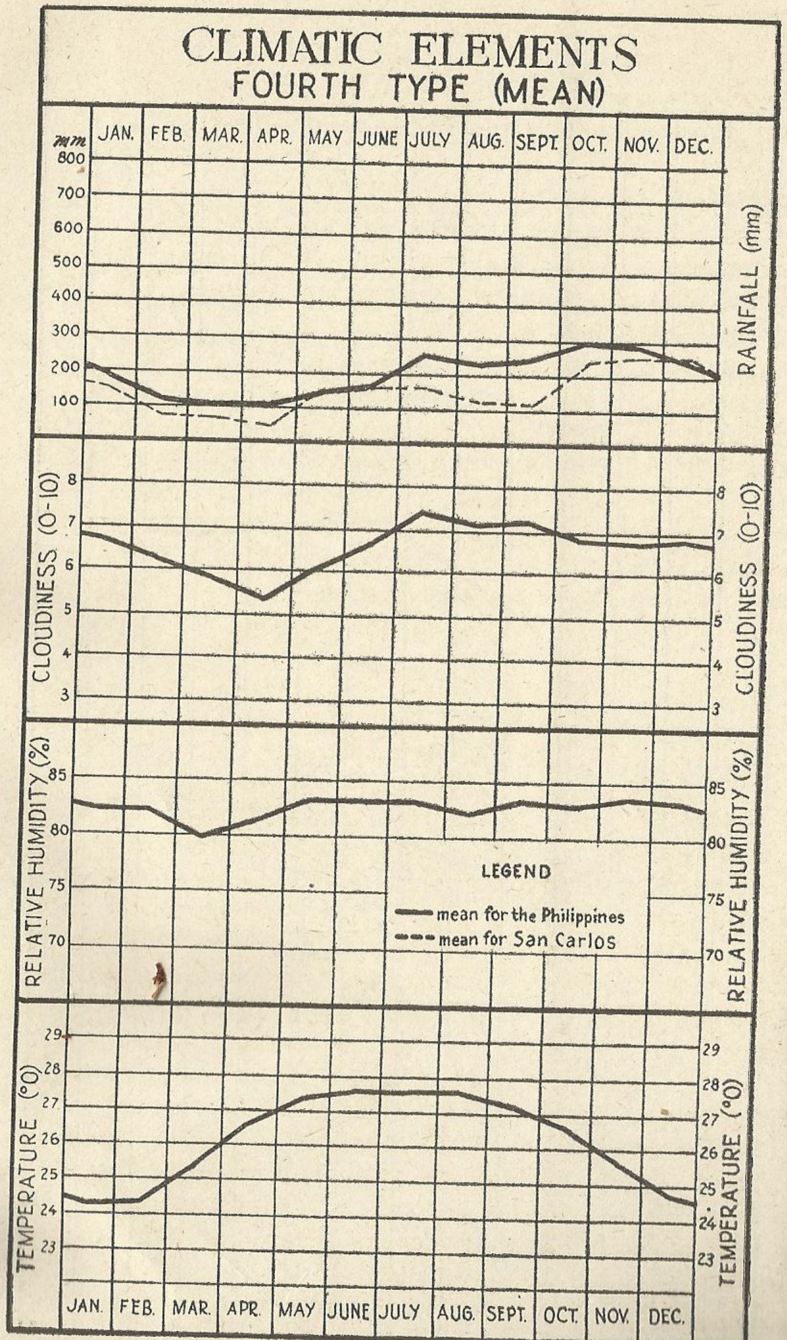


FIG. 6. Graph of the fourth type of climate of the Philippines, and of San Carlos, Negros Occidental.

mum. In plants, germination and its subsequent growth are favored markedly when they are subjected to their optimum temperature requirements which vary in different species. The optimum germination temperature requirement for wheat, oats, and barley is from 77 degrees to 88 degrees Fahrenheit, and for maize, about 91 degrees (Weir, 1936).

Weir (1936), also states that the optimum temperature for germination is also the best temperature for growth. He further explains that at the lowest temperature growth ceases, while at the highest temperature growth is barely possible, but at optimum, growth is most active.

Agricultural products are adversely affected by changes in temperature. Harvesting, curing, storing, and other field operations incidental to the preparation of the products for the market are dependent upon temperature. In Negros Occidental, the temperature is at the minimum during the months of December, January, and February, as shown in the following data obtained from the 1918 census of the Philippines and based on six years' record of the Bacolod wheather station:

January	25.9°C	July	26.6°C
February	26.0	August	26.6
March	26.8	September	26.7
April	27.9	October	26.8
May	28.3	November	26.4
June	27.5	December	26.3

In Negros Occidental and for that matter throughout the Archipelago, three air streams are recognized, to wit: (*a*) the northern air stream sometimes called the northeast monsoon, which carries the wind from the northeast quadrant during the months of October to January; (*b*) the trades coming from an easterly direction between east to southeast, which occur from February to April; (*c*) the equatorial current, which is referred to as the southwest monsoon and is influenced by cyclonic disturbances during the rest of the year.

The northeast monsoon as observed in Negros Occidental is at its maximum in January when its velocity at the open sea is from 15 to 20 miles per hour. Sometimes stronger winds but of short duration develop as a result of high barometric pressure.

The southwest monsoon of the province is not as steady as the northeast monsoon, which sets in from June to October, with a wind velocity of from 10 to 15 miles per hour. It is preceded by a transition of variable winds and calms. During the southwest monsoon, squalls which are associated with thunderstorm occur, particularly near the land which result in heavy downpour. The advent of northeast monsoon is preceeded by a transition of variable wind movement. The chain of volcanic ranges which traverse from the north to as far as south of the province is interrupted by low-lying lands, thereby allowing the moisture-laden winds of the northeast monsoon to reach the central and western Negros Occidental.

Typhoons in the Province of Negros Occidental are uncommon. Of the serious ones which hit the country, only 7 per cent passed through this province.

Negros Occidental is a province where relative humidity is rather high. Districts enjoying the first type seasonal climate has a mean annual relative humidity of 80 per cent. Whereas in the third type the highest value occur in the months of September to January. In the fourth type the value is relatively high but uniform.

AGRICULTURE

The Province of Negros Occidental is one of the most intensively cultivated areas in the Archipelago. The largest cultivated area in the western coastal plain of the province located from Manapla in the north down to Ilog in the south, was almost entirely cultivated to sugar cane broken only by roads, rivers, towns, and occasional rice paddies. Sugar cane plantations, locally known as "Haciendas," of various sizes are found throughout the entire plain. In most of the large plantations, modern farm machinery is employed.

Some wide plantations of corn and rice are also found in the valleys of Cartagena, Sipalay, Maricalum, and Hinubaan. Other farm crops which do not receive as much attention as rice and sugar cane are fruit trees, garden crops, and coconut.

According to the Philippine Statistical Reports of 1939, the Province of Negros Occidental has an actual soil cover of approximately 774,064 hectares, distributed as follows:

	Area Hectares	Per cent
Commercial forest	277,857	35.89
Noncommercial forest	35,270	4.57
Swamps (fresh water & mangroves)	14,680	1.88
Open and cultivated lands	446,257	57.66
Total soil cover	774,064	100.00

According to the census report of 1939, the farm area of Negros Occidental, which is less than the open and cultivated lands, was utilized into cultivated land, idle land, pasture land, forest land, and other lands as follows:

	Area Hectares	Per cent
Cultivated land	198,578.36	66.66
Idle land	43,958.23	14.74
Pasture land	28,794.15	9.65
Forest land	12,757.12	4.27
Other lands	13,960.86	4.68
Total farm area	298,048.72	100.00

During the Japanese Occupation, the province had to increase her areas for rice and corn, because of the hardship of importing staple crops from other provinces. Some of the sugar cane lands were abandoned or otherwise planted to root crops, cereals and legumes.

Table 4 shows the ten leading crops grown in the province in 1938 based on area planted; namely—sugar cane, palay, corn, coconut, camote, tobacco, cassava, derris, gabe, and ubi. These crops gave the province in 1938 a total produce valued at ₱54,994,909.

TABLE 4.—*Ten leading crops in Negros Occidental showing hectares, production, and value*

Crops	Area (Ha.)	Production	Value (Pesos)
1. Sugar cane:		[b] 8,238,040	49,428,240
Sugar	97,280.67	[a] 361,336	3,117
Chewing	----------	[a] 48,046	551
Panocha	----------	[c] 9,960	996
Basi	----------		
2. Palay:	47,559.51	[d] 1,210,186	3,316,215
1st lowland	596.57	[d] 10,622	29,372
2nd lowland	15,137.19	[d] 231,075	603,322
Upland			
3. Corn:	22,097.12	[d] 193,853	431,584
1st crop	15,694.82	[d] 114,108	281,256
2nd crop	11,751.33	[d] 71,539	193,984
3rd crop	891.79	[e] 4,658,907	19,532
Green corn	12,244.48		
4. Coconut:		[f] 1,294,132	21,334
Food	----------	[g] 4,376,250	197,261
Copra	----------	[c] 5,425	1,118
Oil	----------	[c] 5,898,922	304,942
Tuba	----------	[g] 2,399,989	57,177
5. Sweet potato	1,424.66	[g] 474,766	36,264
6. Tobacco	911.87	[g] 956,768	22,997
7. Cassava	532.30	[h] 356,476	17,064
8. Pineapple	279.39	[g] 532,864	22,420
9. Gabe	272.64	[g] 56,975	6,163
10. Abaca	209.91		

[a] Stalks. [c] Liters. [e] Ears. [g] Kilos. [b] Piculs. [d] Cavans. [f] Nuts. [h] Fruits.

Sugar cane.—Sugar is one of the four leading export products of the Philippines. Before the second World War, about 60 per cent of the sugar export of the Philippines was produced by the Province of Negros Occidental. There were then 17 modern sugar centrals in operation. All these mills had a total daily capacity of 36,763 tons of cane.

In 1938, the sugar cane fields from San Carlos in the eastern side up to Manapla in the north and then down south to Ilog and Kabankalan in the western portion of the province, covered an area of 97,280.67 hectares, or 48.99 per cent of the total cultivated area. This hectarage included those devoted to sugar cane that were used for chewing, panocha making, and basi manufacture, which had a total value of ₱4,664. Panocha, however, is produced in Hinigaran and Isabela only. In 1938, these two towns produced 48,046 panochas valued at ₱551. In that same year, only 9,960 liters of basi valued at ₱996, were produced in Isabela. Incidentally, Isabela is the only town that manufactures this beverage from sugar cane. The total cane sugar produced by the centrals in 1940 was 9,193,620 piculs.

Climate and soil are the most important factors in the culture of sugar cane. The soil should be deep and fertile with good drainage. The best cane crops are those planted on alluvial soils with liberal amount of soil moisture during the growth season. High temperature and plenty of sunshine are also important requirements. The land is usually prepared by tractors. A tractor may be either owned by the farmer, or rented from the sugar central at ₱15 for plowing and ₱7 for harrowing a hectare. Furrowing and cultivation are mostly done with the use of native plows. Fertilizers are applied when the plants are about a foot high, or one and a half months old. In the lowland, the fertilizer used is ammonium sulfate, applied at the rate of 300 to 500 kilograms per hectare. Warnerphos or ammophos with 16.5 per cent nitrogen and 20 per cent phosphoric acid, is the fertilizer used in the upland, the rate of application being 300 to 500 kilograms per hectare. Other fertilizers used are guano, farm manure, and pressed cakes, applied at the rate of ½ to 1½ tons per hectare. Whenever the cost of fertilizers is very high some farmers reduce the rate to as low as 50 to 150 kilograms per hectare. Before the war, lime was applied every three or more years to correct soil acidity, as a result of which an increase of from 6 to 10 piculs of sugar per hectare was obtained.

After two or three years of ratooning, the field is broken again for new planting of cane points.

In the Victorias and Manapla section, the popular varieties grown are the Alunan, P.O.J. 2878, and P.O.J. 2883. From Victorias to Kabankalan, the Alunan cane is widely used while in eastern Negros the varieties P.O.J. 2878 and P.O.J. 2883 are grown. Other varieties found on a limited scale are the Badilla, P.S.A. 14, Mauritious, P.O.J. 2867, the red and purple varieties. During the last war, the Japanese introduced some varieties from Formosa, which are being observed now for their adaptability and productivity in many parts of the province.

The Alunan is easily attacked by Fiji, a serious disease of sugar cane in the province. P.O.J. 2878 and 2883 seem to be resistant to this disease. Other pests and diseases observed are the wooly aphids, grubs, mosaic, leaf spots, and chlorosis of the leaves.

Irrigating the sugar cane fields is not the usual practice. This accounts for the thousands of hectares of sugar cane fields which suffered during the droughts of 1948.

Ordinarily, rains begin toward the latter part of April. Planting in the northern part of the province is done any-time of the year. In other parts it is seasonal, i.e., from November to January. It is claimed that these months constitute the best season for planting even in the northern portion, where the rain is evenly distributed throughout the year.

Many planters claim that the Alunan variety is the best sugar cane they have at present. It is a good yielder. It takes only one year to grow and mature the crop. The only drawback of this veriety is its susceptibility to diseases and pests, poor ratooning, and it costs a little more to grow than other varieties. Alunan cane yields from 80 to 200 piculs per hectare. The P.O.J. 2878 and P.O.J. 2883 are other standard varieties which mature in from 14 to 15 months and yield from 80 to 150 piculs per hectare. These canes are hardy and good for 2 to 4 ratoons. P.O.J. 2878 is known to be much more tolerant to wet soils than the Alunan cane. The average cost of production per hectare of sugar cane is ₱400.

Rice.—This is the second important crop of the province. Statistics of 1938 [a] shows that 63,293.27 hectares or 31.87 per cent of the cultivated lands was grown to rice. This area in-

[a] The figures on area planted, production, and value of crops were taken from the 1939 census of the Philippines.

cludes those devoted to second lowland crops and upland cultures. A total of 1,451,883 cavans of palay were harvested from this area with a value of ₱3,948,909.

The province being thickly populated and the land grown mostly to sugar cane, the amount of rice produced locally is not sufficient. Before the war, the province imported her additional requirement of this cereal from Iloilo and Central Luzon. During the Japanese occupation, however, the area for this crop was increased. Some of the sugar cane fields then were cultivated to rice due to the difficulty of importing this staple food crop from other provinces. But now, as the supply of sugar cane points is increased, the area is being reconverted to sugar cane lands.

The cultural management of lowland rice in this province is not as advanced as in the growing of sugar cane. There are, however, farms that employ tractors in breaking up the soil in the first plowing when the fields are still dry. The succeeding operations are similar to those involved in the common native methods followed in other Visayan provinces.

The standard varieties of rice found in this province are Apostol, Bangbang, Elon-elon, Macan, Milagrosa, Ramelon, Raminad, Seraup Besar, and Seraup Ketchil.

The choice of rice varieties in this province is based upon soil and climatic conditions. The early maturing varieties, for example, are commonly grown in the northern portion, the medium late in the central western lowland, and the late maturing varieties in the southwestern section of the province. The production of these varieties varies with the farm practices, types of soils, and water supply. The yield ranges from 15 to 60 cavans per hectare. Large rice haciendas are found in Cartagena, Sipalay, Himamaylan, Isabela, Pontevedra, and Kabankalan.

The land for upland rice is prepared earlier than that for the lowland crop. In the level areas, tractor is used to break up the soil. Succeeding plowings are, however, done by native plows and carabaos. Each plowing is followed by harrowing. The field is furrowed to about 25 to 30 centimeters apart and palay seeds are dropped by hired laborers at regular intervals of about 15 to 20 centimeters, at the rate of 3 to 8 seeds per hill. In some cases broadcasting is done. About 26 to 30 gantas of seed palay is used to plant a hectare. Clean culture is practiced, and in limited cases fertilizers are applied at the rate of from 50 to 100 kilograms per hectare. Cutsiam, Dumali,

Guinatos, Lubang, Magsanaya, Mangasa, and Sinadyaya are varieties of upland rice grown in the province. Upland rice is extensively cultivated in the eastern portion of the province. The production of these varieties ranges from as low as 8 cavans to as high as 30 cavans per hectare.

Wide tracts of upland rice managed in a more advanced way are found in Silay, Talisay, Bacolod, Bago, and Pulupandan.

Corn.—In 1938, there were 50,435.06 hectares planted to corn, consisting of areas devoted to first, second, third, and green crops of this cereal. The value of 379,500 cavans of shelled corn and 4,658,907 ears of green corn produced in this year was ₱926,356.

Corn is grown throughout the province but it is more extensively cultivated in the northern towns of San Carlos, Calatrava, Escalante, and Sagay where the soil is of limestone origin. Other towns that also grow this crop are Cadiz, Cauayan, Isabela, and Kabankalan. Corn grows best in fairly deep, well drained, sandy loam to light clay loam soils with a good supply of lime and humus.

Corn is used in rotation with tobacco or rice. Root crops like cassava, camote, and gabe, and legumes like peanut, mongo, and cowpeas, are also planted after the corn crop.

Another method of corn planting is done by laying furrows at a distance of 50 centimeters apart, planting the seeds singly 20 to 30 centimeters apart in the row. This method is said to produce more than when 2 to 3 seeds are planted in the ordinary hill method.

Coconut.—The production of coconut in this province is very much less compared with the output of other provinces like Laguna and Quezon. In 1939, there were 1,711,817 trees planted over an area of 12,244.48 hectares. Of this number, 1,026,881 trees are bearing, 621,545 are non-bearing, and 63,391 trees are tapped for tuba production. The total value of harvest, including the income derived from tuba, was ₱524,655. Cauayan leads in copra making. In 1939, this town alone produced 1,387,387 kilos of copra. Escalante comes next with a production of 568,630 kilos. For the production of tuba, however, Escalante ranks first with a production of 856,718 liters. Himamaylan and San Carlos rank second and third, respectively.

Coconut in this province is mostly confined to the lowlands along the coastal region.

Root crops.—Root crops grown in the province are camote, cassava, gabe, ubi, and tugue. These crops are used as substitutes for rice and corn. Root crops are planted as minor crops in rotation with rice or corn. Some are planted in between rows of coconuts or in gardens. No wide single tract of land is devoted to the commercial culture of these crops. In 1939, there were 2,255 hectares cultivated to root crops. The following shows the area, yield, and value of each kind of root crop planted in 1938:

Root crops	hectares Area in	Production in kilograms	Value in pesos
Camote	1,424.66	2,399,989	57,177.00
Cassava	532.30	956,768	22,997.00
Gabe	272.64	532,864	22,420.00
Ubi	110.74	306,526	12,335.00
Tugue	14.48	27,165	1,171.00

The towns that supply the province with these commodities are as follows: For camote, Cadiz, Escalante, Sagay, and Kabankalan; for cassava, Cadiz, Manapla, Himamaylan, and Kabankalan; for gabe, San Carlos, Escalante, Sagay, Cadiz, and Calatrava; for ubi, San Carlos, Escalante, Sagay, and Calatrava; and for tugue, San Carlos was the leading producer. High yield per unit area of camote and cassava was observed in Kabankalan.

Tobacco.—In 1938, there were 911.87 hectares devoted to the culture of this crop. The whole production amounted to 474,766 kilos valued at ₱36,264. The production of leaf tobacco in the province is concentrated in the towns of Calatrava, Escalante, and San Carlos, which produced more than 50 per cent of the total output. Tobacco is only a secondary crop to corn. The newly harvested field of wet season corn is prepared right away for tobacco.

Pineapple.—This is cultivated on a very small scale for local consumption only. In 1938, this crop occupied 279.39 hectares, or 0.14 per cent of the cultivated land. It gave a total production of 356,476 fruits valued at ₱17,064. During the same year, 66,872 fruits were produced in Sagay; 37,406 in Murcia; 33,905 in Manapla; and 25,675 in Silay. Higher production in fruits and in income per hectare was noted in Silay. Fertilization with ammonium sulfate at the rate of 100 to 200 kilos per hectare is given as top dressing in Silay. This is the reason perhaps why the production of pineapple fruits in this town is high compared to that of other towns of the province.

The fruit is ready for harvesting 16 to 21 months after planting. Its maturity depends upon the planting materials used. Crowns, slips, and suckers are utilized as planting materials.

Fiber crops.—Abaca, maguey, and cotton are some of the fiber crops grown in the province. It is not cultivated as extensively as other crops. The combined production of these three fiber crops in 1938 was 67,847 kilos valued at ₱6,774. Only 228.10 hectares were planted to these crops, of which 209.91 hectares were devoted to abaca alone. Bago and Manapla lead in abaca production. Maguey is found in Escalante, Bago, and San Carlos. Cotton is grown in patches only. During the Japanese occupation, cotton was extensively cultivated in sugar cane fields in La Castellana, La Carlota, Binalbagan, and Isabela. This fiber plant was found to have thrived well in these places.

At present not much attention is given to the above-mentioned crops. There are indications, however, that cutting and stripping of abaca is going on in Bago. Local uses of abaca fibers are for twines and small ropes for fishing boats. Fish net known locally as "Sarap" is made of abaca fibers. There is no commercial plantation of abaca in this province.

Legumes.—Legumes such as peanut, mungo, soybean, and cowpeas are planted in rotation with upland rice and corn. Sitao, batao, patani, and the like are grown in rice paddies, or in gardens near residences. The towns of Sagay, San Carlos, Isabela, and Saravia are noted for peanut. Large quantities of beans are produced in San Carlos; mungo in Murcia, Bacolod, and Escalante; and soybeans in La Carlota, San Carlos, Saravia, and Victorias. The local experiment station in La Carlota raises soybeans for seed distribution.

The area, production, and value of these leguminous crops in 1938 are as follows:

Crops	Area in hectares	Production in kilos	Value in pesos
Peanut	194.65	91,515	8,206.00
Mungo	184.99	76,452	12,078.00
Beans	81.48	42,281	5,925.00
Soybean	18.85	7,313	1,283.00

Derris is also a leguminous crop that was once grown on a small scale in this province. Before the war, the plant seemed to be popular in Sagay, Cadiz, Bago, Manapla, and Escalante. In 1938, there were 156.30 hectares planted to derris in these towns. The production reached 64,907 kilos valued at ₱22,899. Today, this crop is entirely abandoned due to lack of market.

Vegetables.—Truck farming on a commercial scale is not intensively practiced in the province. Eggplants, tomatoes, onions, radishes, and other vegetables are grown to supply local consumption. Cabbages, pechay, lettuce, and other high-grade vegetables are imported from other provinces. In 1938, eggplant occupied the largest area among the vegetables grown in the province. Tomatoes ranked next followed by onions and radishes.

Below are the five leading vegetables grown in the province with their areas, production, value, and places where they are abundant, as compiled from the census of 1939.

Kind of vegetable	Area planted (Ha.)	Production	Value (Pesos)
Eggplant [a]	109.44	1,442,631 [f]	4,433.00
Tomatoes [b]	56.74	89,846 [g]	7,042.00
Onion [c]	43.30	57,532 [g]	7,215.00
Radish [d]	24.22	88,582 [g]	5,124.00
Cabbage [e]	6.17	28,607 [g]	6,746.00

[a] Abundantly produced in Cadiz and Isabela.
[b] Abundantly produced in Isabela.
[c] Abundantly produced in Escalante and San Carlos.
[d] Abundantly produced in Bacolod, Bago, and Talisay.
[e] Abundantly produced in San Carlos, Escalante, and Victorias.
[f] Fruits.
[g] Kilos.

Other vegetables that gave sizable sources of income to the farmers are patola, squash, libato, ginger, black pepper, upo, ampalaya, garlic, and mustard.

Fruit trees.—The census of 1939 shows that all kinds of fruits thriving elsewhere in the Philippines are also found in Negros Occidental, although very few of each kind is planted for local consumption. Banana leads all other fruit trees in total value of production. It is extensively grown all over the province. Saba, Latundan, and Lacatan are among the varieties commercially propagated.

The five leading fruit trees are listed below showing their extent, number of trees of all ages, number of bearing hills, production, and value.

Kind of fruit	Number of trees (all ages)	Number of trees (bearing)	Production (number)	Value (Pesos)
Banana	1,870,383[a]	895,749[a]	1,384,384[b]	400,500
Jackfruit	135,811	59,351	629,637	109,528
Mango	23,028	5,451	2,515,321	58,720
Papaya	60,930	42,852	806,621	22,795
Orange	19,825	4,992	303,509	8,189

[a] Hills
[b] Bunches

Aside from the above-mentioned fruit trees, chico, avocado, pummelo, siniguelas, lanzones, and santol are also grown in appreciable number. Coffee is also grown to a certain extent. In 1938, the province had a total production of 25,980 kilos of coffee berries, valued at ₱13,282.

Farm mechanization.—Negros Occidental is far advanced in the culture of sugar cane compared with other provinces, especially in the use of farm machinery and fertilizers. However, the native plows and carabaos are still in use.

Soon after the Japanese occupation, farmers became mechanized-conscious, not only due to the lack of work animals but also because of the availability of Surplus machines from the Army. And on account of the great demand for sugar the world over, and because most of the sugar cane fields were abandoned during the enemy occupation, the farmers were faced with the problem of putting their large farms back to production.

Most haciendas have their own machines. Machinery is used extensively in the preparation of the soil for planting. Farmers who do not have their own tractors have their sugar cane fields prepared by machines rented from the sugar centrals.

Farm mechanization is presently limited to such farm operations as plowing, harrowing, furrowing, and in some instances cultivating. Planting, fertilizing, weeding, the later stages of cultivation, and harvesting are still done by work animals and men.

Fertilization and liming.—The continuous cropping of a given land, especially to sugar cane, requires the heavy application of commercial fertilizers, not only to replenish the plant food nutrients used up by the crops, but also to replace those that have either been leached through percolation or lost by soil erosion. Commercial fertilizers are obtained either by direct purchase by the farmer, or on credit basis from the sugar central where he mills his sugar cane.

In lowlands along the coastal plains, ammonium sulfate is the fertilizer popularly used. It is applied at the rate of from 300 to 500 kilos per hectare. Warnerphos is applied in the rolling uplands at higher rates per hectare than those for ammonium sulfate.

Where there is plenty of available guano for sale at reasonable prices, it is applied at a much higher rate than any of the two commercial fertilizers just mentioned. This fertilizer being organic gives a more lasting effect than inorganic fertilizers.

In the Victorias area, cane sugar impurities locally known as pressed cake is used as organic fertilizer applied at the same rate as guano.

The application of fertilizers in this province seems to be limited to sugar cane fields. Fertilizers are seldom applied to other crops like rice.

In general, the soils of Negros Occidental are sour or acidic. The soil reaction ranges from pH 4.5 to pH 7.0. Some lowland soils from Manapla to Ilog need lime. Lime is a good remedy for an acid soil. The application of lime in some sugar cane fields of Victorias and Silay has increased the production of sugar by as much as 10 piculs per hectare. The beneficial effects of lime on the soil cannot be overlooked. Lime encourages chemical reactions, stimulates soil organisms, improves the physical condition of the soil, and increases the availability of plant food nutrients.

Crop rotation.—Crop rotation is important for the control of weeds, insect pests, and plant diseases, and conserve soil organic matter and plant nutrients. It also improves the physical condition of the soils. Moreover, crop rotation makes possible the even distribution of farm labor throughout the year.

Continuous cropping to the same crop is exhaustive to the soil. Sugar cane which is the main crop requires from 12 to 15 months to mature. This makes it a problem to rotate sugar cane with some other crops. And this is especially true in the case of western Negros where there are definite planting and harvesting seasons. In the northern part where the planting season is not definite, sugar cane may be rotated with other crops. But even though this is possible, crop rotation is not practiced. However, in certain farms a system of rotation is followed, which includes upland rice, corn, and tobacco.

Crop diversification.—This agricultural practice, if properly observed in Negros Occidental, may avoid crop failures. Diversification of crops in the province is by regions. There is the sugar cane region, besides the rice, corn, coconut, and tobacco regions. Crop diversification is not extensively practiced in the sugar cane region. However, some areas in the sugar cane farm not suited for sugar cane culture are planted to other crops, like rice and fruit trees. Extensive crop diversification is practiced in the northeastern part of Negros.

Terracing and contour farming.—Compelled by the need of impounding water in the rice fields, dikes are being constructed. Incidentally, this practice saves the soils and plant nutrients

from being washed away. Lowland rice farms located on areas with undulating to slightly rolling topography, if properly diked, present a typical form of terrace farming. Usually, however, furrows are laid following the slope instead of across the slopes. Naturally, when rain falls the furrows become miniature canals for runoff water and cause soil erosion. Continuous accelerated soil erosion soon renders the land unfit for cultivation. This wasteful method of farming is found in many parts of the uplands. Today, some farms have resorted to contour planting of sugar cane.

Irrigation and drainage.—The greater part of the agricultural land of Negros falls under a type of climate with distinct wet and dry seasons. Since sugar cane is a crop that occupies the land throughout the year, irrigation is highly essential. Climatic records reveal that droughts have occurred in this province. Rice is another crop which requires the control of the amount of water during the different stages of its development. If provided with irrigation system, rice may be planted here twice a year, as in Central Luzon and Laguna. The bringing up to maturity of other crops is assured. Irrigated land in this province is limited in extent. Only those along the rivers are supplied with irrigation water. According to the 1939 census, only 9,661.24 hectares, out of its farm area of 298,048.72 hectares, are provided with irrigation water. These lands are mostly lowland rice-fields found in Bago, Isabela, La Castellana, Pontevedra, and San Carlos. Big diversion canals are now being constructed by private individuals in haciendas near La Carlota, Murcia, Sipalay, and San Carlos.

Drainage is not a problem in this province, except in the sugar cane fields located on level areas. In this case open drainage ditches are constructed about 200 to 300 meters apart. Surface drainage in the rolling areas is very excessive and oftentimes result in runoff and soil erosion.

Livestock.—Progressive farmers raise farm animals hand in hand with agricultural crops. This kind of farming is not new, especially in well-diversified farms. The raising of farm animals may in a way help in the control of the prices of farm commodities. If the prices of corn, legumes, or root crops, for example, are too low to cover the cost of production, these products may be given to the animals as feeds. Poultry and hogs are profitable farm animals that can quickly convert these crops into meat. Some by-products of the farm instead of being wasted could be utilized as animal feeds. Farm manures may be added to the soil to replace whatever plant nutrients are taken in by crops, thus maintaining the fertility of the land and at the same time improving the structure of the soil.

Before the war, improved breeds of chickens, hogs, cattle, water buffaloes, and horses were being raised by a number of farmers in the province. During the enemy occupation of the province, however, almost all of these farm animals were either killed or lost. The livestock industry of the province has suffered a great loss during the war. A comparison of the number of livestock in 1939 and 1945 is shown in Table 5.

TABLE 5.—*Showing a comparison of the number of pre-war and post-war livestock in the province*

Kind of livestock	January 1, 1939 [a]	January, 1945 [b]
	Number	*Number*
Carabaos	142,594	42,130
Cattle	38,707	14,150
Horses	8,601	2,810
Hogs	130,082	49,760
Goats	14,016	8,830
Sheeps	5,878	3,130
Buffaloes	652	
Chickens	1,262,093	549,880
Ducks	17,911	10,200
Turkeys	4,139	2,820
Geese	2,647	2,060
Pigeon	13,265	----------
Guinea Fowls	877	----------
Rabbits	408	----------

[a] Census of the Philippines, 1939.
[b] Yearbook of Philippine Statistics, 1946.

Farm tenure.—In 1938, there were 35,896 farms covering an area of 298,048.72 hectares. Based upon the number of ownerships, the distribution of farms according to size is as follows:

	Number of farms	Per cent
Less than 1 hectare	7,529	20.97
1 to 4.9 hectares	22,645	63.09
5 to 10 hectares	2,494	6.95
11 to 20 hectares	1,324	3.69
More than 20 hectares	1,904	5.30

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

	Hectares	Per cent
Owners	9,723	27.08
Part owners	1,098	3.06
Share tenants	23,371	65.11
Share cash tenants	332	0.93
Cash tenants	674	1.87
Managers	700	1.95

The area and percentage of farms operated under the different systems of land tenure are as follows:

	Hectares	Per cent
Owners	111,737.37	37.49
Part owners	9,164.42	3.07
Share tenants	72,514.66	24.33
Share cash tenants	3,404.49	1.14
Cash tenants	13,165.84	4.42
Managers	88,061.94	29.55

Sugar cane farms are mostly operated by administration, that is, the owner employs an overseer whose duties are more or less similar to those of a farm manager. The owner of a sugar cane farm may also rent his farm to another farmer on the basis of percentage of piculs of sugar produced, usually from 10 to 15 per cent. A farmer who has a sugar quota and does not intend to grow sugar cane may sell his quota for ₱6.25 a picul on his (planter's) share.

Some sugar cane farms are operated by tenants. In the Victorias-Manapla sugar cane district, 60 per cent of the farms are operated by tenants and 30 per cent by absentee owners. Most of the rice, corn, coconut, and other annual crop farms are operated by tenants. The average area cultivated by a tenant is 2.77 hectares. When the land is productive, it is worked by administration, but when the land is poor, it is given to a tenant.

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of the soil in the field. It is in itself an institution for the study of soils in their natural habitat. The soils of Occidental Negros were examined systematically in as many sections as possible. The details of the examination usually depends upon the complexity of the soil. Areas with uniform soil formations are traversed less frequently than those exhibiting greater variety of types. Cuts along roads and railways as well as banks of rivers and creeks were examined, and in places like plains, borings were made to study the soil. These excavations expose distinct soil layers or horizons, called collectively the soil profile. Each layer in the profile is studied carefully noting the color, texture, porosity, structure, constitution, content of organic matter, gravels, concretions, stones, and ease of the soil; "kaingins" have somehow caused floods. And man goes on with such unwise practices, unmindful of their adverse effects, from which he himself suffers along with his fellowmen.

The soil is the product of the action of climate and living organisms upon the parent material, as conditioned by the local relief. These different factors in soil formation act in various ways in different places, which has eventually resulted in the formation of different kinds of soils. To study any of these groups of heterogenous materials, a system of classifying them is essential.

The soils of the Province of Negros Occidental represent a wide range in age, relief, and parent rocks. The parent rocks range from the recent alluvial deposits in the lowlands to the volcanic accumulations on the rolling uplands and to the old soils such as the plateaus and mountains developed from varied kinds of igneous and sedimentary rocks.

Prior to this reconnaissance soil survey of Negros Occidental, Pendleton had conducted detailed soil surveys of the Silay–Saravia District in 1925 and the La Carlota District in 1930. Most of the soil series used in the present surveys are those established by Pendleton. These two surveys covered an area of 62,818 hectares, during which 11 soil series and 28 soil types were described.

In the present survey, with the available map prepared to a scale of 1:200,000, most of the soil types were consolidated for purposes of delineation. The soil types combined are so similar to each other that for practical purposes and as far as land-use planning is concerned, they are considered the same. The soil series used in this report, which were established by Pendleton, are Silay, Guimbalaon, Pulupandan, Isabela, La Carlota, and Bago. In addition, other soil series established in other provinces, which have also their counterpart in this province, are the San Manuel, Umingan, Obando, Bantay, Luisiana, and Tupi. The description of the Faraon soils in the Iloilo and Cebu reports was made on the basis of the unpublished report on the soils of Negros Occidental.

The different soil types of the province may be conveniently grouped on the basis of relief and formation, as follows:

1. *Soils of the flat lowlands*
   - *a.* Hydrosols
   - *b.* Silay sandy loam
   - *c.* Silay fine sandy loam
   - *d.* Silay loam

   - *d.* Silay loam
   - *e.* Silay clay
   - *f.* San Manuel fine sandy loam
   - *g.* San Manuel loam
   - *h.* Umingan clay loam
   - *i.* Obando sand
   - *j.* Pulupandan sandy loam
   - *k.* Isabela clay
   - *l.* Isabela sandy loam
   - *m.* Batuan clay

2. *Soils of the rolling uplands*
   - A. Soils derived from sedimentary materials
     - *a.* Faraon clay
     - *b.* Faraon sandy loam
     - *c.* Bolinao clay
     - *d.* Bantay clay loam
     - *e.* Bago fine sandy loam
     - *f.* Bago loam
     - *g.* Bago sandy clay loam
   - B. Soils derived from igneous materials
     - *a.* Victorias clay loam
     - *b.* Cadiz gravelly loam
     - *c.* Guimbalaon fine sandy loam
     - *d.* Guimbalaon loam
     - *e.* Guimbalaon clay
     - *f.* Guimbalaon gravelly loam
     - *i.* Luisiana clay
     - *j.* Tupi fine sandy loam
     - *k.* Tupi silt loam
     - *l.* Manapla–Bago complex

3. *Soils of the hills and mountains*
   - *a.* Faraon clay, steep phase
   - *b.* Rough mountainous land

The distribution of the different soil types, phases, and miscellaneous land types, are shown in the accompanying soil map, while the area and land-use of each soil type is shown in Table 6.

SOILS OF THE FLAT LOWLANDS

Soils of the recent alluvial deposits are classed under this group. The soil material has its origin from the uplands, which as a result of previous erosion had caused the same to be washed down and later deposited on the lowlands as plains.

All plain lands are just a few meters above sea level, especially if near the coast, but may reach up to 100 feet for areas border-

TABLE 6.—*Showing the area, proportionate extent, and present use of each soil type in Negros Occidental* [a]

Soil type Number	Soil type	Area in hectare	Per centum	Present use
1	Hydrosol	10,153.6	1.31	Fish pond, salt beds, forested.
251	Silay sandy loam	7,565.2	0.98	Sugar cane, upland rice, corn.
252	Silay fine sandy loam.	32,434.8	4.19	Sugar cane, upland rice, lowland rice, corn, bananas, fruit trees.
253	Silay loam	27,747.6	3.58	Sugar cane, lowland rice, corn.
254	Silay clay	11,088.8	1.43	Lowland rice, sugar cane, corn.
95	San Manuel fine sandy loam.	2,218.0	0.29	Sugar cane, corn, upland rice, banana, fruit trees.
190	San Manuel loam	14,145.6	1.83	Sugar cane, corn, lowland rice, upland rice, banana, fruit trees.
168	Umingan clay loam	1,322.8	0.17	Lowland rice, coconut, corn sugar cane.
42	Obando sand	1,910.4	0.25	Corn, coconut, maguey, fruit trees.
255	Pulupandan sandy loam.	895.2	0.12	Coconut, corn, fruit trees.
256	Isabela clay	29,681.6	3.83	Sugar cane, lowland rice, corn.
257	Isabela sandy loam	1,162.8	0.15	Sugar cane, corn, upland rice, coconut.
214	Batuan clay	4,503.6	0.58	Corn, upland rice, lowland rice, coconut, fruit trees.
132	Faraon clay	9,846.0	1.27	Sugar cane, corn, coconut, tobacco banana, fruit trees.
258	Faraon sandy loam	467.6	0.06	Sugar cane, corn, coconut, tobacco, fruit trees.
153	Bolinao clay	8,495.6	1.10	Coconut, corn, tobacco, upland rice, sugar cane.
259	Bantay clay loam	55,826.4	7.21	Upland rice, corn, banana.
260	Bago fine sandy loam.	5,011.2	0.65	Sugar cane, upland rice, corn, camotes.
261	Bago loam	3,300.8	0.43	Sugar cane, corn, upland and lowland rice, coconut.
262	Bago sandy clay loam.	10,433.6	1.35	Lowland rice, sugar cane, coconut.
263	Victorias clay loam	1,590.4	0.21	Vegetables, coconut, sugar cane, upland rice, corn.
264	Cadiz gravelly loam	2,138.0	0.28	Sugar cane, upland and lowland rice, banana, coconut, corn.
265	Guimbalaon fine sandy loam.	9,190.8	1.19	Upland rice, sugar cane, corn, coconut.
266	Guimbalaon loam	22,401.2	2.89	Sugar cane, corn, upland rice, lowland rice, coconut.
205	Guimbalaon clay	71,366.4	9.22	Sugar cane, corn, lowland rice, fruit trees.
267	Guimbalaon gravelly loam.	7,908.0	1.02	Upland rice, sugar cane, corn, fruit trees.
268	La Castellana clay loam.	18,141.6	2.34	Sugar cane, corn, upland rice, banana, fruit trees, tobacco.
269	Manapla loam	6,589.2	0.85	Sugar cane, corn, tobacco, upland rice, coconut, fruit trees, lowland rice.
239	Luisiana clay	23,564.0	3.04	Sugar cane, corn, upland rice, tobacco, fruit trees.
270	Tupi fine sandy loam.	7,563.6	0.97	Sugar cane, upland rice, lowland rice, banana, corn, coconut, fruit trees.
271	Tupi silt loam	30,416.8	3.93	Upland rice, pasture, corn, vegetables.
272	Manapla-Bago complex.	882.8	0.11	Sugar cane, coconut, upland rice, corn, banana, vegetables, fruit trees.
155	Faraon clay, steep phase.	144,993.6	14.86	Corn, coconut, upland rice, forest.
202	Rough mountainous land.	219,106.4	28.31	Forest, grassland, upland rice, corn.

[a] Area obtained with the use of a plainimeter. No deductions made for areas occupied by roads, buildings, and rivers. Area computed by Miss Angelita Costa of the Soil Surveys Section.

ing the uplands. In general they are flat, especially those near the coast, but become gently undulating in the upper regions as a result of the various creeks and rivers that bisect them.

Hydrosol (1)[b].—This type of soil formation is found all along the coastal areas of the province, with an aggregate area

[b] A number in parenthesis after a soil type indicates soil type number.

of 10,153.6 hectares. Wide areas of hydrosols are found in Ilog, Hinigaran, San Enrique, Saravia, and Escalante.

The soil is not suited to crops, as it is most of the time covered by sea water, especially during high tide. The soil varies in texture from sand to clay. It is gray to bluish gray, indicating its poor drainage condition.

These hydrosol areas are covered by nipa palms, bakauan, lañgaray, buñgalon, api-api, ferns, and riquiriw. The nipa palms are useful for their leaves, being the best source of thatching material for Filipino homes. The other trees, principally bakauan, make good sources of fuel. The hydrosol areas when cleared of vegetation are used for fishponds. Artificial rearing of milk fish and shrimps can be done in these fishponds. In other provinces, salt beds are constructed in this type of soil, but no such use is made of hydrosols in this province.

SILAY SERIES

This series is the most important soil in the province, not only because of its wide area but also because it is generally grown to sugar cane, the principal crop, and to some extent to lowland rice. This series which was described by Pendleton in 1925 in his survey of Silay-Saravia area, occupies practically the greater part of the northwestern plain of the province. The soil has almost level topography. There are numerous creeks and rivers traversing this soil which greatly aid in draining it. Internal drainage or percolation, however, is highly impeded due to the presence of a hard, almost compact layer of soil locally called "Bakias" beneath the surface. For sugar cane culture, drainage canals are built at regular intervals, but for lowland rice growing, this soil series is well suited. The hard compact soil layer will keep water in the rice paddies for quite a long time.

The soil of this series is water-laid. The hard, compact layers below the subsoil may be attributed to cementing material like silicates. There are no rock outcrops nor any rock underneath the surface. The hard, compact gray layer in the substratum is the principal characteristic that makes this series different from other alluvial soils. The Bantog series is very much different from Silay, the substratum of the former being brown and comparatively softer. The Palo series of Leyte has poor drainage condition. It has no compact substratum like the Silay series. The substratum of Palo soil is loose, and coarse sand.

The native vegetation in this series is practically gone as this soil is cultivated to crops. Along the creeks and rivers, however, there are bamboo groves. On areas that are not well cleaned, cogon, pensamientos, agiñgay, and talahib are present.

There are four soil types under this series, the texture of which ranges from sand to clay. All these soil types are cultivated. Except the clay class which is used for lowland rice, the other classes are devoted to sugar cane, corn, upland rice, coconut and some fruit trees.

Silay sandy loam (251).—This soil series is found near Talisay, Bacolod, and Abuanan. This soil has a nearly flat topography with good external drainage. The internal drainage is poor. This type covers an approximate area of 7,565.2 hectares.

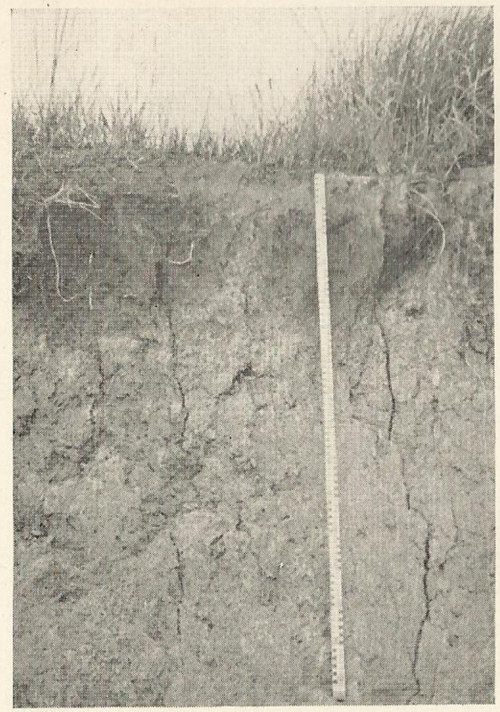
A typical profile of this type has the following characteristics:

Silay sandy loam

Depth of soil cm.	Characteristics
0–15	Surface soil, gray to dark grayish brown when wet, gray when dry; sandy loam with excellent fine granular structure. It is friable, loose or mellow when dry or wet. It has poor organic matter content; non-calcareous; very acidic (pH 5.5),[a] and no coarse skeleton.
15–30	Subsoil, grayish brown when wet to gray when dry, silt loam; structureless; friable but slightly compact when wet and hard to compact when dry. No coarse skeleton. Roots of most cultivated crops penetrate to this layer, but the root systems of trees can go deeper. This layer is separated from the surface soil by a clear and smooth boundary.
30–60	Brown to grayish brown with mottlings of dark brown; silt loam, structureless and massive; very hard and strongly compact when dry or wet. As in other layers, there are no stones or boulders. This layer has a smooth and clear boundary with the subsoil.
60–150	Light gray to a depth of three meters, sandy loam, massive and structureless, very hard and strongly compact when wet or dry. No stones or boulders present and a smooth but diffused boundary separates this layer from the horizon above. Farther down the three-meter depth of this profile is a layer of dark gray clay.

The sandy loam type has a wide range of color depending upon the moisture content. When almost dry it is gray to light gray, becoming light brown when moist, and almost black when wet. These changes in color may be due to the high content of volcanic ash in the soil.

[a] Soil reaction or pH values mentioned in the description of the soils of Negros Occidental were determined in the field by the use of nitrazine paper.



A. Profile of Silay sandy loam. The thin, brown to grayish brown soil is underlain by a hard, compact, white to light gray layer locally called *bakias*.

B. Landscape of Silay sandy loam. The land is flat and has poor drainage. After plowing and harrowing, furrows are laid preparatory to the planting of sugar cane points.

PLATE 4

Being sandy, it is easy to work and cultivate when dry or wet, without any adverse effect on the structure. In cases as those south of Bacolod, the sandy soil has a high content of colloids which makes the soil lump hard upon drying. This is especially true when the field is devoted to lowland rice culture. But this is not the case when the soil is planted to upland crops, like corn and sugar cane. When planted to sugar cane or corn, the soil is friable and does not harden.

Surface drainage of this soil is fair. Drainage in most cases is facilitated with the construction of drainage canals that empty into creeks. The internal drainage is poor. Not much soil erosion takes places in this type even with the presence of the hard compact layer.

The surface soil which varies in depth from 15 to 25 centimeters, is poor in organic matter content. This soil has been cropped for a long time and no effort was made to add organic matter to it. Sugar cane is the main crop grown in this soil type. This plant occupies the land for nearly a year before harvesting, so that not enough time is left to grow green manure crops. Ammonium sulfate is the common fertilizer applied on sugar cane and this leaves an acidic residual effect on the soil. Soils in this type have a pH of 5.5. Sugar cane and corn require, for favorable growth, a pH of from 6.2 to 7.8. It is evident, therefore, that this soil type needs liming to neutralize its acidity. Rice, however, will grow well under a pH of 5.5.

Silay sandy loam has a low productivity. Unless well fertilized, no substantial returns can be obtained. Sugar cane of the variety Alunan is widely grown. Other varieties, like the P.O.J. 2878, are also used when the supply of Alunan cane points is insufficient to plant the whole farm. Ammonium sulfate is usually applied at the rate of 300 kg. per hectare. At this rate of application, a yield of from 100 to 150 piculs of sugar per hectare is obtained.

With the Sugar Limitation Act, some fields previously grown to sugar cane have been planted to upland rice and corn. Rice varieties like Biday, Albayanon and Kuyapu, are planted in March and harvested in July. These varieties give yields of from 30 to 50 cavans of palay per hectare. No other crop is grown after rice for the rest of the year. Oftentimes corn is interplanted with rice. But when grown alone, corn gives a yield of from 20 to 50 cavans a hectare.

Silay fine sandy loam (252).—This soil type does not differ much from the sandy loam type. It is found in Silay, Bacolod, along the course of the Bago River and part in Isabela, with a total area of about 32,434.8 hectares.

The soil type is level and has good external drainage which is partly facilitated with the construction of drainage canals. Internal drainage is impeded due to the presence of a hard compact layer beneath the surface soil. The surface soil is very loose and friable. This layer, to a depth of from 20 to 25 centimeters, is dark gray when dry, becomes almost black when wet. There are no stones or rock outcrops in this soil type. It is acidic with a pH ranging from 5.00 to 6.0. This soil is more acidic than the sandy loam type. The high acidity may be attributed in part to the constant application of ammonium sulfate.

The organic matter content of this soil is very low. Being continually under plant growth throughout the year, crop rotation with the aim in view of plowing under green manures can not be followed. The only organic matter that this soil may receive is part of the dry sugar cane leaves which may be plowed under after harvesting a ratoon crop. It is also the practice of the farmers to burn the sugar cane trashes left after harvesting and this greatly minimizes the source of organic matter.

Some areas under this soil type are artificially irrigated. This irrigation practice increases the trend to acidity, as it tends to percolate much of the soluble bases into the soil. The aim, however, should be to continue the use of irrigation and at the same time correct the soil acidity by the judicious application of agricultural lime.

This soil type is widely grown to sugar cane. The variety Alunan is much more preferred by the farmers than the P.O.J. 2878. The latter variety is planted only when planting material of the Alunan cane is insufficient. The cane after a month or two is fertilized at the rate of 200 to 300 kilograms of ammonium sulfate per hectare. Canes that do not show favorable response to the fertilizer applied, receive additional amounts of the fertilizer a month or two after the first application.

The usual yield of cane sugar for every hectare ranges from 100 to 150 piculs. If the crop is not fertilized, a yield of from 50 to 60 piculs is obtained. Areas not grown to sugar cane are planted to upland and lowland rice, corn, bananas, and fruit trees. Onions have been tried successfully in this soil type, with fairly good yields. This crop grows well when the soil has a pH between 6.2 to 6.9.

Silay loam (*253*).—This soil type, with a total area of 27,747.6 hectares, is found in La Carlota, Bago, and to a certain

extent in Saravia and Himamaylan. It is also found in a very small area in Sagay, near the mouth of the Himugaan River.

Silay loam is level or nearly so, and is fairly well drained, due to the presence of drainage canals. Without this, drainage will be highly impeded. The soil type found in Maao has a thick layer of heavy clay as part of the substratum. Drainage in this case is very much checked.

The surface soil is usually from 15 to 20 centimeters thick, which is dark gray to almost black. It is friable when moist but becomes a little crumbly to almost slightly compact when wet. When dry, it becomes hard or slightly clodded. This is especially true under lowland rice conditions.

Stones or rock outcrops of any kind are absent in this soil. The appearance of this soil indicates the presence of more organic matter than in the sandy loam or fine sandy loam types. Some parts of this soil type are grown to sugar cane, while the others are devoted to lowland rice. Under lowland rice fields, weeds and rice straws are plowed under during the preparation of the field for rice.

This soil type is generally acidic, ranging from pH 5.0 to pH 6.0. The acidity of this soil is greatly increased through the constant application of ammonium sulfate fertilizer in the case of sugar cane fields. This acidity, however, is suited for lowland rice. Lowland rice prefers soil of medium acidity. For sugar cane, on the other hand, a regular application of agricultural lime should be resorted to, in order to correct the acidity, or otherwise bring up the pH value to almost neutral.

In La Carlota, the Alunan variety of sugar cane is highly preferred to the P.O.J. 2878 or the Badilla. When planted on this soil type and fertilized up to 350 kilograms of ammonium sulfate per hectare, a yield of as high as 119 piculs of sugar per hectare is obtained. It is further claimed that when the prices of commercial fertilizers were so cheap that farmers were able to apply up to 400 kilos per hectare, yields of 200 piculs of sugar per hectare were reported.

In some areas like Busay, this type of soil is used for lowland rice field. The rice fields are provided with paddies in order to retain as much as possible the rain water, there being no other means of artificial irrigation. The variety Raminad is used and a yield of from 20 to 25 cavans per hectare is usually obtained. No fertilizer is applied. As in sugar cane, ammonium sulfate can be used for lowland rice, applying at the rate of from 100 to 200 kilos per hectare. Lowland rice needs much more irrigation than sugar cane. With sufficient water, the planting of rice will not be delayed in case of drought.

Silay clay (*254*).—This soil type is found in Bago, Valladolid, Pontevedra, and Hinigaran, and altogether has an area of about 11,088.8 hectares.

The surface soil is of heavy clay that is dark gray when dry and black when wet. It varies in depth from 10 to 20 centimeters. It is strongly hard to almost compact when dry, but becomes very sticky and strongly plastic when wet. It shrinks and cracks well when dried after puddling. If pulverized when moist, it becomes friable when dried. This soil is difficult to work especially when moist or wet. If plowed for upland crops when the soil is wet, it hardens in big lumps and becomes very difficult to pulverize. It should be worked only when it contains just the optimum amount of moisture. When dry, the soil is hard to work, because it becomes strongly compact.

As in the other soil types of this series, there are no stones or rock outcrops. Of all the soil classes under Silay, probably the clay type has the most organic matter content. But like other soils of the Silay series, the clay type is also of medium acidity, ranging from pH 4.5 to pH 7. A pH of 4.5 is strongly acidic, as found in Bago near the Sta. Aniceta Central. The clay soils between Valladolid and La Carlota are usually of medium acidity with a pH of 5.5. Only the Silay clay found near Hinigaran has a neutral reaction.

Silay clay is used principally for lowland rice culture. All the rice fields in this soil type depend upon rainfall for irrigation. There are many rivers that can be dammed for irrigation purposes, which would help much in boosting rice production. Generally, the planting season for lowland rice is in June. The time of harvesting varies, depending upon the varieties planted. For example, the varieties Raminad, Kabunglog, Paticui, Seraup Besar, and Elon-elon are harvested in December, while others like Binarago and Calaua are harvested in October. The late varieties yield from 60 to 80 cavans per hectare. The yield of lowland rice can be greatly increased by providing suitable irrigation systems, rotating the field crops with legumes, planting suitable rice varieties, and judicious application of commercial fertilizers. The amount and kind of fertilizers to apply will have to be determined by careful experimentation.

SAN MANUEL SERIES

The San Manuel series represents soils of alluvial formation and are mostly found along courses of rivers. It has a level topography like the Silay series. But unlike the latter, San Manuel has a better drainage condition. The different soil materials deposited during the formation consist of friable and loose sandy loam and silt soils which are brown to light brown. There is no hard layer present in the substratum as in the Silay. There are no stones or rock outcrops either. The soils in the different layers in the profile are non-calcareous and usually slightly to moderately acidic.

The native vegetation in this soil series has been cut off and the area wholly cultivated. Bamboo groves may still be found in some places along the banks of rivers. Cogon and talahib may also be seen in some places along the rivers.

San Manuel soils have deep water table. Depending upon the location, dug wells have a water table of from 2 to 4 meters from the surface. The water table varies with the season, it being shallow during rainy days but deep during summer time.

This soil series has an elevation of from just a few feet above sea level for areas along the coast, as in Sipalay, to 120 feet in Isabela where this soil type is also found.

Two soil classes have been identified, namely, the fine sandy loam and loam. A typical profile of the former soil type has the following characteristics:

San Manuel fine sandy loam

Depth of soil cm.	Characteristics
0–25	Surface soil, fine sandy loam, brown to pale brown when wet, grayish brown when dry, strongly friable with a good fine granular structure. Seldom cracks or hardens upon drying. Non-calcareous, with good root penetration and a pH of 5.5. It is fairly rich in organic matter.
25–70	Subsoil, brownish gray when dry but light brown whent wet; silt loam in texture with strongly friable constitution and with an excellent granular structure. The surface soil is separated from this layer by a smooth but irregular boundary. There are no stones or boulders present.
70–150	Yellowish brown, to light brown, fine sandy loam with strongly friable consistency and fine granular structure. Non-calcareous, no stones or boulders present. The boundary line separating this layer from the subsoil is smooth and gradual.

San Manuel fine sandy loam (*95*).—This soil type is found chiefly along the courses of rivers, such as the Bago, Pagiplan, Sipalay, and also near San Enrique. This soil type has an area of about 2,218.0 hectares. In general, this soil type has good to excessive drainage. The loose consistency of the soil in the profile facilitates internal drainage. Being near the river, it becomes subject to floods during the rainy season. The Bago River and its tributaries, the Sipalay, and the Pagiplan overflow their banks as often as twice a year. The flood waters, however, quickly recede. It is claimed that the high yields of crops planted in this soil are due to the renovation of soil fertility brought about by floods.

This type has sandy to fine sand areas which are very small and insignificant to be worth delineating. The depth of the surface soil varies from 25 to 40 centimeters. Being on a level stand, surface erosion is negligible, but located as it is along a river, the land is frequently subjected to stream bank erosion. Encouraging the growth of cogon, talahib, or other deep-rooted plants along the banks of rivers will help much toward the control of this form of erosion.

The surface soil is very friable and can be plowed either when dry or wet, without any danger of puddling. Under cultivation, the soil is brown to dark brown. But under native growth, the soil is dark grayish brown to dark gray. Devoting the soil to crops for several years changes its color to dark grayish brown. These changes in color may be due to the exhaustion of organic matter by the crops, or to the further oxidation of the iron compounds into the ferric stage. This soil is of medium acidity with a pH of 5.5. The acidity may have been brought about by continuous cropping to alkali-loving plants as well as by the continued leaching of the bases.

Corn is the most important crop grown in this soil type. The Visayan or white variety is commonly planted. In Sipalay, good stands of corn are produced. A hectare of corn requires from 3 to 4 gantas of seed and produces from 24 to 32 cavans of shelled corn. Ordinarily two crops a year are grown. This high yield of corn is traceable to the constant overflow of the Sipalay River which rejuvenates the fertility of the soil. Correction of the soil acidity by adding agricultural lime so as to have a pH of 6.0 will further increase the production per unit area.

This soil is also grown to coconuts, bananas, upland rice, and sugar cane, but all on a small scale. For lowland rice, this soil is used only as seedbeds.

San Manuel loam (*190*).—This soil type is found near Isabela and in Sipalay. A very small area near the town of Hinigaran also belongs to this type. Altogether this soil type has an area of 14,145.6 hectares.

San Manuel loam has a fine granular soil that is mellow and very friable. The surface soil, to a depth of from 30 to 40 centimeters, is dark yellowish brown. Some portions of the area have a heavier texture, especially those bordering other soil types. Drainage condition in this soil is not as good as that of the fine sandy loam type. Internal drainage is fair to poor. For this reason, this soil is often used more for lowland rice than for corn or sugar cane.

This soil is medium to moderately acidic. In Sipalay this soil has a pH of 6.00, while in Isabela the same soil type has a pH of 5.0. Sugar cane is the principal crop grown in this soil type around Isabela and the constant application of ammonium sulfate has partly caused the high acidity of the soil. In Sipalay, sugar cane was once the crop grown in this kind of soil but it was later changed to lowland rice. Rice will do well from pH 5 to pH 6.00, but sugar cane prefers a pH of 6.2 to 7.8.

Sugar cane of the variety Alunan is commonly planted, although some farmers grow other varieties, whenever there is shortage of Alunan cane points. The cane crops are fertilized with ammonium sulfate at the rate of 250 kilos per hectare when the plants are about one or two months old. At this rate of application, a yield of from 100 to 110 piculs of sugar per hectare is obtained.

Lowland rice is planted in this soil type in Sipalay. Some rice fields are artificially irrigated, while the greater areas are dependent upon rainfall for irrigation water. Rice is planted in June and harvested in October or November, depending upon the variety used. The varieties Raminad, Milagrosa, and Seraup Kitchel, which yield from 60 to 70 cavans of palay to the hectare, are harvested in December, while the variety Maalhay, which gives an average of 50 cavans of palay per hectare, is harvested in October. After the harvest of the early varieties of rice, corn follows in the rotation. This practice is not sound, but it is done on the only excuse that more food crops must be produced by the farmers.

UMINGAN SERIES

Like the Silay and San Manuel soils, the Umingan series is also of alluvial formation and has a flat or nearly level topography. It is also found along courses of rivers that were probably responsible for its formation. It has a fairly good drainage condition like the San Manuel soils. Umingan soil is found only in the southwestern coast of the province as small alluvial fans bordered by steep slopes of hills. This soil series is only a few feet above sea level. The native vegetation in most cases have been removed to give way to the cultivation of crops. Along the banks of the rivers that bisect this landform are nipa palms and mangroves. Cogon and other grasses have gained foothold on cleared lands that are not cultivated.

The Umingan series differs from the San Manuel series in that the former has a layer of river-washed stones in the substratum which is absent in the latter series.

This soil series is represented by only one type, a typical profile of which has the following characteristics:

Umingan clay loam

Depth of soil cm.	Characteristics
0–30	Surface soil, weak reddish brown, moderately friable when wet, and mellow to slightly loose when dry. It has a good fine granular structure and is fairly rich in organic matter. It is non-calcareous and plant roots easily penetrate this horizon. Stones or any coarse skeleton or rock outcrops not present.
30–60	Subsoil, dark brown to brown clay loam to loam to very fine sandy loam that is strongly friable and loose with a good coarse granular structure. Some river-washed stones and gravels are sometimes present in this layer. It is non-calcareous and a smooth but diffused boundary separates this layer from the surface soil.
60–150	Substratum, light brown to yellowish brown fine sandy loam that is slightly compact and structureless. This horizon is characterized by the presence of a layer of river-washed stones. Boundary to the subsoil is smooth and diffused.

Umingan clay loam (*168*).—This soil type is found in the coastal plains between Linaon and Inayauan. These alluvial fans are very limited in size and altogether have an area of 1,322.8 hectares. This type is well drained by creeks that traverse it. Some of the creeks can be used for irrigation purposes. Irrigation in this type is essential, the land being used primarily for lowland rice culture.

The surface soil can be easily worked, it being friable and mellow and may be plowed when wet. The soil is dark brown to reddish brown and is fairly rich in organic matter. It is non-calcareous but medium acidic, having a pH of 5.5. This

soil reaction is just about right for lowland rice. The water requirement is very high because of too much percolation brought by the loose soil materials either in the subsoil or in the substratum.

Coconut is the principal crop along the coastal areas of this soil type. Corn is also planted on the well drained areas, and in small patches in the rice fields after the rice harvest.

OBANDO SERIES

The Obando series are soils developed from accumulated materials of sea wave actions. Soil materials brought down by streams to the sea are triturated and sorted, and finally deposited to form the coastal beaches. It is not unlikely that the sand particles consist chiefly of quartzs and mixed with broken marine shells. This series is found in Pulupandan, Binalbagan, Ilog, Cauayan and in Sipalay. The land is excessively drained. There are no rock outcrops.

Obando sand (*42*).—This is the only soil type under this series and found as coastal beaches in some places south of Bacolod. The topography is flat and excessively drained due to the loose and structureless sand materials that form the whole depth of the profile.

The surface soil is very shallow ranging from 10 to 15 centimeters and the color ranges from almost light gray to light brownish gray when dry, but becomes dark gray when wet. Generally this soil is very poor in organic matter, but is calcareous by reason of the presence of marine shells. The soil, however, is weakly acidic having a pH of 6.7. Furthermore, this soil has a very low water holding capacity.

The subsoil is sandy and slightly darker than the surface soil. The lower layer from a depth of 80 centimeters is made up of coarse sand with marine shells intermixed.

This soil type is mostly inhabited by fishermen and is seldom used for agricultural purposes. Pandan trees may be seen all along the shore lines. A leguminous vine called "mariacapra" spreads out and covers the shores. Sometimes wild magueys are found too. Coconut seems to be the most suitable crop in this soil type. The trees grow luxuriantly and they yield from 10 to 30 nuts each tree every harvest time. It is also claimed that these trees produce more "tuba" than those growing in the interior. When adequately supplied with organic matter, this soil is good for vegetables.

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PULUPANDAN SERIES

This soil series was first described and mapped by Pendleton in his survey of the La Carlota District in 1930. In his report he described the soils to be recent coastal deposits, formed by the sea throwing up barrier beaches of sand and shell materials.

This series is found in a small area along the coast between Pontevedra and Hinigaran. The land is nearly level or very gently undulating. Being of coarse material drainage is quite excessive. There is no creek or river which crosses this soil type. The elevation ranges from one meter to almost the sea level.

This series is represented by only one soil type, Pulupandan sandy loam, having an area of about 895.2 hectares. A typical profile of the type shows the following characteristics:

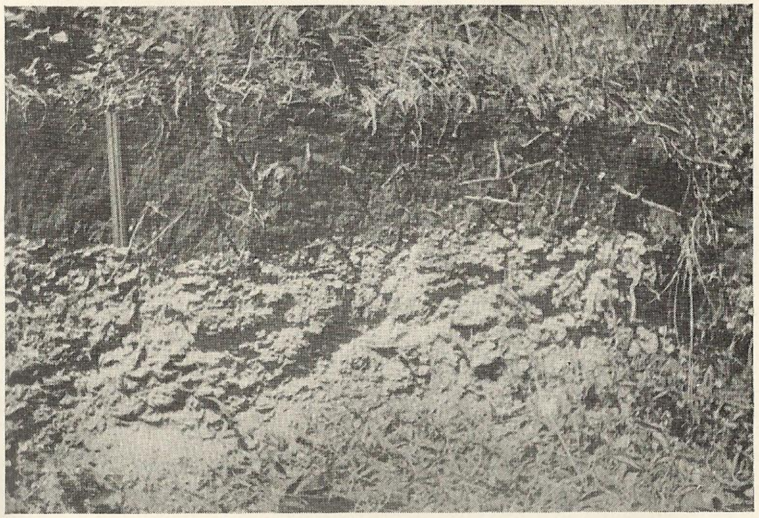
Pulupandan sandy loam

Depth of soil cm.	Characteristics
0–20	Surface soil, sandy loam, black when wet but brownish gray when dry, soft and strongly friable, structureless, and fairly rich in organic matter. Partly calcareous with pH from 6.0 to 7.0.
20–35	Subsoil, grayish brown, sandy, slightly compact but otherwise strongly friable and soft, structureless; calcareous; poor in organic matter and contains some broken marine shells.
35–150	Light brown to gray at times reddish gray sand mixed with large quantity of marine shells. The shells are moderately compact.

Pulupandan sandy loam (*255*).—The surface soil is loose and friable, varying in depth from 15 to 30 centimeters. It is black when wet but turns lighter when dried. Where the soil is shallow some of the marine shells are exposed when plowed. The surface soil is fairly rich in organic matter but the lower horizons are very poor in this material. As this soil has poor water-holding capacity, shallow-rooted crops may suffer from lack of soil moisture.

The subsoil is sandy, with a mixture of a small quantity of marine shells, known locally as "cagaycay." Farther below the subsoil is a layer of almost pure marine shells. These shells are mostly bivalves and extend down to a depth of 3 to 4 meters from the surface. The shells are dug and used for road surfacing.

Coconut is the principal crop raised in this soil type. Other trees grown are mangoes, bananas, and many other kinds of



A. Profile of Pulupandan sandy loam. The 30-centimeters dark colored sandy loam soil is underlain by a gray layer of marine shells which is from 2 to 3 meters deep.

B. Coconut is the principal crop grown on Pulupandan sandy loam. The national highway between Pontevedra and Hinigaran passes through this soil type.

PLATE 5

fruit trees. Corn is also planted but do not produce well, the average yield being only 7 cavans per hectare.

ISABELA SERIES

Another fairly wide soil of the lowland is the Isabela series. This soil was also identified by Pendleton, but it includes only a small part of the La Carlota area. The greater part of this soil series is found in Isabela, Binalbagan and as far south as Cauayan. It is also found in the lowlands of San Carlos. Isabela soils have flat topography and because of their heavy texture drainage is poor.

This soil was formed from alluvial deposition and has an elevation ranging from 80 feet at Isabela to a few feet above sea level in Ilog. This soil is well traversed by big rivers such as the Binalbagan and Ilog. In many places along the courses of these rivers, the surface soil has been greatly altered due to constant deposition of eroded materials whenever they overflow their banks. The cuts along the river banks clearly show the successive layers of recent deposition of eroded materials carried down by the rivers.

The Isabela series has a dark gray to black surface soil that ranges in depth from 30 to 60 centimeters. The texture likewise ranges from clay to sandy loam. The subsoil is clay and black to grayish black in color. The lower layer is silty clay to clay and has a yellowish brown color. This lower layer extends from four to six meters from the surface.

The native vegetation in the Isabela series has been almost cleared off. This soil is widely cultivated to crops. However, those that are not cultivated are covered by species of grass like cogon and talahib. Sugar cane and lowland rice are the two important crops grown in this soil. Corn and coconut are also grown as minor crops.

This series is different from other series of alluvial formation. It is different from the Bantog in the color of the surface soil. Bantog soils are dark brown with dark brown to light brown subsoils. Isabela soils are distinctly black. It has great similarity to the Matina series of Davao, differing only in the color of the subsoil. Matina subsoils are gray to dark grayish brown. Isabela soils are similar to the Medillin clay of Cebu, with the exception that the substratum of the latter has weathered limestone gravels.

There are two types identified under this series, namely, the sandy loam and the clay. The clay type is the most important agriculturally, a typical profile of which has the following characteristics:

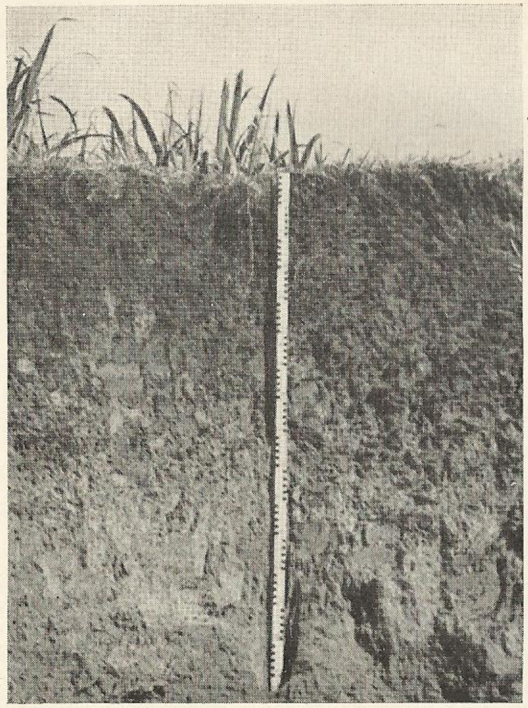
Isabela clay

Depth of soil cm.	Characteristics
0–30	Surface soil, grayish black to black, heavy clay, with good coarse granular structure, very sticky and strongly plastic when wet, moderately friable when dry, with fairly rich organic matter content, and no rock outcrops or coarse skeleton of any sort. Plant roots penetrate this layer. Non-calcareous, with a pH of 6.5.
30–60	Subsoil, heavy clay, grayish black to bluish black when wet, light grayish black when dry. Good coarse granular structure, strongly sticky and plastic when wet, hard to slightly compact when dry, non-calcareous, no coarse skeleton, with a pH of 7.00. This layer is separated from the surface soil by a wavy and diffused boundary.
60–100	Yellowish gray to yellowish brown clay when wet, light brown to yellowish brown when dry, with a good coarse granular structure, strongly sticky when wet, but friable when dry, no coarse skeleton, non-calcareous, with a pH of 7.0. This layer is separated from the subsoil by a wavy and clear boundary.
100–150	Substratum, yellowish brown clay to silty clay, structureless, strongly sticky and plastic to slightly compact when wet. No coarse skeleton present, non-calcareous and has a neutral reaction. This is separated from the upper layer by a wavy but diffused boundary.

Isabela clay (*256*).—This is the most important soil type under this series. It is found in Isabela, Binalbagan, Kabankalan, and San Carlos. Altogether this type covers about 29,681.6 hectares. It is level or nearly so and because of the heavy texture of the soil drainage condition is very poor.

The surface soil is distinctly black and has an appearance of being powdery. Although clay in texture, it does not crack or shrink like the silty clay. The surface soil in some cases, as in between Isabela and Binalbagan, reaches to a depth of 50 centimeters. The difficulty with this soil is that when it is wet, it becomes very sticky and therefore hard to work. When worked wet, it will puddle and become hard and difficult to pulverize. It is friable and soft only when it is moist.

The soil reaction ranges from pH 5.5 to 7.0. It is weakly to moderately acid in the vicinity of Isabela and rather neutral or nearly so in Kabankalan and Cauayan. This soil type in San Carlos has a pH of 6.0. The acidity in the first place may be due to the constant application of ammonium fertilizers in the sugar cane fields.



A. Profile of Isabela clay. The surface soil is thick, black, heavy clay, while the substratum is yellowish brown clay from 2 to 10 meters in thickness.

B. Isabela clay is a flat and poorly drained land. After the furrows are laid, cane points at the rate of 50,000 a hectare are dropped and later covered with soil by means of the feet of women and children mostly.

PLATE 6

The subsoil is grayish black and at times bluish black, which partly shows its lack of aeration. It is also sticky and slightly hard to compact when wet. This layer is shallow in places between Ilog and Cauayan but rather thick between Isabela and Binalbagan. In San Carlos the surface soil is from 20 to 30 centimeters deep. The other layers in the profile are also correspondingly shallow.

One good quality of this soil is the absence of boulders that would likely interfere with tillage operations. One drawback, however, is its poor drainage condition. Sugar cane fields are provided with drainage canals at regular intervals to facilitate the drawing out of excess water. The water table varies in depth from 2 to 4 meters in Isabela to 6 meters in Ilog. Sugar cane and lowland rice are the principal crops grown in this soil type. Before the imposition of sugar quotas, nearly the whole soil type was planted to sugar cane. The Alunan cane is preferred to the P.O.J. 2878. Before the war when fertilizers were cheap, as much as 500 kilos of ammonium sulfate per hectare were being added to this soil for sugar cane, obtaining yields as high as 150 to 200 piculs of sugar per hectare. After Liberation, prices of fertilizers became so prohibitive that only as much as 200 kilos could be applied, yielding around 120 piculs of sugar per hectare.

The lowland rice fields are not irrigated and depend only upon rainfall for water. The fields are not fertilized as in sugar cane. Some of the common rice varieties grown around Isabela are Roxas, Pinili, Kalubod, Apostol, Raminad, and Amalia (Elon-elon). The rice season is from June to October, and up to December for the late-maturing varieties like the Raminad and Elon-elon. An average of 40 cavans of palay per hectare is obtained. In Dancalan the variety Wagwag produces up to 80 cavans, provided there is adequate moisture in the soil. Corn is oftentimes planted after the rice harvest. Some corn fields have excellent stand and yield as much as 30 cavans to the hectare.

Isabela sandy loam (*257*).—This type is found in the town of Ilog and has an area of about 1,162.8 hectares. The soil is loose and friable, with a depth of from 25 to 40 centimeters. Unlike the clay type, the sandy loam type is brown to yellowish brown. It is also planted to sugar cane and partly to coconuts, bananas, and many kinds of fruit trees. This soil is subjected to yearly floods from the Ilog River. The water does not stay long and readily recedes toward the sea.

BATUAN SERIES

Batuan clay (214).—Along the proposed Kabankalan–Bais highway is a narrow stretch of flat land with a black and heavy clay soil developed from limestone. Sporadic patches of Faraon clay occur in this level area which are not indicated in the soil map. Batuan clay differs from Faraon first in topography; secondly in depth of soil; and thirdly in the absence of outcrops or erosion pavements. Internal drainage is quite poor.

Batuan clay has the following profile characteristics:

Batuan clay

Depth of soil cm.	Characteristics
0–20	Surface soil, dark brown to grayish brown when dry, black when wet; heavy clay, plastic when wet, coarse granular.
20–40	Brown to light brown, columnar, plastic and sticky clay with abrupt boundary from surface soil.
40–	Thick layer of hard, white and compact coralline limestone rock.

A large area of this soil type is uncultivated, it being still covered by primary forest. The cultivated fields are planted mostly to lowland rice and some to corn. Areas once cultivated by the Kaingin system are now covered by cogon and talahib.

SOILS OF THE ROLLING UPLANDS

The flat lowlands in Negros Occidental are those along the coastal areas. The rolling uplands are intermediary—found between the coastal plains and the central mountainous areas. In some places, as those in Cauayan in the southwestern end and those in Calatrava in the eastern side, no rolling lands are found.

The narrow coastal plains are abruptly bounded by steep slopes of the hills and mountains. In some cases, the steep mountains rise from the coast line.

The rolling lands are more prominently found in the northwestern part of the province. This land-forms are widely cultivated to crops, although some grasslands are not planted, either because the land is very stony or the soil is so highly eroded that it cannot support a good crop. External drainage is excessive which partly accounts for the accelerated erosion.

SOILS OF SEDIMENTARY MATERIALS

Sedimentary materials in soil development are the limestone, shale, sandstones, and conglomerates. The first two classes of

materials are the only ones found in Negros Occidental. The former makes up the greater part of the soils in southwestern and northeastern parts of the province. The latter is the parent rocks of soils in Tablas Valley. Limestone is the rock formed from the constant deposition of exoskeleton of marine animals known as coral. Limestone may also be formed in other ways, but the limestone of Negros is distinctly coralline.

Shales, on the other hand, were silty or clayey materials deposited under water during a certain period of the earth's history, which became hard after subjection to pressure. Subsequently this mass of solid materials rose from the bottom of the water to become part of the landform.

FARAON SERIES

Faraon soils are derived from the decomposition of coralline limestone. This soil series is found in the hilly areas from Kabankalan to the coast extending beyond the boundary of the province in the direction of Tolong. This is also found as an important soil from Sagay to San Carlos. The topography ranges from rolling to hilly. Drainage condition in this area is very excessive externally. Internal drainage is fair, owing to the varied pores which the limerocks naturally contain.

Soils in the Faraon series are black and usually clayey. When the land is highly eroded, the parent rocks become exposed, giving the appearance of being rocky. In extreme cases of erosion, the land can not be plowed because of the exposed rocks. The limestone rocks in Faraon are comparatively soft, roughly angular and oftentimes colored. This series is different from the Sibul or Binangonan series in that the limestone rocks in the latter two series are hard, massive and white.

The Faraon series in the southern part of Negros Occidental is well covered by primary forest wherein hardwoods of the molave type are found. The Faraon soils in the northeastern part is so unwisely cultivated that practically no more soil is left as a result of erosion. In other cases, the lands have been abandoned and cogon grass has finally gained foothold.

Faraon clay (132).—This is the most important soil type of this series, a typical profile of which has the following characteristics:

Faraon clay

Depth of soil cm.	Characteristics
0–30	Surface soil, black clay, medium granular structure, soft and very strongly plastic when wet, slightly hard and brittle

	when dry. Fair in organic matter, at times limestone rocks are found on the surface. An abrupt and irregular boundary separates surface and subsoil layers.
30–45	Subsoil, dark yellowish-gray, like the surface soil also strongly plastic when wet but hard when dry, with a moderate fine granular structure; also mixed in this layer are partially weathered limestone rocks. The horizon is separated by a clear and smooth boundary.
45–60	Yellowish-gray highly weathered limestone rocks, soft, and weak coarse granular.
60–150	Grayish to white porous limestone rocks, soft, and easily broken.

Faraon clay is the principal soil type in Sagay, Escalante, and San Carlos and has an aggregate area of 9,846.0 hectares. This type has a rolling to gently rolling topography. Several small intermittent creeks traverse the area. The elevation varies from a few feet above sea level to 50 feet.

The surface soil, ranging in depth from 15 to 30 centimeters, is black clay. When moist it is friable, but becomes sticky and plastic when wet. The soil between Calatrava and San Carlos is deep, while that in Sagay and Escalante is highly eroded. The subsoil is grayish black to dark gray and is also clayey. Oftentimes this layer is absent in well-developed profiles. The substratum is gray to yellowish gray, porous, soft and highly weathered limestone. In some instances the surface soil rests over a substratum that is made up of hard gray coralline limestone.

When the surface soil becomes eroded, erosion pavements or bedrocks left after the soil has been washed away, becomes very prominent on the surface. This characteristic is distinct of this soil type. In Sagay, the soil has been so severely eroded that the only planting space left are the crevises of rocks.

Corn, coconut, bananas, and tobacco are the principal crops in Sagay and Escalante. Very rarely upland rice is planted. The soil in this place has a pH of 7.0 or neutral. Corn growth is so poor that the yield barely exceeds 5 cavans per hectare. Coconut and bananas, on the other hand, grow fairly well. The deep root system of these crops help much in securing the needed essential elements for proper growth. Sugar cane is the important crop grown between Calatrava and San Carlos. The soil in this section has a pH of 6.5 or very nearly neutral, which is suitable for cane growing. For favorable growth of canes, a soil reaction from pH 6.2 to pH 7.8 is desirable.

This soil type should be good for orchards or citrus, bananas, mangoes, and other fruit trees. Putting the soil to orchards or other permanent trees will aid in the conservation of the soil.

Faraon sandy loam (*258*).—This soil type, with an area of only 467.6 hectares, is located near Escalante. The land is rolling and well drained. Internal drainage is poor. The surface soil is gray to dark gray sandy to sandy clay. It is friable when moist, but tends to become sticky when wet. The surface soil is as deep as that of the clay type and its subsoil is 30 centimeters thick, which is clay, light gray, slightly compact coarse granular, with a clear and smooth boundary from the surface layer. The substratum which barely reaches to a depth of 50 centimeters consists of weathered limestone. The surface soil is of medium acidity having a pH of 5.5. The high acidity may be due to the leaching out of bases.

This soil type unlike that of the clay type is not as eroded and seldom are its bedrocks exposed. It is commonly planted to sugar cane. The canes do not grow well, either because of drought or lack of essential food nutrients. Some portions are not cultivated and are just covered by bermuda grass.

BOLINAO SERIES

The Bolinao series is made up of soils developed from limestone. This series is found around Escalante. This soil has all the characteristics of the Faraon series, except for the color of the soil and consistency of the bedrock. The Bolinao soils are red or dark reddish brown. The bedrocks are harder and whiter than those of the Faraon series.

Drainage condition is fair like that of the Faraon. A few creeks traverse the area, but it has many gullies that drain the runoff water. It ranges in elevation from sea level to 50 feet.

Bolinao clay (*153*).—This soil type has an area of 8,495.6 hectares, comprising the gently rolling to rolling lands in Vito, Cervantes, and around Danao Sugar Central, all in the municipality of Escalante. The surface soil ranges in depth from 10 to 24 centimeters. The soil is heavy clay and has a distinct red or reddish brown color. When wet this soil is very sticky and plastic like the Faraon, but is friable and mellow when moist. The soils around Vito and Cervantes are so severely eroded that the bedrocks are already exposed. The soils in the neighborhood of Central Danao are quite thick and so far have not suffered much from erosion. But it was observed that most of the crests of hills or ridges in this area are severely eroded.

As in the Faraon series, corn, coconut, and bananas are the principal crops. The yield of corn varies from 4 to 5 cavans per hectare, using the variety known locally as "Mimis". Sometimes upland rice is planted during the rainy season (May to June). The *Lubang Puti* and the Visaya varieties are common, but the yield is from 5 to 10 cavans only. The poor yield in this soil may be due to its reaction—ranging from pH 6.0 in Vito to pH 6.5 in Cervantes. Corn is suitable within this range of reaction, but erosion has made the soil unfertile.

Sugar cane is the principal crop around the Danao Central. The soil in this place has a pH of 7.0 or neutral. Sugar cane requires a pH of 6.2 to 7.8. The variety P. O. J. 2878 is planted, yielding from 100 to 150 piculs of sugar per hectare.

Like the Faraon series, the Bolinao soil is also good for fruit trees. It was also noted that some plants, especially in the eroded soils, are chlorotic. Chlorosis in this case may be either due to unavailability of iron and manganese in the soil as a result of high alkalinity, or the soil is deficient in some elements.

BANTAY SERIES

The Bantay series is found on the Tablas Plateau in the central part of southern Negros. On the plateau, the land is rolling and can be well cultivated, but its borders are hilly with steep slopes. There are many creeks and rivers, some of which are intermittent, that help in draining this land. The tributaries of the Tablas and Ilog Rivers are the principal drainage ways of this series.

This plateau rises abruptly from Dancalan to a height of 1,000 feet, then gradually descend to Calantucan or Tabo. From Tabo the land again rises to a height of 1,800 feet to the east. This plateau is inclined from south to north. The parent rock is shale. The shale rocks are either dull gray to brown or dusky red. The rocks are quite brittle.

The soil developed from the weathering of this shale rock is dark gray to gray clay loam. The native vegetation is dominantly grassland, of which cogon and bacuit dominate. All over the open grassland are binayuyu trees. Second-growth plants include small species of bamboo locally called Pawa, some boho, calansi (a species of bamboo smaller than the boho), and pakol (a species of wild banana).

This series was originally described in Ilocos Sur Province. Most soils developed from shales are red or black clay which are very sticky when wet. The Bantay soil is a clay loam and is not sticky when wet. This soil is similar to the Cabantian series in Davao, differing only in the texture and color of the different layers. Cabantian soils are reddish brown clay. The Himayangan series in Leyte although developed from shales, differs from Bantay in that it has a layer of compact sand below the shale substratum.

Bantay series is represented by only one soil type, a typical profile of which has the following characteristics:

Bantay clay loam

Depth of soil cm.	Characteristics
0-20	Surface soil dark gray when wet, light gray when dry; clay loam, with good fine granular structure that is soft and friable when wet or dry. It is poor in organic matter, non-calcareous and quite acidic—from pH 4.5 to pH 6.0. There are no stones on the surface.
20-30	Subsoil, dark gray to light gray, silt loam with good fine granular structure, and friable to brittle in consistency. Poor in organic matter, non-calcareous, no coarse skeleton, but of medim acidity—pH 5.5. Boundary from the surface layer is wavy and clear.
30-50	Gray and mottled with brown, highly weathered shale, massive and structureless; hard to slightly compact, non-calcareous, and more acidic than the above layer—pH 4.5. The layer is separated from the subsoil by smooth and diffused boundary.
50-150	Gray, brown, mottled with red weathered shale. Hard and compact to almost massive structure. Boundary from surface layer is wavy and clear. This layer has a pH of 5.0.

Bantay clay loam (*259*).—The greater part of the soil in the Tablas Plateau belongs to this soil type which covers an area of about 55,826.4 hectares. This soil is the product of development from the weathering of the parent rock which is shale. The shales in some points are soft and whitish, and in other portions are hard but brittle and dusky red. The land is well drained by the many creeks and tributaries of Ilog and Tablas Rivers. External drainage, by reason of the 5 to 15 per cent slopes, is excessive. Percolation or internal drainage is fair.

This soil type is mostly grassland, of which cogon and bacuit predominate. Growing at random over the grassland are binayuyu trees. Patches of primary forest are found in the interior around the sitio of Pispis. The second-growth forest found in the vicinity of Calantucan is made up mostly of several species of bamboo, wild bananas, and low trees.

Bantay clay loam has a surface soil varying from 15 to 25 centimeters thick. In some places soil erosion has washed off most of the soil, leaving the bare rocks which may be mistaken as outcrops. The soil is friable, loose, and with a good fine granular structure. Soil under grassland is darker in color and supposedly contains more organic matter than the cultivated soil. There are no rock outcrops that will interfere with tillage operations. Bantay silt loam has a strongly acid reaction, or a pH of 4.5. With this reaction neither corn nor rice will grow well. It is advisable to correct this acidity by proper liming.

Upland rice, of the varieties Lubang and Visaya, is one of the crops planted. The crop is sown in May and harvested in October. Upland rice production is so low that a yield of 25 cavans of palay per hectare is seldom obtained. Corn is also grown but yields are very poor. The acidic reaction of the soil which is the limiting factor for the growth of rice, is less favorable for corn. Corn requires a soil reaction between pH 6.2 and pH 7.

BAGO SERIES

This series is widely distributed in the lower sections of the upland soils of the Victorias-Manapla District. The appearance of the landscape is similar to that of the Victorias and Cadiz series. Bago includes soils of the rolling or gently undulating uplands and small valley floors. The undulating uplands have excessive external drainage and where the water collects on the valley floors where the drainage condition is very poor, the water remains stagnant for some time. Internal drainage in general is poor. Pendleton is of the belief that this soil was once a coastal swamp covered with brackish water but that it rose to the present position when the whole western plain of Negros was elevated as a result of volcanic actions. Chemical tests and field experiments have shown this soil to be deficient in potassium.

The surface soil of this series ranges from fine sandy loam, loam to clay. In all cases the soils thus formed are gray, with plenty of grayish brown spherical concretions. The subsoil is grayish to almost bluish gray clay with some concretions. The substratum is light bluish gray clay. This layer is sometimes mottled with brown. Sometimes the substratum is found over a hard light gray layer which is probably volcanic tuff. The

grayish clay soil from the subsoil to the substratum makes this series different from others previously described.

The greater part of this soil in the Victorias-Manapla District is devoted to sugar cane, corn, and lowland rice. Of the grass family, some cogon and talahib were seen. A species of grass called "Luya-luya", which is believed to be very difficult to eradicate in the rice fields, is very common in Sumag and Abuanan. It was also noted that white ants seem to prefer this soil to the other soil types as material for building their mounds. Binayuyu trees are also found growing at random over the open grassland.

There are three soil types classified under this series, of which Bago fine sandy loam is the most important agriculturally. A typical profile of the latter has the following characteristics:

Bago fine sandy loam

Depth of soil cm.	Characteristics
0–20	Surface soil, fine sandy loam, gray, light gray to dark gray; friable and loose when dry, soft and very slightly plastic or sticky when wet; good fine granular structure; poor in organic matter content; good root penetration; non-calcareous; no rock outcrops but with some brownish concretions, and soil almost neutral in reaction.
20–70	Subsoil, clay, gray to yellowish brown; sticky and plastic when wet; hard when dry; massive; poor in organic matter; poor for root penetration; non-calcareous but with some concretions present; very slightly acidic to almost neutral in reaction and boundary to surface layer is smooth and diffused.
70–150	Substratum, light brown to yellowish brown or even gray clay; no concretion; with mottlings of brown or dark brown, plastic and sticky when wet, structureless, non-calcareous; sometimes rested over a hard gray volcanic tuff. Boundary to subsoil is smooth and diffused.

Bago fine sandy loam (*260*).—This soil type is found in Haciendas Dolores, Pacita, Rosalia, San Ramon, San Jose No. 2, and in the Barrio of Tortosa, and all together aggregate an area of 5,011.2 hectares. This soil type has generally an undulating slope. This type has an elevation of about 80 feet above sea level. Drainage is mainly external. Internal drainage is poor. The loose and friable surface soil has always been constantly washed away due to poor percolation. Erosion in this soil type is serious.

The surface soil generally ranges in thickness from 10 to 15 centimeters, but this reaches up to 20 centimeters. The loose and friable fine sandy loam is gray when dry but becomes slightly darker when wet. Very often the surface layer on tops of slopes are eroded, leaving only the clayey subsoil. In other cases, plowing is so deep that part of the clay subsoil is brought on top and gets incorporated with the surface layer, thus altering the physical properties of the soil. Concretions are present on the surface but not as abundant as in the Victorias series.

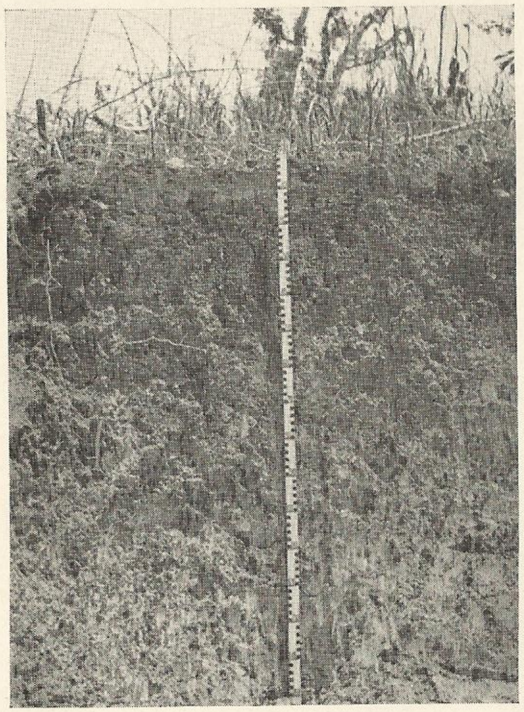
The subsoil varies considerably in thickness from 35 to 50 centimeters, and ranges in color from yellowish brown to gray and grayish brown. This layer is sticky and plastic clay which becomes hard and compact upon drying. There are no coarse skeletons other than concretions.

This soil type is also used for sugar cane. In Hacienda Tortosa the variety P.O.J. 2883 is grown and P.O.J., 2878, in Hacienda San Jose Patpatao. This is one of those soils said to be deficient in potassium. In Hacienda Dolores, this type is used for growing sweet potatoes, corn, and some peanuts. This soil is generally classed as poor. It has to be fertilized to as much as 500 kilograms of Warnerphos to obtain yields from 80 to 100 piculs of sugar a hectare.

Bago loam (*261*).—This soil type is widely distributed in the intermediate upland regions from the Barrio of Nanca to Barrios of Chambery, Concepcion, Luna, Mabini, and Daga all in the northern part of the province. Altogether this soil type has an area of 3,300.8 hectares. It has a topography similar to that of the fine sandy loam type. The elevation slightly varies from 120 feet in Hacienda Estaquince; 80 feet in Hacienda Angeles; 120 feet in Hacienda Banco to 180 feet in Hacienda Nabinay. Drainage condition is poor. The greater part of the rain water is lost as runoff. The clay soil below the surface layer impedes internal drainage.

Bago loam is a product of the development of the older alluvial deposits. Its surface soil which is coarser than the subsoil has a depth from 15 to 20 centimeters. It is dark grayish brown when wet. When dry it is gray and in some places brown. Concretions are present but stones or boulders are not found. The soil is fairly friable when moist but when wet is a little sticky. It becomes hard and compact when dry.

The subsoil is clay with gray to grayish brown color. This clay is very soft, plastic and sticky when wet. Since it is impractical to increase the internal drainage of this soil, the farmers should adopt suitable farm practices to control the



A. Profile of Bago sandy clay loam in Hinigaran. The gray surface soil lies over a substratum of light gray and plastic clay.

B. The Bago soil is a gently undulating to slightly rolling land with poor internal drainage. When canes are one month old, fertilizers are applied around the plants by women and children.

PLATE 7

flow of the runoff water. Contour farming and strip cropping are some of the practices suggested.

Sugar cane is the principal crop raised on this soil type. This soil is deficient in potash but only Warner-phos fertilizer is added for sugar cane. An average yield of 70 piculs to the hectare is obtained. Sometimes corn, lowland and upland rice, and coconuts are also grown. This soil is considered as poor.

Bago sandy clay loam (*262*).—This soil type is found in widely scattered areas in the lower sections of the upland soils. Unlike the other two types, Bago sandy clay loam occurs in the low-lying areas between high slopes. Like other types in the series, it has very poor internal and external drainage. Bago sandy clay loam is found in Haciendas Cristina, Sta. Filomena, San Ramon, Hortencia, Omapog, and Socorro.

The surface soil has the characteristic clay properties and is gray to light gray in color. When wet it is soft, plastic and sticky. The soil ranges from 15 to 30 centimeters deep. There are places in this type where the soil throughout the depth of the profile is so soft that upon plowing the working carabao sinks. The subsoil could be hardly recognized from the surface soil as it also is clay with a gray color. It is a little bluish gray, due to poor drainage. The soil is sticky and plastic when wet, but it becomes hard and compact upon drying. This layer is very deep attaining more than 1 meter. The substratum is plastic clay but may in other places gradually grade into coarser clay below.

Bago sandy clay loam is seldom devoted to upland crops. It is more often used for lowland rice. This type in Hacienda Filomena is planted to the Pinili variety, which is claimed to yield from 40 to 50 cavans of palay per hectare when there is enough moisture. It is planted in June or July and harvested in November. Other farmers plant the variety Caditdit which yield 50 cavans of palay to the hectare.

SOILS OF IGNEOUS MATERIALS

Igneous materials for soil formation consist of such rocks as basalt, andesite, and volcanic tuff. These are the three important rocks in the formation of soils in Negros. Most of these materials are extrusive rocks or solidified molten materials brought upon the earth's surface by volcanoes. Other molten rocks are pushed from within the earth towards the surface but, never reaching it, are left to cool slowly deep underground. Such rocks are called intrusive rocks. Volcanic tuff is composed mainly of the basic rock minerals. Lava ejected from volcanic craters had been deposited layer by layer at different intervals, covering mostly the western and northern portions of Negros. All these forms of rocks upon action of the forces of weathering produced soils ranging in color from gray to dark red, and in texture from sandy to clayey.

VICTORIAS SERIES

This series covers part of the upland soils reported to be deficient in potassium. An extensive area of this series is found between Victorias and Manapla. This series is characterized by a gently rolling topography. In areas where creeks are far apart from each other the land is almost flat, but where the land is crossed by many creeks, a rolling topography results. Drainage is mostly external and quite excessive. For this reason, this soil type is seriously eroded. Internal drainage is impeded due to the presence of a layer of clay soil below the surface. The soil of this series had been developed from older alluvial deposits. The parent material consists of almost compacted fine sandy loam. The area is slightly elevated over the alluvial plains such as those of the Silay and the swampy areas or hydrosol. Its elevation ranges from 80 to 140 feet above sea level. There are no stones or boulders on the surface but concretions are quite numerous. Concretions are rounded or oval and dark brown. Some are hard but some can be crushed with the fingers, revealing a black powdery mass.

The greater part of this series is under cultivation to crops. Abandoned farms, however, are covered by a thick growth of cogon. This soil is non-calcareous and highly acidic. However, some limestone rocks are found in Hacienda Rosalia, but its source is not known. It is possible that such lime rocks were transported there. Root penetration for most ordinary crops is limited to the surface layer. This series has a deep water table. Dug wells in Victorias have water at about 5 meters from the surface.

This series is represented by only one soil type, a typical profile of which has the following characteristics:

Victorias clay loam

Depth of soil cm.	Characteristics
0–15	Surface soil, grayish brown to brown when wet and grayish brown when dry; clay loam; good medium granular; slightly friable to sticky when wet and friable when dry; poor in organic matter content; pH of 5.0 and concretions present.
15–35	Subsoil, brown to grayish brown when wet, yellowish brown when dry; clay to clay loam; poor coarse granular; sticky when wet, hard and slightly compact when dry; pH 5.0; concretions present; separated from the surface soil by a smooth and abrupt boundary.
35–150	Substratum, light gray with ripples of reddish brown when wet or dry; fine sand; structureless and massive; compact and hard either wet or dry; no concretion; with a pH of 6.0. The boundary from the subsoil is smooth and abrupt.

Victorias clay loam (263).—This soil type is found in Barrio Tortosa, Haciendas Milagrosa, Dos Hermanos, Sta. Barbara, Concepcion, Fe Palid, and Bayabas, which altogether aggregate 1,590.4 hectares. The soil type, as found along the highway between Victorias and Manapla, is almost rolling due to the presence of many creeks. Where the land is not well traversed by creeks, an undulating to almost flat topography is found. Drainage condition is good to excessive and is almost purely of the external form. Internal drainage is rather poor due to the presence of clay layer below the surface.

The surface soil of this type is about 15 centimeters deep. The soil is brown, light brown, to grayish brown. It is friable, loose, and with good fine granular structure. Most often, however, plowing to more than 15 centimeters deep has brought up the clayey subsoil and incorporated with the surface soil. In this way, the texture and consistency of the surface layer has changed considerably. Concretions which are spherical and brown are plentiful. There is no other form of coarse skeleton on the surface horizon. This layer is very acidic, ranging from pH 5.0 to 6.0

The subsoil is from 30 to 40 centimeters deep and consists of grayish brown to yellowish brown clay to clay loam soil. When wet it is sticky and plastic and becomes hard upon drying. It has a poor coarse granular structure that tends to become compact or massive on drying. Concretions like those on the surface soil are present.

The substratum of this soil consists of a more or less compact fine sandy loam to sandy loam to even sandy clay. When dry this layer is hard and almost compact. When wet it is soft, and depending upon the texture, it becomes either friable or sticky. The substratum is as a whole gray. But in some places ripples of reddish brown and some specks of brown may be found. The rippled color may indicate the nature of its deposition during the early part of the formation.

Victorias clay loam is heavily eroded. There are many places here where due to sheet erosion, the color of the surface of the ground ranges from brown to yellowish brown and gray, depending upon whether the layer exposed is the surface soil, subsoil, or substratum. Some farms showed a loss of more than half a meter deep of soil, under which condition a farmer can never expect uniform growth of such a plant like sugar cane. Efforts were made in Hacienda Rosalia to check this sheet erosion through the building of check dams on the lower part of the slope. While this is good in the absence of other methods, the fact remains that large areas on the upper parts are eroded and rendered unfit for crop production. Contour farming or strip cropping may be the solution to this problem. The farmers should be trained to plant along the contours.

Victorias clay loam is planted to sugar cane mostly of the varieties P.O.J. 2878 and 2883. This soil is reported deficient in potassium, but due to the unavailability of potash fertilizer only Warner-phos or nitrogen-phosphorus fertilizer is applied at the rate of from 300 to 500 kilos per hectare. With this rate of application, a yield of from 70 to 105 piculs of sugar per hectare can be obtained. In Hacienda Fe Palid, an application of 450 kilos per hectare of Warner-phos gives 105 piculs. In Hacienda Villa Elena, 500 kilos of the same fertilizer gives only from 70 to 80 piculs of sugar to the hectare. The variety P.O.J. 2878 is used in both farms. Upland rice is planted in areas not grown to sugar cane, and depending upon the availability of water, a production of from 5 to 30 cavans of palay is obtained.

CADIZ SERIES

Cadiz soil is similar to Victorias soil, except in the internal characteristics. Occupying also the same geographical position as the Victorias soil, Cadiz series has an undulating to almost flat topography. Drainage condition is fair. This soil like the Victorias series had been developed from older alluvial deposits. However, the presence of a thick layer of almost compacted, reddish gravel or lava flow, called locally "igang" beneath the surface or subsoil layer, differentiates this series from the Victorias. The soil in the substratum is reddish brown clay loam. The Cadiz soil is more elevated than the Silay series. Its elevation ranges from 180 feet in Hacienda Nabinay to just a few feet near the coast in Cadiz Viejo. The elevation in Hacienda Sicaba-Lacson is 140 feet. This soil is non-calcareous and its water table may be several meters below the surface.

The Cadiz series is represented by only one soil type, a typical profile of which has the following characteristics:

Cadiz gravelly loam

Depth of soil cm.	Characteristics
0–15	Surface soil, brown to light brown when wet, grayish brown when dry; gravelly loam; good coarse granular; slightly friable to sticky when wet, friable when dry; poor organic matter content; gravels and concretions present.
15–25	Upper subsoil, brown to yellowish brown when wet, brown to light brown when dry; clay loam poor coarse granular; sticky to plastic when wet, hard when dry; concretions present; boundary from the surface layer is smooth and clear.
25–80	Lower subsoil, dark brown when wet or dry with reddish specks; clay loam; poor coarse granular; slightly sticky and plastic when wet; hard and compact when dry; the boundary from the upper subsoil is smooth and clear; gravels (*igang*) present.
80–110	Substratum, dark yellowish brown when wet, yellowish brown when dry; clay; structureless, plastic and soft when wet; gravels present; the boundary separating this layer from the lower subsoil is smooth and clear. Boring difficult because of gravels.

Cadiz gravelly loam (264).—This soil type has an area of 2,138.0 hectares. It is well developed in Cadiz Viejo and Barrio Sicaba. The land is very gently undulating to almost flat. Drainage condition both internally and externaly is fair. The soil of this type was developed from older alluvial deposits. The alluvium unlike that of the Silay or San Manuel consists of lava flows rich in iron. In places where the weathering process is more pronounced, reddish brown clay have been formed, but in other areas such as those of the lower regions of Cadiz Viejo these lava flows are still in existence and appear as a hard almost compact mass of burned rock, which is locally called "igang". Generally found below the subsoil and in some cases as part of it, this "igang" impedes internal drainage. Farmers dealing with this kind of soil have to subsoil the land once every five or six years to break this mass.

Cadiz gravelly loam has a surface soil about 15 centimeters deep. It ranges in color from dark gray in some places to gray and grayish brown in other parts. The soil is slightly friable, with a good coarse granular structure. Gravels and concretions are plenty. These are less around Haciendas Carolina, San Isidro, Apanoy, and Mansilang. The subsoil reaches up to 50 centimeters from the surface and consists of a clay to clay loam soil that is light grayish brown to brown. Mottlings of reddish brown to dark red are also present. Soft reddish gravels are present as part of the hard substratum. The subsoil is slightly compacted. Where the subsoil is absent, the surface soil is immediately above the hard substratum. On a farm in Cadiz Viejo, and in Hacienda San Isidro this hard layer is already exposed. In cases like this, plowing the land becomes difficult.

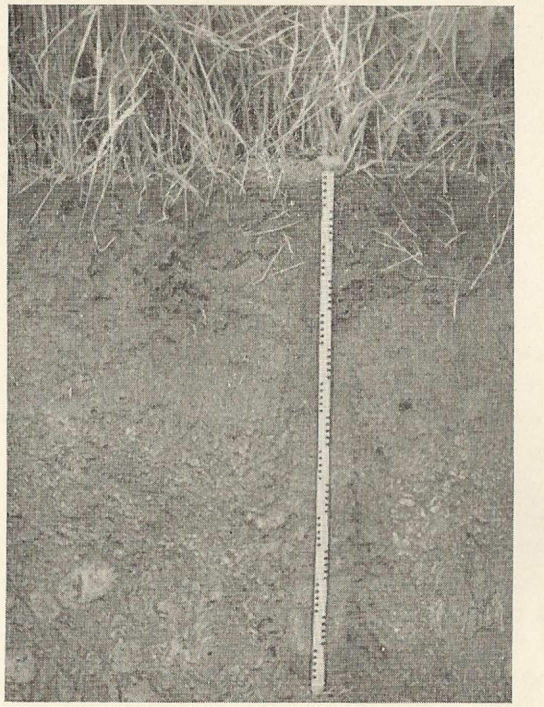
Below this hard layer is the substratum composed of grayish clay to yellowish brown clay loam extending to undetermined depth.

Sugar cane is the main crop in this soil type. As in other soils of the upland, Warner-phos is the fertilizer used. It is applied at the rate of 400 to 500 kilograms per hectare. With this rate of application a yield of from 70 to 80 piculs of sugar per hectare is obtained using the variety P.O.J. 2878. La Carlota canes are grown in Hacienda Sicaba Lacson.

GUIMBALAON SERIES

This soil was described by Pendleton in his soil survey of Silay–Saravia area and La Carlota District. Guimbalaon soil had been formed from older alluvium and is located principally around the slopes of Mounts Mandalagan and Silay, including Canlaon Volcano. These older alluviums are the country rocks and washed-out materials from the upper slopes which have altogether developed into brown to dark brown soils. Guimbalaon soils vary in topography from roughly rolling with steep slopes and deep gullies and ravines to gently rolling. Soils close to mountains are usually more broken by gullies than those near the border of coastal alluvial soils. Slopes on the rolling land range from 5 to 15 per cent, while those near the mountain-sides have much greater slopes. External drainage is fair but it is excessive in cultivated lands. Internal drainage is also fair.

The Guimbalaon soils east of Silay have an elevation of 500 feet, in Granada, 500 feet; and 1,000 feet in Araal on the western slope of the Canlaon Volcano. Guimbalaon series is made up of fairly matured soils developed from basalt and andesites. In some instances the solum has a depth of more than 2 meters, while in other cases, the true soils are only one-half meter deep. The parent materials exist as partially weathered rock fragments, brittle, coarse granular with concentric circles showing the degree and manner of weathering that takes places in a rock.



A. Profile of Guimbalaon clay in La Granja, La Carlota. The soil is dark brown to reddish brown. The substratum consists of partially weathered igneous rocks.

B. Guimbalaon clay has an undulating to rolling topography with good drainage. Sugar cane is the main crop. Erosion control measures are needed in this soil type.

PLATE 8

The Guimbalaon soils are widely cultivated to crops. Parts close to mountains and hardly accessible are still under dipterocarp forest. Grasses, dominantly cogon cover a wide section along the borders of the forest area. These grasslands are the result of kaingins and their size is increasing with the continuation of this bad agricultural practice.

The Guimbalaon soils closely resemble Luisiana soils, except for the presence of rock outcrops in the former and the fact that the latter are deeper and darker red soils. The Guimbalaon soils also resemble the Antipolo series, except for the absence of a layer of tuffaceous materials below the subsoil, which is the distinguishing characteristic of the latter. The Alaminos soil is closely similar to Guimbalaon, except that the former has a well-developed profile and is deep with a dark brick red color through the whole depth. Concretions are present on the surface layer. Guimbalaon soils are dark brown to reddish brown and contain concretions. Externally, Guimbalaon soils and Kidapawan series are the same, the only difference being the presence of gray sand far below the substratum in the latter.

There are three types identified under this series, namely clay, loam, and fine sandy loam. The most important is the clay type, a typical profile of which has the following characteristics:

Guimbalaon clay

Depth of soil cm.	Characteristics
0–30	Surface soils, reddish brown to dark reddish brown when wet, brown to dark brown when dry, clay; with good, fine granular structure; slightly sticky when wet; friable when dry, fair in organic matter content, non-calcareous, with a pH of 6.5. Roots of crops easily penetrate through this layer. Boulders occasionally present.
30–70	Subsoil, reddish brown light reddish brown when wet, light reddish brown when dry; clay; good medium granular; slightly sticky when wet, friable when dry; non-calcareous; with a pH of 6.5; no coarse skeleton; separated from the surface layer by a smooth and diffused boundary.
70–150	Substratum, brownish red with mottlings of red; weathered rocks (andesites or basalts) fragmentary; soft to brittle weathered mass; non-calcareous; boulders sometimes present. Reaction is pH 6.0. Boundary to the subsoil layer is clear and smooth.

Guimbalaon clay (*205*).—This soil type is dominant along the western slopes of Mandalagan and Canlaon Volcano and around Mount Silay. Its elevation ranges from 500 to 1,800 feet above sea level. The topography ranges from rolling to roughly rolling. Being located near the edges of mountains, the river beds are deep and highly dissected by deep guillies. Outcrops of big boulders are ocassionally present. In some places outcrops are so plentiful that the land could not be cultivated. This soil type has a total area of 71,366.4 hectares.

The surface soil of Guimbalaon clay varies in depth from 20 to 35 centimeters. In the grassland or forest area, the surface soil is dark gray to grayish brown, while that of lands under cultivation for a long time is dark brown to almost reddish brown. The color becomes darker when wet. This soil is friable when moist. It is hard when dry and slightly sticky when wet. In many instances, tractors are utilized for tillage in this soil type. First plowing of the soil is hard, but in old cultivated lands this is done rather easily. Special precaution must be taken when tillage is done by machinery because of the presence of rock outcrops. The subsoil is brown, dark brown to reddish brown clay to heavy clay loam. The dark color of the subsoil indicates maturity. Sometimes in very deep soils a lower subsoil exists before reaching the parent material. This is of heavy clay which is slightly plastic when wet and possesses no definite structure. The parent material, which is made up of partly weathered rocks, varies in depth from 70 to 200 centimeters. The parent material is dark brown to reddish brown, coarse granular and brittle.

This soil being friable, granular and with steep slopes, is subject to serious erosion. Its low crop yield may be traced to soil erosion. To minimize losses due to erosion, the practice of contour farming or strip cropping is suggested.

This soil is quite acidic. Most areas have shown a pH of 5.0 to 5.5. Generally, acidic soils are less productive because of the low rate of availability of nutrient elements and the increase in solubility of aluminium which is toxic to crops. Liming is therefore needed in this soil to correct soil acidity. This soil is mostly planted to sugar cane. For this crop ammophos has been found to be better than ammonium sulfate. This shows that the soil has a very low phosphorus content. Because of the prohibitive price of ammophos, some farmers apply only ammonium sulfate with a little increase in the cane yield. When the rate of 300 kilograms per hectare of nitrogen and phosphorus-carrying fertilizers are applied, a yield as high as 100 piculs is obtained. Moreover, the application of lime in this soil usually gives an increase of 10 to 11 piculs of sugar per hectare.

Upland rice of the varieties Lubang, Ginatos, and Elephante are planted, yielding from 15 to 20 cavans of palay per hectare.

Other upland crops grown are corn, coconut, cassava, and fruit trees. Corn planted in old fields produced only 10 cavans per hectare. Where the soil is relatively new as in kaiñgins, corn varieties like Calimpos and Teneguiv give as much as 30 cavans per hectare.

Older fields in this soil type should be rejuvenated. Rejuvenation calls for the restoration of the productive capacity of the soil. This can be done by green manuring, application of organic fertilizers, and crop rotation. Crop rotation should include green manuring. Leguminous plants should be more preferred than other plants for green manuring purposes, and in order to produce good green manure crops, the soil reaction should be corrected by liming.

Guimbalaon fine sandy loam (*265*).—This soil type is located east of Silay, Talisay, and Bacolod, covering an area of 9,190.8 hectares. It is in most respects similar to the loam type. The surface soil of Guimbalaon fine sandy loam is light brown to grayish brown when dry, but becomes dark brown upon wetting. To a depth of from 20 to 30 centimeters, the A horizon lies over a clay substratum. Drainage is good to fair and the topography is generally flat to undulating. Bamboo clumps are abundant along the banks of creeks and gullies.

Sugar cane is the most important crop grown. Most of the canes are of the Alunan variety. This variety is very susceptible to the Fiji disease. Another crop is upland rice (Dumali), which yields from 20 to 30 cavans of palay per hectare. Ginatos, another variety, when planted in May and harvested in August produces from 8 to 12 cavans of palay per hectare. Corn yields about 10 cavans per hectare.

This soil is acidic with a pH of 5.5. Like the other types, this soil needs liming and green manuring, in order to partly increase the organic matter content of the soil and by addition of more nitrogen and other mineral elements in available forms.

Guimbalaon loam (*266*).—This soil type is located in Murcia, La Carlota, and upper Isabela and covers an area of about 22,401.2 hectares. It has a rolling to undulating topography. Unlike the Guimbalaon clay which can not be cultivated in wide lots because of gullies and rivers, the loam type is not so dissected or broken. The elevation of this soil type varies from 400 to 500 feet in Murcia, 300 feet in La Carlota, and 200 feet in upper Isabela.

Guimbalaon loam is a medium brown soil, varying from light brown to dark brown or dark grayish brown when moist.

Fields long under cultivation show a darker color of brown to almost reddish brown. This may be due to the exhaustion of organic matter and partly to good drainage and soil reaction. The surface soil, to a depth of from 20 to 30 centimeters, is friable or loose with a fine granular structure. Stones or boulders are comparatively few in this type, except on that portion east of Isabela.

The subsoil is brown to light brown or grayish brown loam to clay loam and at times gravelly loam. The substratum has plenty of boulder rocks placed almost close to one another. The rocks are angular in form showing that they were not transported by water.

A large portion of this soil type is under cultivation. The creeks and gullies are in most cases lined with bamboo groves. The other open but uncultivated areas are cogonals. Sugar cane is the principal crop grown in this soil type. The variety Alunan (locally called La Carlota) is very popular. Other upland crops are corn and rice. Their yields are also the same as those obtained in the Guimbalaon clay. Guimbalaon loam is very acidic in reaction, having a pH of 4.5 in Murcia; pH 5 near Mambucal; pH 5.0 near Maao; and pH 5.5 in Magallon. This soil being quite acidic, needs correction by the addition of agricultural lime. As in the other types of this series, the addition of phosphorus-carrying fertilizers had given encouraging results in field experiments previously conducted on the matter.

Guimbalaon gravelly loam (*267*).—This soil type is found in Haciendas Paz No. 1 and 2, Tellong, and San Jose No. 3, covering a total area of 7,908.0 hectares. It is slightly undulating in general topography. Only along creeks and rivers that traverse this soil type does the land become rolling. The banks of rivers are rather steep. The greater part of the type is cultivated to crops, but those along the banks are seldom cultivated and cogon grass predominates. Drainage condition as a whole is good to almost excessive. Elevation in Hacienda Paz No. 2 is 300 feet; 240 feet in Hacienda San Jose No. 3, and 380 feet further south in Hacienda Romana.

The surface soil of this type is generally shallow, being from 10 to 15 centimeters deep only. The soil is dark brown friable and porous. It has a good coarse granular structure to almost nutty. The presence of a considerable amount of these gravels makes the soil light. The gravels are angular in shape, dark

brown and found throughout the depth of the surface soil. Aside from these gravels, concretions of similar color are found. The subsoil is loam to clay loam, yellowish brown in color.

Boulders are not present in Hacienda Paz, but in Hacienda San Jose No. 3, some boulders are found. This is to be expected since the adjoining soil type is of the Guimbalaon clay, stony phase. This soil type may be considered poor. The principal factors affecting production are leaching of the bases and soil moisture.

LA CASTELLANA SERIES

The development of this series was influenced by the effects of volcanic ejecta, like the occurence of numerous boulder outcrops, which is its distinguishing characterictic. It is found mostly on the foothills and western slopes of Canlaon. Small areas are also found in the cut-over sections of the Insular Lumber Company in Fabrica. The topography ranges from hilly to rolling. Some of these areas have flat topography but are cut by ravines with steep slopes. Its elevation ranges from 800 feet above sea level in Bugang, a sitio east of Mount Silay, to 180 feet in Antipolo near La Castellana, and 300 feet near Biao in lower Isabela.

The soils of La Castellana series were developed from andesites and basalts, and partly from volcanic tuff, breccia and other igneous rocks. Drainage condition is fair to good. In cultivated areas, external drainage is so excessive that sheet erosion commonly occurs. Some parts of this soil type are planted to crops, while others are just open lands covered by grasses, like cogon, talahib, and bacuit.

The soil is usually dark grayish brown or light gray when dry; but becomes brown to dark brownish gray when wet. The subsoil is mainly brown, changing to dark grayish brown or light brown, occasionally with mottlings of red. The substratum is gray to reddish gray or reddish brown clay loam, which is mixed with rocks.

This soil differs slightly from the Guimbalaon series. In the first place, the presence of large number of boulders on the surface of La Castellana is not common in Guimbalaon. Secondly, the color of their surface soils vary including the depth of development of their profiles, being much deeper in Guimbalaon than in the La Castellana. There is only one soil type in this series, a typical profile of which has the following characteristics:

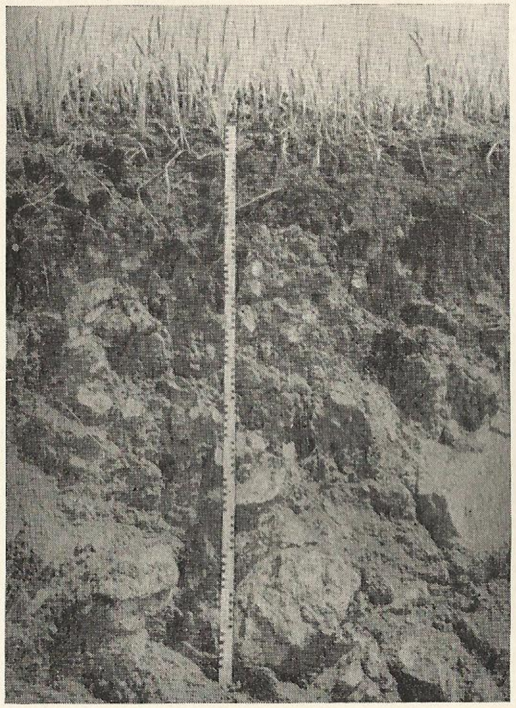
La Castellana clay loam

Depth of soil cm.	Characteristics
0–25	Surface soil, brown to almost black when wet, but gray to light brown when dry; clay loam; good fine granular structure; friable when moist; rich in organic matter, non-calcareous, stony, pH 5.5 and with good root penetration.
25–70	Subsoil, brown mottled with reddish brown to gray; clay; good fine granular structure; slightly compact; non-calcareous, plenty of stones and even boulders; grass root seldom penetrate this layer; and with pH of 5.5 The surface soil is separated from the subsoil by an irregular and clear boundary.
70–150	Substratum, gray to reddish brown; clay, compact and hard due to presence of stones and boulders, non-calcareous but acidic, with a pH of 5.5. This layer is separated from the subsoil by an irregular and broken boundary.

La Castellana clay loam (268).—The soil of this type is typically dark gray or grayish brown, clay loam to silt loam. In some places, it is brown to dark brown especially when wet. This soil in Antipolo is very typical of the type. The lower valleys surrounding most hills belong to the Silay, Kamandag and Bago soils, as classified by Pendleton. No efforts were made to separate these soil types, being too small to be delineated on the map, so they were included under the La Castellana clay loam. Likewise, there are several small, isolated hills between La Castellana and Isabela classified under La Castellana clay loam that could not be well delineated. Eroded soils of this type appear brown because the subsoil is mixed with the surface soil by constant plowing. The surface soil ranges from 15 to 30 centimeters deep. Due to the presence of stones and bolders on the surface, it is very difficult to till this soil. Some farmers have tried collecting these stones for piling on the sides of their fields. Others have made use of these stones for building fences.

The subsoil is from 40 to 50 centimeters thick and is brown mottled with reddish brown. From this layer down to the substratum, stones and boulders are also present.

Sugar cane was the principal crop grown before the imposition of sugar quotas. Lately only small areas that are not so steep are planted to sugar cane, while the rest is devoted to upland rice, corn and some coconuts. Like the Guimbalaon soils, La Castellana soils have to be treated with nitrogen and phosphorus fertilizers. Without such treatment, these soil will barely produce 50 piculs of sugar per hectare. The soils are also acidic, having a pH of 5.5, thus the need of lime application



A. Profile of La Castellana clay loam taken in Antipolo, La Castellana. The surface soil is shallow and dark gray to brown. The substratum is gray clay with plenty of boulders imbedded.

B. Landscape of La Castellana clay loam in the logged-over area of the Insular Lumber Company in Fabrica, Sagay. Boulders are strewn all over the surface. These boulders are oftentimes used for building fence as shown in the above picture.

PLATE 9

to correct soil acidity. This acidity may be just right for rice but not for sugar cane and corn. A large part of this soil type is uncultivated because of the presence of big boulders so it is covered by grasses. A good use of this kind of soil would be either to graze cattle on it, or plant agho (*Leucaena glauca Benth*) for fuel purposes. Fruit trees will also be suitable in this soil type.

MANAPLA SERIES

The Manapla soil is found in many places in the province. In the northern part of the province, it is found around Central Leonor to Escalante; in the central part, it is found in Barrios Antipolo and Maao; and in the south, in Himamaylan. The topography is rolling to gently rolling. A greater part of the area is rolling with an elevation of 100 feet above sea level. The only rolling portion is between Himamaylan and Carabalan, with an elevation of 180 feet. The numerous gullies and creeks that bisect this soil help in the drainage of the area. At times drainage is excessive causing much soil erosion. Internal drainage is rather poor owing to the heavy texture of the soil in the lower layers.

The surface soil ranges in color from dark gray to dark brown and even reddish brown loam to clay and sandy loam. The differences in color may be due to the organic matter content. Usually soils under grasses are dark to almost black, while those that have been under cultivation for a long time and are adversely affected by soil erosion manifest a brown to dark brown color. The surface soil is further characterized by the presence of iron concretions and river-wash stones. The stones are not as numerous and as big as those in the Guimbalaon or La Castellana series. The subsoil is grayish brown to dark brown clay loam with coarse skeleton mostly rounded pebbles. The substratum is yellowish brown with mottlings of red to white and streaks of dark red. In this layer weathered coarse skeleton is present. In some sections it is absent.

This soil is cultivated to crop, especially sugar cane, wherever a sugar central is near, otherwise it is devoted to some other upland crop. Quite prominent too is the growth of bamboos along the creeks and gullies that traverse this type. Between Himamaylan and Carabalan a comparatively small area is under cultivation. The rest are open cogonals with some binayuyo trees, pandan, and many kinds of herbs.

Only one soil type (Manapla loam), was described under this series, a typical representative of which has the following characteristics:

Manapla loam

Depth of soil cm.	Characteristics
0–20	Surface soil, dark brown to grayish brown when wet, dark brown to dark gray when dry; loam, clay loam to silt loam; good medium granular; friable to slightly sticky when wet; friable and crumbly when dry; fair in organic matter content; non-calcareous; plenty of rounded pebbles; roots easily penetrate this layer; and reaction is pH 5.0.
20–50	Subsoil, grayish brown when dry, dark brown when wet; clay loam; good medium granular, friable to slightly sticky when wet, friable when dry; non-calcareous, with a pH of 4.5. This layer is separated from the surface by a smooth and diffused boundary. Coarse skeleton present.
50–110	Lower subsoil, yellowish brown with mottlings of red; clay; massive; sticky to slightly compact when wet; crumbly to slightly compact when dry; non-calcareous; reaction is pH 4.5; and some coarse skeleton present which are highly weathered.
110–150	Substratum, white with streaks and ripples of dark red; clay; sticky and slightly compact; no coarse skeleton; non-calcareous; with a pH of 4.5. This layer is separated from the above by a smooth and diffused boundary.

Manapla loam (269).—This is the only type delineated under this series. It is found in several places in close association with the Giumbalaon and La Castellana soils. This type covers a total of 6,589.2 hectares.

The surface soil ranges from 15 to 25 centimeters deep and is friable when moist. The clay loam type which is present in some areas is a bit sticky when wet. The color varies from dark gray to brown and dark brown. Some iron concretions are present. This type as found around Central Leonor contains a lot of gravels and pebbles, but these do not in any way interfere with tillage operations. The soil type around Maao contains less coarse skeleton and the solum is quite deep.

The subsoil is from 20 to 50 centimeters thick and is grayish brown, dark brown to bluish gray, medium gray or light gray. It is mottled red to brown on the lower valleys, signifying poor drainage. The substratum is a thick layer of brown yellowish brown, bluish gray to light gray clay loam to clay. No coarse skeleton is present.

Manapla loam is also quite acidic like the other soils already described. The soil reaction near Maao is pH 4.5 to 5.0 and at Libacao and Carabalan, it is pH 5.0. This reaction is good

only for rice but not suitable for either corn of sugar cane. Fruit trees in general require a pH of 5.5 to 7.00. Lowland rice grows well when the acidity is between pH 5.5 and pH 6.1. Around Central Leonor, the soil reaction is pH 6.0. This is quite suitable for sugar cane, so this crop is mostly planted. Corn is likewise grown. The soil here is not as acidic as in other places of this type owing to the presence of calcareous soils in the vicinity. The corn grown near Central Leonor usally yields from 10 to 15 cavans per hectare.

LUISIANA SERIES

This series is made up of characteristic dark reddish brown to almost red soil that is deep and without boulders. It is found mainly in the northern part of the province from Victorias to Sagay covering the rolling lands on the slopes around Lantawan Mountain. The elevation ranges from 100 to 800 feet above sea level. It is well drained, although the external drainage is more intense than the internal form.

The surface soil is moderate reddish brown to dark reddish brown from 20 to 35 centimeters deep, clay loam to clay. The subsoil is almost similar in color and texture to the surface layer. There is no clear line of separation between the two layers. The substratum is clay and its color gradually becomes lighter with some cloudy mass of dark red. No rocks or coarse skeleton are present in any of the layers.

This series differs from the Guimbalaon soils in that the latter are brown to dark brown with rock outcrops. Furthermore, the soil layers in Guimbalaon series are comparatively thinner. The Alaminos soil closely resembles Luisiana soil in profile development but the former has a dark red to brick red color with some boulders and concretions on the surface soil. This series is represented by Luisiana clay a typical profile of which has the following characteristics:

Luisiana clay

Depth of soil	Characteristics
0–25	Surface soil, dark reddish brown to pinkish red clay with a good fine granular structure; sticky and slightly plastic when wet, strongly friable to sligthly compact when dry; fair in organic matter content; deep root penetration; absence of any coarse skeleton; and non-calcareous.
25–100	Subsoil, dark reddish brown; clay; medium coarse granular structure; sligthly sticky and hard when wet, and hard to slightly compact when dry; poor in organic matter content, non-calcareous; absence of any coarse skeleton; and

with a smooth but diffused boundary between the surface layer and this horizon.

100–150 Substratum, yellowish red to almost red, speckled with cloudy deep red; clay; fine granular structure; slightly compact and hard; no stone or boulders present, non-calcareous; and is separated from the subsoil by a smooth and diffused boundry. This layer usually extends deeper than 150 centimeters.

Luisiana clay (*239*).—The dark reddish brown to almost red soils in the northern part of Negros, covering the rolling lands from Manapla to Sagay, are classified under this type. There are, however, other soil types intermixed within this area, such as the Guimbalaon, La Castellana, Silay, and Faraon soils. Luisiana clay is a soil with deep profile development, signifying very intensive soil weathering. This is further confirmed by the fine texture of the soils in the different horizons of the profile. The area of this type is 23,564.00 hectares. The surface soil to a depth of from 20 to 35 centimeters, ranges from clay loam to clay. It is a distinct dark red soil when wet but purplish red when dry. This soil is sticky when wet but rather friable and crumbly when moist. The organic matter content is low, especially in old cultivated fields, while in forest areas and grasslands it is rather fair. The soil is such that the roots of most crops can easily penetrate even to the lower layer of the subsoil. The surface soil is quite acidic. Agricultural lime must be added to correct the present pH 5.00 to either pH 6 or to neutral to suit most crops. The high acidity is due to exhaustion by leaching and absorption by crops of the basic elements in the soil.

The subsoil is dark reddish brown and of the same texture as the surface soil which makes both appear almost the same. The color in the subsoil is lighter than that of the surface soil. The change in color from the surface to the substratum is very gradual and there is no distinct demarkation of the different layers. Weathering of the soil in the substratum is intense, as the depth of either the parent material or the bedrocks is not visible.

As a whole the soil is well drained. Slopes range from 3 to 10 per cent—all within the limits for safe cultivation. But runoff does always takes place in the cultivated areas and sheet erosion is common. The erosion on the surface soil is not readily noticed because of the similarity in color and texture of both the surface soil and subsoil. It is only evident in the production of crops.

A large portion of the type is cultivated to sugar cane. In the northern section of the province the varieties P.O.J. 2878, Badilla, and Alunan are planted. Badilla usually gives over 100 piculs of sugar which is slightly better than the Alunan cane that yields only 90 piculs. The low yield is due to limited application of ammophos brought about by the prohibitive price of this fertilizer. Like in most other upland soils, the use of phosphorus-carrying fertilizer is desired in view of the deficiency of this element in the soil. At the time of this survey, ammophos or warnerphos was applied at the rate of 100 kilograms per hectare, as against 300 to 450 kilograms when the price was low, in which case yields as high as 120 to 150 piculs of sugar per hectare were obtained.

Other upland crops planted are rice, of the varieties Ginatos, Mayuro, Ujuy, Pinandan; corn of the varieties Calimpos and Teneguiv; and tobacco. Upland rice planted at the rate of 25 gantas to the hectare, yield an average of 30 cavans of palay. Tobacco is planted in January.

Not all parts of this soil type are cultivated due to the presence of wide areas of cogonals, especially near the cut-over sections of the Insular Lumber Company in Sagay. These cogonals were once under dipterocarp forest.

TUPI SERIES

The Tupi series consists of black friable light soils occupying the rolling areas southeast of Mount Mandalagan and the Tablas Plateau. These soils are the product of older alluvial deposits consisting mostly of coarse sand and gravels. The elevation varies from 500 feet in Granada to 900 feet in Alegria, and around 600 feet in Pispis, a sitio of the Tablas Valley. There are many creeks and springs draining these soils. Internal drainage is somewhat excessive owing to the coarse texture and loose consistency of the soils. The bedrocks are mostly andesites and basalts with some diorites.

Underneath the 15 to 30 centimeters of black silt loam to fine sandy loam surface soil is a brown to light brown subsoil that is fine sand and structureless. The substratum consists of a deep layer of light gray coarse gravelly sand that is structureless and a little compact. Stones and boulders are present in this layer. This soil is different from the Umingan in the color of the layers, in topography, and the fact that the stones or gravels in Tupi are not found in a definite layer but are scattered in the substratum.

This series as found around Alegria is mostly cultivated to upland crops. Some areas though are grasslands covered by cogon and talahib. Bamboo groves are found along the creeks. In the Tablas Valley the greater part of the soil is still uncultivated but mostly covered by cogon and bacuit. Patches of second-growth and primary forests are also found in that region.

Tupi series is represented by two soil types, the Tupi fine sandy loam and Tupi silt loam. The following profile characteristics is typical of the first soil type:

Tupi fine sandy loam

Depth of soil cm.	Characteristics
0–30	Surface soils, black when wet, light gray when dry; fine sandy loam to sandy loam and silt loam; excellent fine granular structure; very loose and friable either wet or dry; rich in organic matter; non-calcareous; boulders present as outcrops; and with a pH of 5.5. Root penetration is way down this layer.
30–70	Subsoil, yellowish brown to light yellowish brown; fine sand; structureless; friable but slightly compact; non-calcareous; no coarse skeleton; poor in organic matter; with a pH of 5.5. Boundary separating from the surface soil is smooth and clear.
70–150	Substratum, light gray to gray; coarse sand; to coarse gravelly sand; structureless; slightly compact and friable; non-calcareous, with stones and boulders present; reaction is pH 5.5. Boundary to the subsoil is smooth and abrupt.

Tupi fine sandy loam (*270*).—This soil type has a surface soil with a depth from 15 to 30 centimeters and ranges in texture from sandy to silty. The soil is dark gray to grayish black when dry but becomes black when wet. It is very loose and friable and this consistency persists either when dry or wet. It is easy to plow or perform any tillage operation in this soil type. The subsoil is yellowish brown to light yellowish brown fine sand. It is friable but slightly compact with no definite form in structure. The substratum is gravelly sand, gray, friable to very slightly compact. Stones or even boulders are present on this layer.

Drainage condition as a whole is satisfactory. The grades of slopes range from 3 to 10 per cent. In spite of such slope runoff is excessive, causing both sheet and gully erosion. For this reason, the thickness of the surface soil vary to a wide degree. There are even cases when soil erosion is so severe, especially on tops of ridges, that plantings are made on the gray gravelly sand, which is already the substratum. If this

soil should be cultivated to clean culture crops, one of the many methods in soil erosion control should be practiced. For permanent crops, the plants should be set along the contours so that if it is desired to plant the spaces between the trees, the cultivation could also be done along the contours.

Like most of the other soils described, Tupi fine sandy loam is also acidic in reaction, having a pH of 5.0. Leaching of the basic elements has caused part of the acidity. The constant application of fertilizers with acidic residual effect, like ammonium sulfate has also caused this acidity. The andesite rocks from where the soil has evolved is by nature acidic in reaction.

This soil type around Granada to Alegria is widely grown to sugar cane of the variety Alunan. The canes are fertilized with 300 kilograms of ammonium sulfate. The production when the crop is fertilized is between 100 to 120 piculs of sugar per hectare. Some of the cane fields are irrigated. Irrigation is needed as this soil type falls under the distinct dry and wet season, and the dry season coincides with growing season of the canes.

Some fields are devoted to lowland rice of the varieties Wag-wag, Macan, and Apostol. The rice paddies are located in the valleys between ridges. These varieties give yields from 40 to 60 cavans of palay per hectare. Other crops grown are bananas, corn, and several kinds of fruit trees. The soil reaction may be favorable for lowland rice but not for corn. Without fertilizing corn the yield is extremely small. Corn must be fertilized or green manuring must be resorted too and included in the rotation system. To be able to grow legumes well for green manuring, lime, to correct the soil acidity, must first be applied.

Tupi silt loam (*271*).—This soil type is found in the Tablas Valley adjoining the eastern boundary of the province. It is a wide rolling area of grassland and small timberlands. Internal drainage is fair. Numerous creeks which are tributaries of the Tablas River help drain this area.

Tupi silt loam has a very friable and granular surface soil that is from 15 to 30 centimeters deep. The soil is light brown when dry but becomes black when wet. It is easy to till, but the presence of numerous rock outcrops makes cultivation with machinery quite dangerous. The subsoil is brown to dark brown sandy loam with some fragments of partially weathered rocks.

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There is not much cultivation done in this soil type, as the place is very sparsely populated due to difficult accessibility and the prevalence of malaria in the whole area.

Tupi silt loam is a very acidic soil. With a pH value of 4.5, only acid-tolerant plants can survive. To make this soil suitable for most crops, a large quantity of lime must first be applied. To cultivate a grassland for the first time, no regular crop should first be planted. The land can be cleared and plowed and then be planted to legumes. After this crop, regular crops may be grown thereon.

Manapla–Bago complex (*272*).—This soil complex is found in the Barrio of Tiglawigan and comprises the upland soil under the Manapla and Bago series. These soil types are found in such an intricate pattern in this area that their delineation on the map used is impossible, so the whole group was mapped as a complex. All the soils, however, are of the upland class and their topography are more or less similar, rolling and even undulating. One noticeable characteristic of the surface soil is the presence of white crystals of quartz, which appear like fertilizer salts. These crystals are present even on the surface soil of the Guimbalaon clay, which lies adjacent to this complex.

The Manapla loam in this area has a surface soil that is generally gray to grayish brown with numerous rounded pebbles. This soil is found in some fields in Haciendas Sta. Cruz, San Isidro, Chin Juan, and Daguinot No. 3. The Bago loam on the other hand, is found in some fields in Lanka, Daguinot, and Tiglawigan. The surface soil is rather shallow with a clayey subsoil and substratum. Another type which is a variation of the Bago soil is found in Hacienda San Pablo. The soil is loamy sand that is 30 to 35 centimeters deep. It is dark gray to grayish black with plenty of grains of quartz crystals. The soil is light to work on, friable, structureless, and contains no coarse skeleton like stones or boulders. The subsoil to a depth of 65 centimeters is grayish black coarse sand, very friable and loose. Further down to the substratum is clay loam with fragments of weathered rocks of andesite or basalts, a variation of the Manapla profile.

These soils were altogether mapped under the Manapla-Bago complex. Sugar cane is the principal crop with coconut ranking next. The varieties of sugar cane grown are the P.O.J. 2878 and 2883.

SOILS OF THE HILLS AND MOUNTAINS

The areas in this classification are too rough for farming purposes. They are covered by thick forest, stony, or steep slopes. Areas under this category are better if not touched at all, for it would mean a lot towards safeguarding such natural resources as the forest, soil, and water. These areas are the headwaters of most of the big rivers in the province and a protection of these headwaters means protection to the lowlands against floods and water shortage. But considerable damage by kaingineros has already been done to most of these areas and the adverse effects will be felt in the near future, if the practice is not stopped. In some sections, however, as in the eastern side between Escalante and San Carlos, the mountains have been so completely stripped-off that nothing but the bare rocks are left. The people have destroyed the forests and the soil. More dangers lie ahead.

Faraon clay, steep phase (*155*).—The nature and characteristics of Faraon series have already been discussed. This is a phase which differs from the type in its slopes. Faraon clay, steep phase, has a slope ranging from 30 to 100 per cent. This phase is found in the southwestern part of Negros from Ilog around the coast to the boundary of Oriental Negros. It is also found in the northeastern section of the province from Escalante southward to the boundary of Oriental Negros. The phase has a very rugged topography with good drainage. In the cultivated areas the drainage is quite excessive and often cause considerable danger in the form of soil erosion. In forested areas, however, the drainage condition is good.

Faraon clay has as bedrocks coralline limestone. Rocks are conspicuously seen as outcrops under virgin forests and almost completely exposed in eroded areas. In the virgin state this phase of Faraon supports first group timber or the molave type of forest. In these forests are several species of rattans out of which many people make an industry. This kind of vegetation is found only in the southwestern part of Negros. But indications are that the people are beginning to destroy the forest for kaingin purposes. On the other hand, the phase between Escalante and San Carlos is now completely denuded of its native vegetation. Farmers are still planting on these areas such crops as corn, bananas, cassava, and upland rice, with yields that barely cover production costs.

The farmers are planting on the rocks so to speak. Practically no soil is left on such eroded places. For this reason the crops grown are small, chlorotic, and the yield is miserably small. Corn ears that are ten centimeters long are considered good. There are more pebbles and cobbles of limestone than there are soils. At a distance the hills appear as a gray mass.

Faraon clay, steep phase, if under cover should be left as such. If logging is done, a selective method of cutting must be practiced in order not to destroy the whole area. In deforested and eroded areas, efforts should be made to restore the cover of trees by reforestation. Planting to agho or ipil-ipil is another means to protect the soils in the area. Ipil-ipil can be utilized for fuel purposes 3 to 4 years after planting. This soil type has an area of 144,993.6 hectares.

Rough mountainous land (202).—This miscellaneous land type is of non-agricultural value like the Faraon clay, steep phase. But unlike it, the areas classified under rough mountainous land are soils mostly derived from basalt and andesites. These are fine-textured rocks mainly dark in color and of volcanic origin. Because of the humid condition and the comparatively high temperature prevailing in this locality, rock weathering is intense with the resulting formation of deep soils. In some sections outcrops of boulders are abundant.

The topography is irregular hilly and mountainous roughly broken by very deep gullies and cañons, and cliffs. It is well drained by many creeks and rivers which are the headwaters of the Hinigaran, Bago, Binalbagan and Ilog Rivers.

The soil formed from the decomposition of this rock is dark brown to reddish brown loam to clay loam, ranging in thickness from 20 to 35 centimeters. By reason of their richness in organic matter, these soils are mellow and friable. The soils under forest are brown to light brown, while those under grassland are grayish black. Such soils may be classified under Guimbalaon, La Castellana, or Luisiana series. This land type has an area of 219,106.4 hectares.

The areas covered by Lantawan Peak, Mounts Silay, Mandalagan and Canlaon, and the chain of mountain ranges along the boundary between Occidental and Oriental Negros, are classified under this category. A great part is covered by dipterocarp forest, which is entirely different from the forest found in the Faraon clay, steep phase. In many sections close to the base of the mountains, the forest has been cut down and the cleared areas are at present cogonals. Some of these cogonal areas can not be cultivated because of the boulders, but they can be well utilized for pasture. Water for the animals abounds

throughout the year. Another way to utilize these cogonals, especially those along the western side of the range, is to plant them to ipil-ipil. Fuel for domestic purposes may become scarce in the near future and the agho farm will come in handy to solve the problem.

MECHANICAL ANALYSIS OF NEGROS OCCIDENTAL SOILS

Mechanical analysis has for its purpose the determination of the composition of different grades or sizes of the minerals that compose the soil. These minerals are sand, silt, and clay. The sand includes particles from 2.0 to 0.05 millimeters in diameter; the silt from 0.05 to 0.002 millimeters; and the clay, particles smaller than 0.002 * Particles larger than 2.0 millimeters are considered coarse skeleton which includes gravels, pebbles, and cobbles. Depending upon the relative amounts of sand, silt, and clay fractions present in the soil, the class name is determined as sand, sandy loam, loams, silt loam, clay loam, clay, etc.

The textural classification of the soils of Negros Occidental was first determined in the field by the feel-method. Later, representative samples of each soil type collected in the field were analyzed in the laboratory to check the feel-method. The method of mechanical analysis followed was the modified Bouyoucos, using the conventional jar, hydrometer, and thermometer. The samples were oven-dried before weighing and no effort was made to remove the organic matter in the soil. The result of analysis is shown in Table 7. In case where the field naming of the textural class does not vary considerably from the anlysis, the latter class name is maintained.

Grouping the soils of the province on the basis of textural grade only, 29.00 per cent of the area of the province is clay; 20.49 per cent is clay loam; 11.98 per cent are loam and silt loam; and 8.80 per cent are sand and sandy loam.

Usually soil analyzing 30 per cent or more of the clay fraction is considered clay soil. Lately, however, the percentage was increased to 40 so that all soils having an analysis of 40 per cent or more of the clay fraction are classed as clay soils.

* Previous to 1938, the United States Department of Agriculture used the 0.05 to 0.005 millimeters for the size of silt and smaller than 0.005 millimeters for clay.

TABLE 7.—*Showing the average mechanical analysis of soil of Negros Occidental* [a]

Soil type No.	Soil type	Sand 2.0-0.05 mm.	Silt 0.05-.002 mm.	Clay 0.002- mm.	Total Colloids
		per cent	*per cent*	*per cent*	*per cent*
251	Silay sandy loam	56.8	37.6	15.6	24.4
252	Silay fine sandy loam	57.6	31.2	11.2	20.6
253	Silay loam	62.6	21.0	16.4	23.8
254	Silay clay	28.2	35.4	36.4	51.4
295	San Manuel fine sandy loam	60.2	25.4	14.4	21.4
190	San Manuel loam	38.2	33.4	28.4	41.4
168	Umingan clay loam	32.2	41.4	26.4	41.4
42	Obando sand	80.8	8.8	10.4	15.2
255	Pulupandan sandy loam	58.0	26.8	14.4	27.2
256	Isabela clay	18.2	37.4	44.4	59.4
257	Isabela sandy loam	44.5	35.5	20.0	31.8
214	Batuan clay	----	----	----	----
132	Faraon clay	15.0	22.8	62.2	75.6
258	Faraon sandy loam	59.0	28.2	12.8	16.8
153	Bolinao clay	20.4	19.0	60.6	71.2
259	Bantay clay loam	43.0	26.2	30.8	43.8
260	Bago fine sandy loam	65.4	18.4	16.2	28.8
261	Bago loam	46.8	27.0	26.2	31.6
262	Bago sandy clay loam	59.6	15.4	25.0	34.0
263	Victorias clay loam	43.4	24.2	32.4	42.8
269	Cadiz gravelly loam	54.0	23.0	22.2	31.6
265	Guimbalaon fine sandy loam	59.2	25.2	15.6	21.4
266	Guimbalaon loam	57.6	16.8	25.6	32.0
205	Guimbalaon clay	29.2	20 2	49.6	60.4
267	Guimbalaon gravelly loam	59.2	23.2	17.6	24.4
268	La Castellana clay loam	33.6	33.4	33.0	48.0
269	Manapla loam	46.4	29.0	24.6	33.2
239	Luisiana clay	23.2	19.8	57.0	68.4
270	Tupi fine sandy loam	57.6	30.2	12.2	29.4
271	Tupi silt loam	55.8	19.2	25.0	31.1
155	Faraon clay. steep phase	19.0	28.8	52.2	68.8

[a] The modified Bouyoucos method of analysis was followed. Data for surface soils only. Analyzed by Edmundo K. Villegas of the Soil Surveys Section.

MORPHOLOGY AND GENESIS OF SOILS

The soil is the natural medium for the growth of plants. It is a mixture of fragmented and partly or wholly weathered rocks and minerals, organic matter, water, and air in varying proportions. It has more or less distinct horizons or layers developed under the influence of climate and living organisms. The soil is not only dynamic in nature but it varies from place to place. Its characteristics at any given place depends on a number of factors, to wit: (1) composition of the parent material; (2) climate of the place; (3) plant and animal life in and on that soil; (4) relief of land; and (5) length of time the forces of development have acted on it. Each of these different factors has sub-factors which influence the formation of the soil. Some factor or factors are more dominant than the others and depending upon the length of time they have acted on the rock, a certain kind of soil is developed.

Having known the different factors in soil formation, it is but proper to determine how these have acted together, bringing about the formation of the soils of Occidental Negros.

The geology of Negros Occidental reveals several rock formations, ranging from very recent to mature. The alluvial plains on the western side from Victorias in the north to Cauayan in the south (with interruptions of low hills between Hinigaran and Binalbagan) and the very narrow coastal plain in San Carlos, are all recent formations whose parent materials are alluvium from the washed-off upper areas. The Silay, San Manuel, Umingan, Obando, Isabela, and Pulupandan series are all soils of recent formation. Sedimentary rocks as exemplified by shales, limestone, and sandstone, have played an important role in soil formation. Shales are silt or clay or a mixture of the two materials which were deposited at the bottom of the sea. Subjected to considerable pressure, these materials hardened into big stratified lumps or rocks. Limestone, on the other hand, are deposits of exoskeletons of marine animals especially corals. In certain localities of the sea, where the water was once favorable for the growth of these animals, they have multiplied considerably and their bodies have accumulated to considerable depth. Later, through volcanic actions which were responsible in the land-forming mass of the island, these deposited materials (silt, clays, and coral bodies) rose from the level of the sea and became part of the land mass of Negros. Shale rocks are found as bedrocks in the Tablas Plateau. The Bantay soil had developed from this rock. Limestone formation as found in Sagay to San Carlos and in Kabankalan to around the southern peninsula of Negros gave rise to the development of the Faraon, Bolinao, and Batuan soils. The original land mass in Negros was a narrow and long island composing the range of mountains formed by the Mandalagan, Silay, and Canalaon. The rolling lands around this range were older volcanic depositions and consist of such igneous rocks as basalt and andesite. From these depositions evolved the Victorias, Manapla, Cadiz, Guimbalaon, La Castellana, Luisiana, and Tupi soil series.

The Tupi series are soils formed from deposits of volcanic material like boulders, sand, and ashes. When dry, the soil is gray but becomes black upon wetting. It is believed that due to the high acidity of the soil (pH 4.5), the organic matter was not decomposed as it should, thus remaining in the soil and imparting the black color.

Negros Island falls under the Tropical Rain Forest type of climate. This is characterized by heavy precipitation distributed throughout the year and accompanied by a relatively uniform high temperature. Under these conditions, chemical reaction is active and the leaching of alkali or alkaline earth metals is also rapid. These conditions are conducive to the formation of lateritic soils. Guimbalaon, Luisiana, Victorias, Manapla, and Cadiz soils are what can be considered lateritic soils. Chief charateristics of these soils are (1) red-colored soils throughout the whole depth of the profile, (2) rapid percolation of moisture, (3) acidic reaction, and (4) low phosphorus content. Under this heavy rainfall, most of the soluble basic soil constituents in the lowlands have been leached, making most of them highly acidic in reaction. The profiles of these soils are mature.

Cultivation of crops on sloping lands and high rainfall both contributed to soil erosion in most of these red soils as well as the black soils developed from Tertiary materials. Profile development in this case is still young.

Guimbalaon soils which originally had a clay and red soil profiles were covered by a thin mantle of volcanic ash similar to that of the surface soil of Tupi. This is especially true of the Guimbalaon soils near the surroundings of Canlaon Volcano. This deposited volcanic ash (30 centimeters deep) has become part of the profile of Guimbalaon giving it a sandy loam texture and black in color. This sandy loam soil remains on the surface layer of Guimbalaon, provided there is not much soil erosion as on fairly level areas. On undulating areas with heavy rainfall, part of the black sandy loam surface soil has been washed away. Tillage operations every year tend to mix the sandy loam soil with the red clay soil of the Guimbalaon. Depending upon the degree of soil erosion or the amount of sandy loam and clay that were mixed, loam, and clay loams with shades of color varying from brown to dark brown, were developed. On sloping lands where soil erosion was severe, most or all of the black sandy loam soil on top was eroded, thus giving rise to the Guimbalaon clay with the usual red top soil.

The soils of Negros Occidental may be classified into groups based on topography, mode of formation, and development of the profile, as follows:

Profile Group I
- Obando
- Pulupandan

Profile Group II
- San Manuel
- Umingan

Profile Group IV
- Silay
- Isabela
- Bago

Profile Group V
- Cadiz

Profile Group VI
- Victorias
- Manapla

Profile Group VII
- Guimbalaon
- La Castellana
- Luisiana
- Tupi

Profile Group VIII
- Batuan
- Bolinao
- Bantay

Profile Group IX
- Faraon

Profile group I.—Soils in this group had developed from recent alluvial fans, flood plains, and other secondary materials which have undeveloped soil profiles. The Obando soil was formed from the accumulation of sand (quartz and grounded marine shells) as a result of wave action. Oftentimes marine shells are imbedded in the profile. Pulupandan soils have bedrocks consisting of thick deposits of marine shells.

Profile group II.—Soils in this group are young alluvial fans, flood plains, and other secondary deposits having slightly developed profiles. The profiles have slightly compact subsoil horizons. The San Manuel soil is a deposit consisting of light soils. The subsoil and the substratum are thick deposits of sand or sandy loam soils with no stones or boulders associated with it. The Umingan soil, on the other hand, is similar to the San Manuel with but one difference—the presence of a layer or river-washed stones in the substratum. The layer of stones showed that the area under this series was formerly a river bed or near a river.

Profile group IV.—This includes soils of older plains or terraces having strongly developed profiles (dense clay subsoils) underlain by unconsolidated material. Silay soils have hard and compact substratum known locally as "bakias" which correspond to the "Padas" of Java soils. This hard, white layer is a cemented sandy material with a silicious substance as the binding element. Although iron compounds serve as binding substance, it cannot be claimed with certainty that the binder in the case of bakias in Negros is an iron compound, since the soil and the hard layer are not red or brown. The compact layer varies in thickness from two to five meters. The Isabela soils, on the other hand, consist of a thick layer of highly compacted clay soils which range from two to six meters in thickness. The Bago soil is a thick layer of clay but unlike the Isabela, the substratum of Bago soil is gray, very fine clay, and highly plastic when wet. Pendleton, attributes the formation of this soil to the raising above sea level of an old marsh.

Profile group V.—The soils in this group are older plains or terraces having hardpan subsoils underlain by unconsolidated rock-like hardpan horizons that do not soften with water. The Cadiz soil series falls under this group. The subsoil of Cadiz is an accumulation of iron concretions and gravels which had coalesced and hardened as a result of pressure. This hardened layer which is locally called "Igang" accumulates about 80 centimeters below the surface. In the case of eroded soils, this hardened layer is exposed.

Profile group VI.—The parent rock materials from which the Victorias soil was developed consist of partially weathered andesites. The Victorias soil may be considered as secondary or transported since the materials from which it was developed were brought down as alluvium. But since this alluvium was partially weathered and became true soils only after further action by the weathering forces, this soil has been classified as primary. In the same manner, the parent rock materials of Cadiz series were transported as alluvium and became true soils only after further weathering processes. The Victorias soil contains concretions mostly confined to the surface.

Profile group VII.—This includes soils of upland areas developed from hard igneous rocks, with rolling to steep topography. The Guimbalaon soils had been developed mostly from andesitic rocks. The rocks in the substratum are partially weathered. Weathering in this series gives rise to red soils. La Castellana soils are also of andesitic rock formation but this gives rise to gray or dark grayish brown soils. Luisiana soils are similar to Guimbalaon in texture and color, but differ only in degree of weathering. Luisiana series have so deeply weathered rocks that they can no longer be discerned in the profile. Tupi soils, on the other hand, are accumulation of volcanic deposits like ash, sand, and gravels.

Profile group VIII.—This includes soils of the uplands, developed from consolidated sedimentary rocks like limestone, sandstone, and shale. The topography is generally rolling to steep. The Bolinao, Batuan, and Bantay series belong to this group. The first two soil series were derived from limestone, while the latter from shale. The Bolinao soil is distinctly red, while the Batuan is black. The cause or causes of the development of red soils in Bolinao are not fully understood. Laterization process may probably have been taking place in this soil. Others have attributed the physical characteristics of the limestone as the cause of development of either black or red soil.

Profile group IX.—This includes soils of the upland areas developed from softly consolidated material like limestone, sandstone and marl. Faraon soil falls under this group. This soil has soft limestone as bedrock. Soil profiles ordinarily have the A, B, and C horizons as the succeeding layers. This order seldom occurs in Faraon. More commonly the B horizon is absent and sometimes the A horizon rests on the bedrock of limestone. This takes place when the profile development is quite very active, as in the case of this soil series.

PRODUCTIVITY RATINGS OF NEGROS OCCIDENTAL SOILS

The productivity rating of soils is a new feature of a soil survey report. A soil productivity rating designates in a single index figure the combined effects of many soil characteristics. It summarizes for a given soil type the effect on yield of the internal and external characteristics of soils, namely, depth and texture of both surface and subsoil, nature of the parent material, fertility, reaction, topography, and drainage. The objective behind this productivity rating is to bring about the relation between soil type and crop production.

There are two methods in use for getting the productivity rating, namely: (1) inductive method and (2) deductive method. The first method was devised by Storie of the University of California. It employs four factors called "A" which consists of the general characteristics of the soil profile; "B" which consists of the texture of the surface soil; "C" which consists of the slope; and "X" which consists of soil conditions, like drainage, alkalinity, nutrient level, soil acidity, erosion, and microrelief. These four factors are expressed in percentage and are then multiplied together. The final product is the percentage of the productivity rating.

In the second or deductive method, ratings are assigned to the yields that are considered to be representative of the specific crops grown on a particular soil. In other words, an average yield per hectare of a particular crop is established and this is set as the standard. The particular crop is grown on an average soil under current practices and without the use of fertilizers or soil amendments. To get the productivity rating of a soil type, we get the average yield of a certain crop grown in this soil type and compare it with the above standard for the same crop. The comparison which is expressed in percentage shows how good a soil type is compared to the standard for that particular crop. A rating of 50, for example, shows that the soil type is one-half as productive for the specific crop with the standard index of 100. A soil with a rating of 100 will mean that it is the same as the standard in yield for that particular crop in a given place.

There are a number of factors which affect the productivity of the land. Climate, for example, is a variable which will cause the yield of crops to fluctuate from year to year. In sugar cane, plenty of moisture with good drainage is needed, to get high yields.

The crop productivity index is based on several factors, to wit: observations on the crops in the fields, soil conditions, interviews with local farmers, and information given by the office of the provincial agricultural supervisors. Not all crops are found grown on a soil type, so that only those that are commonly raised are noted. In some instances, because of the absence of records, indexes were obtained by estimates, as if a certain crop is grown in a given soil type.

The following are average yields per hectare, without the use of fertilizers and other amendments, that had been established as standards of 100:

Sugar cane	80 piculs per hectare
Upland rice	30 cavans per hectare
Lowland rice	60 cavans per hectare
Corn	17 cavans per hectare
Coconut	3,750 nuts per hectare
Tobacco	1,475 kilograms per hectare
Bananas	900 bunches per hectare

The above crops are arranged according to their importance in the province of Occidental Negros. The productivity ratings of the different soil types for the crops are shown in Table 8.

TABLE 8.—*Productivity ratings of the soils of Negros Occidental*

Soil type [a]	Crop productivity index or [b]						
	Sugar cane [c]	Up land rice	Low land rice	Corn	Coco-nut	Tobac-co	Bana-na
San Manuel fine sandy loam	165	75	------	175	100	90	100
San Manuel loam	200	75	70	175	100	90	100
Isabela clay	185	100	100	115	90	70	80
Isabela sandy loam	165	100	100	115	100	80	80
Umingan clay loam	165	75	80	145	90	70	80
Luisiana clay	125	75	50	115	90	70	90
Silay sandy loam	165	75	------	115	90	80	90
Silay fine sandy loam	185	75	------	115	90	80	90
Silay loam	150	75	------	115	90	80	90
Manapla loam	145	75	50	115	80	80	90
Tupi fine sandy loam	135	75	50	115	80	------	90
Tupi silt loam	125	75	50	115	80	------	90
Faraon clay	150	50	------	145	80	90	100
Bolinao clay	150	50	------	145	80	90	100
Guimbalaon fine sandy loam	115	100	------	90	70	------	90
Guimbalaon loam	125	100	------	115	70	------	80
Guimbalaon gravelly loam	100	75	------	100	70	------	70
Pulupandan sandy loam	------	------	------	100	100	------	90
La Castellana clay loam	100	75	------	100	80	80	90
Victorias clay loam	115	100	------	90	80	------	90
Batuan clay	------	50	100	100	80	------	90
Silay clay	100	100	100	100	------	------	80
Obando sand	------	------	------	90	100	------	80
Guimbalaon clay	100	100	------	145	80	------	80
Cadiz gravelly loam	100	------	------	90	80	70	80
Bantay clay loam	------	100	70	60	60	80	80
Bago fine sandy loam	100	50	------	90	------	------	------
Bago loam	100	50	50	90	------	------	70
Bago sandy clay loam	100	50	50	90	------	------	70
Faraon sandy loam	100	50	------	115	80	80	80
Faraon clay, steep phase	------	50	------	50	70	70	80
Rough mountainous land	------	75	------	80	------	------	80

[a] Soils are listed in the approximate order of their general productivity under current practices.

[b] Absence of rating indicates that the crop is not commonly grown on a particular soil type.

[c] Ratings for sugar cane are all based on current practices which consist of an application of from 300 to 500 kilograms of ammonium sulfate, or of ammophos at the same rate of application.

It will be noted that ratings for sugar cane are very high. It is the current practice in Negros Occidental to fertilize their sugar cane fields with either ammonium sulphate or ammophos as the soils require. Crops other than sugar cane are not fertilized.

Since it is difficult to measure either the exact significance of a crop in the agriculture of an area or the importance or suitability of certain soil types for particular crops, too much significance should not be given to the precise order in which each soil is listed. The arrangement does not give information as to the general productivity of the soils.

Economic considerations do not play any part in the determination of the productivity of the soils as listed. In order to determine the true value of the land, such factors as distance to market, relative prices of products, and cost of production should be considered.

CHEMICAL CHARACTERISTICS OF THE SOILS OF OCCIDENTAL NEGROS

To promote scientific agriculture, an understanding of the chemical nature of soils is fundamental. For this reason, the classification of soils based mainly on morphologic and genetic studies made in the fields is supplemented by the chemical investigations on these soils conducted in the laboratory. The results of chemical studies are distinct aids not only in tracing the genetic relationship of soils and parent materials and in studying the process of soil formation, but also in the formulation of soil management and cropping practices. Thus, comprehensive chemical studies reveal: (*a*) the soil reaction (the degree of acidity or alkalinity) which is a guide for determining the natural crop adaptability of the soil type; (*b*) the deficiency, sufficiency, or excess of nutrient elements required by plants for their growth; (*c*) what toxic substances are present or what elements exist in toxic concentrations; and (*d*) the lime and fertilizer requirements of the soil type for maximum crop production.

The elements carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, and iron are needed by plants in comparatively large quantities. Also essential in plant nutrition, but in very minute amounts, are the elements boron, copper, manganese and zinc. The latter group of elements is called trace or rarer essential elements, because they are needed by plants in such minute quantities as one fourth part per million in the soil solution. Of these essential elements, carbon, hydrogen, and oxygen are derived from the air and water, and the rest from the soil.

The nutrient elements in the soil must be available to plants in a certain proportion if such plants are to grow and reproduce normally. A deficiency of anyone of these essential elements adversely affects the quality and quantity of crop yields.

Cropping, leaching, and erosion tend to deplete the natural supply of the essential nutrient elements in the soil, but the elements that usually become deficient or critical in amounts are nitrogen, phosporus, and potassium. Nitrogen deficiency can be corrected by the addition of animal manures, green manures, or commercial nitrogenous fertilizers, such as ammonium sulfate and sodium nitrate. Insuffficency of phosphorus is usually remedied by the application of phosphatic fertilizers, like superphosphates and guano. Potash deficiency may be remedied bv the application of wood ashes or commercial potassic fertilizers, such as muriate of potash and potassium sulfate.

Acidity in Philippine soils is quite common. Excessive soil acidity is usually accompanied by a deficiency of calcium. So that the addition of lime to acid soils corrects not only the acidity but also the calcium deficiency. Magnesium deficiency in soils is usually remedied by the application of dolomitic limestone or magnesium sulfate. Certain brands of commercial mixed fertilizers in the United States, especially those for use in the southern states, now contain trace elements to take care of deficiencies of such elements in the soil.

METHODS OF CHEMICAL ANALYSIS

The response of plants to fertilizers in a given soil is better correlated with the results from the determination of readily available nutrient elements than with those from the total analysis. For this reason, rapid chemical tests for available elements were mainly used in the analysis of the soils from the province of Occidental Negros. Total nitrogen was determined because this element, in the presence of proper micro-organisms and under favorable conditions, is easily convertible into forms available for plant assimilation.

Selected rapid chemical tests for available plant-nutrient elements successfully used abroad are being calibrated under Philippine conditions with actual results of fertilizer and liming experiments conducted in pots and in the field. While comprehensive data from local experiments are not yet available, results of tests abroad are cited for purposes of comparison.

In the preparation of samples for all the chemical analyses or tests, the surface soil samples were first air-dried, pulverized with the use of a wooden mallet, passed through a 2-mm. sieve, and then thoroughly mixed.

Soil reaction or the hydrogen-ion concentration in the soil was determined, using a Leeds and Northrup Universal pH meter fitted with a glass electrode.

The total nitrogen content of the soil was determined according to the "Methods of Analysis" of the Association of Official Agricultural Chemists of the United States (*8*).* Ammonia and nitrates were determined by the methods of Spurway (*47*). For the readily available phosphorus determination, the method of Truog (*52*) was followed. Available potassium, calcium, magnesium, iron, and manganese were determined according to the methods of Peech and English (*38*). In the colorimetric

* Italic numbers in parenthesis refer to Literature Cited, Page 116.

determination of available constituents, a Leitz photoelectric colorimeter provided with suitable light filters, was used.

INTERPRETATION OF CHEMICAL TESTS

*Soil reaction or pH value.**—Soil reaction which affects the behaviour and availability of plant-nutrient elements as well as those of toxic substances in the soil constitutes a very important limiting factor for plant growth and reproduction. Thus, in soils with a high degree of acidity or those with very low pH values, aluminum is rendered so soluble that its concentration in the soil solution becomes toxic to the growing plants. On

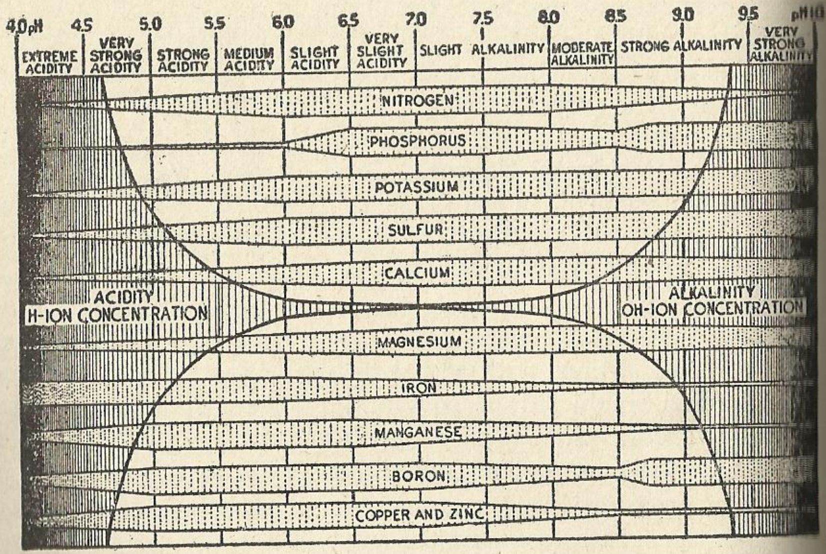

FIG. 7. CHART SHOWING GENERAL TREND OF RELATION OF REACTION TO AVAILABILITY OF PLANT NUTRIENTS

Width of bands indicates *favorableness of reaction influence* to the presence of adequate amounts of the nutrients in readily available forms, and not to actual *amounts necessarily present;* these amounts are influenced by many other factors.

the other hand, in soils of very high alkalinity or those with very high pH values, iron, manganese, copper and zinc are rendered unavailable to plants which in turn exhibit malnutrition or abnormal growth.

Troug (*53*) recently published a modified version of Pettinger's Chart showing the general trend of the relation of soil reaction to the availability of plant-nutrient elements. This

* Soil reaction means the degree of acidity or alkalinity of the soil expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, lower values indicate acidity, and higher values indicate alkalinity.

chart is reproduced here with Troug's accompanying explanation.

"In this chart, reaction is expressed in terms of the pH scale. The change in intensity of acidity and alkalinity from one pH value to another is shown graphically in the diagram by the change in width of the heavily cross-hatched area between the curved lines.

"The influence of reaction on availability of each nutrient element is expressed by the width of the band (the wider the band, the more favorable the influence) carrying the name of the respective element. Thus, for the maintenance of a satisfactory supply of available nitrogen, for example, a reaction or pH range of 6 to 8 is the most favorable. This does not mean that if the reaction of a soil falls in this range a satisfactory supply of available nitrogen is assured. All it means is that so far as reaction is concerned, the conditions are favorable for a satisfactory supply of this element in available form. Also, the narrowed band for nitrogen at pH 5 does not necessarily mean that a deficiency of this element will prevail at that pH; it means that so far as reaction is concerned, the conditions are not favorable for an abundant supply in available form. Other factors than reaction may promote the presence of an abundant supply; moreover, certain crops having a low requirement may be fully satisfied with a low supply."

Different plants have been found to have different pH preferences and different tolerance limits. Table 9 gives the pH rquirements of some economic plants. It can be seen from this table that different plant species have different optimum soil reaction requirements, some species growing most favorably under slightly acid soil conditions, like rice, pineapple, and tobacco (pH 5.5 to 6.1), while other crops like alfalfa, sugar cane and orange prefer less acid or even slightly alkaline soil conditions (pH 6.2 to 7.8). The pH tolerance limits for the first group of plants mentioned above have been estimated at pH 4.8 to 6.9, while those for the second group are pH 5.5 to 8.5. Some plants, however, like corn and tomato can tolerate a rather wide pH range (pH 4.8 to 8.5), although the best growth of these plants had been observed between pH 6.2 and pH 7.0.

Table 10 shows the average chemical analysis of the surface soil of the different soil types in Occidental Negros, which had been arranged in the order of decreasing productivity ratings for sugar cane (see Table 8). The productivity ratings

TABLE 9.—*The pH requirements of some economic plants* [a]

(X, most favorable reaction; Y, reaction at which plants may grow fairly well or normally; O, unfavorable reaction.)

Plants	Soil reaction					
	Strongly acid, pH 4.8–5.4	Medium acid, pH 5.5–6.1	Slightly acid, pH 6.2–6.9	Neutral reaction, pH 7.0	Slightly alkaline pH 7.1–7.8	Medium alkaline, pH 7.9–8.5
Alfalfa, (*Medicago sativa* Linn.)	O	Y	Y	X	X	Y
Bean, lima (*Phaseolus lunatus* Linn.)	----	Y	X	Y	Y	----
Corn, or maize (*Zea mays Linn.*)	Y	Y	X	X	Y	Y
Lettuce (*Lactuca sativa* Linn.)	O	Y	X	Y	O	O
Onion (*Allium cepa* Linn.)	O	Y	X	Y	Y	Y
Orange, sweet (*Citrus sinensis* Osbeck [b]	----	Y	X	X	X	Y
Peanut (*Arachis hypogaea* Linn.)	Y	Y	X	X	Y	----
Pe-tsai (*Brassica pekinensis* Rupr.[c]	Y	Y	X	X	X	X
Pineapple [*Ananas comosus* (Linn.) Merr.	Y	X	Y	O	O	O
Rice (*Oryza sativa* Linn.) [d]	Y	X	Y	O	O	O
Soy bean [*Glycine max* (Linn.) Merr.]	Y	X	X	X	Y	Y
Sugar cane (*Saccharum officinarum* Linn.)	O	Y	X	X	X	Y
Sweet potato [*Ipomoea batatas* (Linn.) Poir.]	Y	X	X	Y	O	O
Tobacco (*Nicotiana tabacum* Linn.)	Y	X	Y	O	O	O
Tomato (*Lycopersicum esculentum* Mill.)	Y	Y	X	X	Y	Y

for sugar cane were chosen from among the different crop ratings presented in Table 8, because sugar cane is the most important agricultural crop of Occidental Negros from the standpoint of value of production as well as of hectarage. In four soil types of the province where sugar is not commonly grown, corn was chosen as the indicator crop, because these two crops are similar in many of their soil requirements.

The pH values of the surface soils of Occidental Negros ranged from 4.30 (those of Cadiz gravelly loam and Victorias clay loam) to 7.85 (that of Faraon clay, steep phase). These extremes in pH values are accompanied by a wide variation in available calcium contents. While Cadiz gravelly loam and Victorias clay loam have 700 and 900 p.p.m. of available calcium,

[a] Data taken mostly from Weir, Wilbert Walter. 1936. Soil Science. Its Principles and Practice. J. B. Lippincott Co., Chicago and Philadelphia.

[b] From Spurway, C. H. 1941. Soil reaction (pH) preferences of plants. Mich. Agr. Exp. Sp. Bull. 306. Optimum range given was pH 6.0–7.5.

[c] From Arciaga, Antonio N. and N. L. Galvez. 1948. The effect of soil reaction (pH) on the growth of pe-tsai plants and on their nitrogen, calcium, and phosphorus content. Philippine Agriculturist 32: 55–59. Normal growth reported was in pH 4.2 to 8.6; optimum range was pH 5.9–8.6.

[d] A pH range of 5.7 to 6.2 was found to be the most suitable for the growth of the Philippine upland rice, variety Inintiw, by Rola, Nena A., and N. L. Galvez, 1949. Effects of soil reaction on the growth of upland rice and on its, nitrogen, calcium, phosphorus, and iron content. Philippine Agriculturist 33: 120–125.

TABLE 10.—*Average chemical analysis of the surface soil of the different soil types in Negros Occidental, (arranged in the order of decreasing productivity ratings for sugar cane)* [a]

Soil type	Productivity ratings for sugarcane 100-80 piculs Ha.	PH value	Total Nitrogen (N)	Available constituents in parts per million (p. p. m.)								
				Ammonia (NH_3)	Nitrates (NO_3)	Phosphorus (P)	Potassium (K)	Calcium (Ca)	Magnesium (Mg)	Manganese (Ma)	Iron (Fe)
San Manuel loam	200	6.10	.08	10	10	27	212	3,000	1,000	75	6
Isabela clay	185	6.10	.11	10	25	83	223	4,800	3,450	141	3
Silay fine sandy loam	185	5.20	.06	10	10	21	144	1,200	410	141	6
San Manuel fine sandy loam	165	5.95	.08	2	10	18	133	2,200	620	75	6
Isabela sandy loam	165	7.15	.09	2	25	42	216	25,600	2,940	38	3
Umingan clay loam	165	6.45	.16	10	2	35	216	4,200	1,800	13	3
Silay sandy loam	165	5.00	.07	10	10	31	169	600	210	177	8
Faraon clay	150	7.00	.11	2	5	50	74	9,000	4,820	9	1
Bolinao clay	150	6.70	.15	2	25	19	134	14,300	4,880	9	1
Silay loam	150	5.30	.08	2	10	19	211	1,800	710	113	5
Manapla loam	145	5.00	.11	10	10	4	107	2,200	550	113	4
Tupi fine sandy loam	135	5.10	.16	10	25	5	220	trace	90	trace	5
Guimbalaon loam	125	5.15	.09	10	25	7	198	400	1,350	250	4
Louisiana clay	125	5.10	.10	2	5	4	127	500	570	125	3
Tupi silt loam	125	5.20	.18	25	2	8	118	1,000	680	113	8
Guimbalaon fine sandy loam	115	5.40	.05	10	25	8	97	300	260	200	5
Victorias clay loam	115	4.30	.17	10	2	7	107	900	410	250	3
Guimbalaon clay	100	5.20	.15	10	25	4	305	1,100	490	177	5
Silay clay	100	5.20	.09	2	10	6	111	2,100	810	250	10
Cadiz gravelly loam	100	4.30	.15	10	2	9	96	700	240	250	4
Guimbalaon gravelly loam	100	5.60	.08	2	5	5	165	500	480	200	4
La Castellana clay loam	100	4.70	.17	10	10	5	190	1,300	1,670	100	9
Faraon sandy loam	100	6.20	.04	2	2	6	20	800	540	18	1
Bago fine sandy loam	100	6.40	.12	2	2	4	64	500	260	27	2
Bago loam	100	5.47	.09	2	10	7	63	1,100	190	250	3
Bago sandy clay loam	100	5.10	.06	10	5	7	30	600	470	125	9
Pulupandan sandy loam	100 [b]	6.50	.17	10	10	15	79	4,700	720	trace	4
Obando sand	90 [b]	6.70	.05	2	5	7	53	900	860	13	4
Bantay clay loam	60 [b]	5.05	.12	2	25	8	100	1,600	1,000	63	7
Faraon clay, steep phase	50 [b]	7.85	.35	10	50	20	176	28,600	6,930	25	1

[a] Productivity ratings as reported by the fieldmen who identified and classified the soil types (see Table 8). Ratings for sugar cane are all based under current practices which consist of an application of from 300 to 500 kg. of ammonium sulfate or the same rate of ammo-phos.

[b] Productivity rating for corn, sugar cane being not commonly grown on this soil type. For corn, rating of 100–17 cavans per hectare.

respectively, Faraon clay, steep phase, has 28,600 p.p.m. of the same constituent.

For sugar cane and corn, many of the soil types in Occidental Negros will need liming, considering their low pH values and available calcium content. Even the most productive soil type for sugar cane and corn in the province, namely, San Manuel loam, which has a pH value close to the optimum pH requirement of these two crops, may still respond to a light application of agricultural lime.

Nitrogen.—A constituent of the protoplasm of every living cell, nitrogen is vitally needed for the growth and reproduction by both plants and animals. In plants nitrogen is used largely in their vegetative growth, although it functions also in the development of fruit, grains and seeds. An ample supply of available nitrogen in the soil may stimulate plant growth and hasten maturity, but the presence of excessive amounts tends to cause excessive vegetative growth and delay in maturity. In soils sufficient in nitrogen plants produce dark green leaves, while in those deficient in nitrogen, chlorosis or yellowing of the leaves develops and in advanced or severe cases, stunted growth results.

Besides delaying the maturity of crops, excessive supply of nitrogen in the soil causes other adverse effects such as: (*a*) lodging in rice, wheat, oats, and other small grains, (*b*) decreased resistance of plants to diseases, (*c*) lowering of the purity of cane juice in the case of sugar cane, and (*d*) decreased tensile strength of bast fibers in fiber plants. However, for certain crops like leafy vegetables and forage grasses where succulence is considered a good quality, an abundance of nitrogen in the soil is highly desirable.

Soil nitrogen is found chiefly in the organic matter, which consists of the decaying plant and animal residues and the complex substances synthesized by the living soil microorganisms. Through the action of specific soil microorganisms in a process called nitrification, the nitrogen of nitrogenous organic matter is mineralized, passing three stages; namely—its conversion first into ammonia, then into nitrites, and finally into nitrates. For the production of nitrates through nitrification, moist warm soils which are well aerated, the proper microorganisms and a sufficient supply of nitrogenous organic matter are needed.

It is known that most plants assimilate their nitrogen from the soil as nitrates, while rice and other members of the grass

family can absorb ammoniacal nitrogen. In the latter form, nitrogen can be fixed in the soil and therefore not easily lost through leaching, unlike nitrates which cannot be fixed and which are very soluble. In the use of commercial fertilizers to correct the nitrogen deficiency of the soil, the choice of the kind of nitrogen-carrier will depend on the cost of the fertilizer and its application and the crops grown. For short-season crops like vegetables where immediate effect is desired, nitrates are preferable to ammoniacal nitrogen. In combination with calcium or sodium, nitrates tend to reduce soil acidity, while the ammoniacals generally increase soil acidity. However, for long-season crops like sugar cane and irrigated crops like rice, ammoniacal nitrogen is preferable to nitrate as far as efficiency and lower cost are concerned.

According to the methods of Spurway for determining both ammonia and nitrates, 2–5 parts per million (p.p.m.) of soil are considered low, 10–25 p.p.m. as medium or normal supply, and 100 p.p.m. or more as very high or excessive. Low values for ammonia accompanied by a medium or normal supply of nitrates are normal for many soils where nitrification proceeds to completion, or where the ammonia is converted into nitrites and then into nitrates right away. Low tests may also mean that the ammonia is used up by plants as fast as formed, or that it is fixed in the base exchange complex of the soil. Comparatively high tests for ammonia may mean that the soil has a high content of decaying organic matter, or that it was recently fertilized with ammoniacal compounds.

The content of available nitrogen as indicated by these tests may vary considerably during the growing period of the plant. In order to be of some diagnostic value regarding sufficiency or deficiency of nitrogen in the soil, the results of the three nitrogen tests must be interpreted together. Low results with the three tests mean nitrogen deficiency. Low tests with chlorotic and stunted plants are positive indications of deficiency in available nitrogen. High content of ammonia with a low test for nitrates may indicate that some unfavorable soil conditions are interfering with nitrification. Low nitrate tests, however, may also mean that the nitrate is absorbed by the plant as fast as produced, or that it is lost from the soil through leaching.

The average total nitrogen content of Philippine cultivated soils so far analyzed in our laboratory is about 0.14 per cent. With this average as basis, it can be seen from Table 10 that about two-thirds of the identified soil types in Occidental Negros are quite low in total nitrogen content, in spite of the reported current practice of applying 300 to 500 kilograms of ammonium sulfate or of ammophos per hectare on the areas where sugar cane is grown. The application of nitrogenous fertilizers is reflected, however, by the fairly normal or medium supply of available nitrogen of the majority of the soil types in the province.

Results of fertilizer constituent test on sugar cane at Victorias by Locsin (*24*) showed that a soil with a total nitrogen content of 0.13 per cent and an available nitrogen content of 11 p.p.m. responded quite well to nitrogenous fertilization.

In a well-controlled fertilizer experiment on sugar cane grown on Silay sandy loam comparing the application of different amounts of ammonium sulfate, Richardson (*41*) found that 750 kilos of ammonium sulfate per hectare while lowering the juice quality slightly, gave highly significant gains in cane and sugar yields. The soil on which the experiment was conducted contained 2 p.p.m. of available ammoniacal nitrogen and 5 p.p.m. of available nitrate nitrogen. Enough superphosphate and muriate of potash to correct the phosphorus and potassium deficiencies of the soil were added in the same rate of application to all the plots, but variable amounts of ammonium sulfate were applied. The highest amount tried which was 750 kilograms of ammonium sulfate per hectare gave the highest average yield, which was 213.46 piculs of sugar per hectare.

Phosphorus.—Like nitrogen, phosphorus is a constituent of every living plant and animal cell. Without phosphorus, cell division cannot take place and, therefore, growth is suspended. Phosphorus is needed in the formation of seeds and has a marked influence on the maturity of crops, especially grain crops. Being needed in the production of nucleo-proteids and fats and albumin, as well as in the conversion of starch into sugar, phosphorus hastens the ripening processes in plants in general.

Plants grown on phosphorus-deficient soils are of inferior feeding value because of their reduced phosphorus content. The importance of this fact in the nutrition of animals is obvious even considering only that phosphorus is essential in the formation of bones and teeth.

Plants with a sufficient supply of phosphorus develop relatively

extensive root systems, while phosphorus-starved plants have stunted root systems which mean decreased feeding zones.

In agricultural or cultivated soils, phosphorus is probably the most deficient among the major plant-nutrient elements. Stunted growth is the most characteristic symptom in plants grown on soils deficient in phosphorus. The stunted plants usually have dark green color, while some plants, like corn develop reddish or purplish coloration on the leaves and stems when deficient in phosphorus. In some varieties of rice, phosphorus deficiency may delay maturity by as much as two months.

The quantity of available phosphorus that should be present in the soil to sustain normal plant growth varies according to soil and climatic conditions. According to Troug (*52*), under Wisconsin (U.S.A.) conditions the minimum limit for available phosphorus should be 37.5 p.p.m. for good, heavy or clayey soils and 25 p.p.m. for lighter or sandy soils. He also suggested that for certain sections of southern United States where the climate permits a longer growing period than in the northern part, 10 to 15 p.p.m. of readily available phosphorus might suffice for a good crop of corn. For some Philippine soil types, there are indications that 30 to 40 p.p.m. of available phosphorus, as determined by the Truog method, might maintain a good crop of rice (Marfori, *29*).

It may be seen in Table 10 that the ten most productive soil types for sugar cane in Occidental Negros have available phosphorus ranging from 18 to 83 p.p.m. and the rest of the soil types where sugar cane is grown have less than 10 p.p.m. of available phosphorus. This shows that the native fertility of the soil is a great factor in the crop productivity of the soil.

Of the thirty soil types identified in the province, only five have more than 30 p.p.m. of available phosphorus. In spite of the reported common application now of ammophos, a phosphatic fertilizer, on sugar cane crops of the province, the soils of Occidental Negros, in general, have lower available phosphorus contents than those of the soils of some other provinces already surveyed, like Laguna, Bataan and La Union. This may be due to the greater exhaustive effect of sugar cane on the plant-nutrient supply of the soil than those of other agricultural crops. More constant use of phosphatic fertilizers where needed, or heavier phosphatic fertilization than the common current rates is probably needed by the sugar cane crops of the province. This is especially so when we compare the usual local rate of 300 to 500 kilograms of ammophos (generally containing 20 per cent P_2O_5) per hectare with the current rates in the Hawaiian sugar cane plantations of equivalents of 230 to 2,330 kilograms of ammophos of the same composition, the average being about 700 kilograms per hectare, (Borden, *11*). The average sugar cane yield in Hawaiian plantations is more than double that of Occidental Negros (*19*).

Potassium.—Plants usually need and contain more potassium than any other essential nutrient element derived from the soil. Plant ash usually contains about 40 per cent of potassium as potash (K_2O). Potassium, unlike phosphorus, is not localized in any part of the plant, although it tends to accumulate in the leaves and stems instead of in the grain. One of the most important functions attributed to potassium is its effect on the synthesis by plants of carbohydrates and proteins. Potassium is needed in the production of starch, sugar, and other carbohydrates and in the translocation of these materials within the plant. It is also needed in the development of chlorophyll and in the synthesis of oils and albuminoids. Potassium improves the general vigor of the plant and increases its resistance to diseases. Potassium increases also plumpness in grains, and makes the stalks or stems of plants more rigid, thus minimizing lodging (Millar and Turk, *32*).

Marked disturbances in plants are caused by a deficiency of potassium in the soil. The leaves become yellowish or dull-colored at the tips and margins and finally brown, spreading upward and inward toward the centers. The deficiency may cause also the formation of small, shrunken, or misshaped flowers, pods, fruits, tubers, and roots. Parker and Jones (*37*) reported that potassium applications increased the size of orange fruits in long-term fertilizer studies in California.

Potassium is found in both the organic and mineral matter of the soil but occurs chiefly in the mineral portion in unavailable form. Most soils, except peats and mucks, contain relatively large amounts of total potassium, but the amount available to plants is generally small, especially in sandy soils. The unavailable mineral potassium gradually becomes available to plants through the action of weathering, by base exchange, and through solution in the soil water.

The major portion of the soil potassium usually exists in the difficultly available or non-replaceabale form, principally

in primary minerals such as the feldspars and micas which are prominent constituents of igneous rocks. A minor portion of the total potassium, usually not more than one per cent, is present in available or replaceable form, that is, in the clay minerals (principally kaolinite, montmorillonite, beidellite, halloysite, etc.). The portion of total potassium that is water-soluble is still much smaller than that in replaceable form, and it is quite a blessing to agriculture, for it is the water-soluble potassium that is easily lost by the soil in drainage or through leaching.

In soils where the base-exchange capacity is rather large and the total exchangeable-base content is low, part or all of the potassium added as fertilizers is fixed in the clay mineral exchange complex and may be considered stored for the future use of plants.

In a critical study of the fertilizer requirements of lowland rice on some Philippine soil types, Marfori *et al* (*30*), of the Division of Soil Survey and Conservation, found that where the soil is highly deficient in available potassium small applications of potassic fertilizer generally will not give immediate significant increases in crop yield because of the fixation of the added potassium in the base-exchange complex of the soil. However, large initial applications of potassic fertilizer on such a soil will satisfy or saturate its potassium-fixing-capacity and leave enough readily available potassium for the immediate needs of plants, insuring higher crop yields. It was also found that on Buenavista silt loam and Maligaya clay loam with available potassium contents of 9 p.p.m. and 50 p.p.m., respectively, large applications of potassic fertilizer gave statistically significant increases in crop yield, using Guinangang rice as the plant indicator. On Marikina clay loam and San Manuel silt loam which contain respectively 132 p.p.m. and 161 p.p.m. of available potassium, repeated large applications of potassic fertilizer did not give at all any statistically significant increase in yield, using Guinangang rice as the crop indicator.

Locsin (*25*) after conducting experiments on potash fertilization on sugar cane in various haciendas at Victorias, Occidental Negros, reported that soils containing 85 p.p.m. or less of available potassium, as determined by the Peech and English method (equivalent to 286 kilograms of available K_2O per-hectare-foot) gave positive crop response to potash applications, while soils containing 151 p.p.m. or more of available potassium gave negative crop response.

It might be expected that rice and sugar cane will have greatly varying minimum available potassium requirements when one considers that the amount of potash removed from the soil by a good crop of sugar cane has been estimated to be about 460 kilograms of K_2O per hectare, while that removed by rice has been estimated to be about 98 kilograms of K_2O per hectare, (Phil. Agriculture, Field Crops, *4*). A great number of fertilizer experiments where the nutrient contents vary gradually from soil to soil need to be made to establish more definite limits of nutrient requirements.

The data of Bray (*13*) and of Murphy (*34*) on available soil potassium which were obtained with methods similar to those of Peech and English are cited here for comparison.

According to Bray, for most Illinois or Corn Belt soils, corn or clovers will not respond to potassium fertilization, when the available soil potassium is 150 p.p.m. (300 pounds per acre) or more. The minimum requirement of available potassium for soybeans was estimated at 100 p.p.m., while that for wheat and oats was about 65 p.p.m. However, in a later report (Linsley, *23*), Bray recommends 100 p.p.m. (200 pounds per acre) of available potassium as the minimum requirement for the principal Illinois crops to be grown in a 4-year rotation.

According to Murphy (*34*), Oklahoma soils containing less than 60 p.p.m. of replaceable potassium generally respond to potash fertilization when other factors are favorable for plant growth. He found that on Oklahoma soils with 100 to 124 p.p.m. of available potassium, crop response was very doubtful; on soils with 125 to 199 p.p.m. there was no crop response ordinarily; and no soils with over 200 p.p.m. of replaceable potassium ever gave crop response to potassium fertilization.

Basing on the results of experiments on potassium fertilization conducted in the Islands and on the findings from abroad cited above, it may be assumed tentatively that about 100 to 150 p.p.m. of available potassium is the average minimum requirement of most Philippine crops, especially rice and sugar cane. Table 10 shows that the available potassium contents of the soils of Occidental Negros vary from as low as 20 p.p.m., that of Faraon sandy loam, to 305 p.p.m., that of Guimbalaon clay. From Table 10 it may also be seen that San Manuel loam and Isabela clay, the two most productive soil types of the province for sugar cane, have over 200 p.p.m.

of available potassium; that the seven most productive soil types for sugar cane, with productivity ratings of 165 or over for this crop, have over 125 p.p.m. of available potassium. About one third of the soil types of the province, however, have less than 100 p.p.m. of available potassium and most probably are in need of potassic fertilizers for most agricultural crops.

It may be relevant to state at this point that in Hawaii where the average yield of sugar is about 300 piculs per hectare (FAO, *19*), and the potash applications in sugar cane fields "appear to be well founded and rational", (Borden, *11*), rates of potassic fertilization, where practiced at all, were between 100 and 344 pounds of K_2O per acre, averaging 204 pounds, or the equivalents of 187 to 643 kilograms of *muriate* of potash (60 per cent K_2O) per hectare, averaging 382 kilograms.

Calcium.—Essential not only for plant growth but also in the nutrition and development of the animal body, "calcium makes up approximately 40 per cent of the mineral elements of the human body" (Smith and Hester, (*46*). "Calcium is the outstanding element of the mineral matter which gives shape and permanence to the body's framework; which endows our bones with the strength, and our teeth with the hardness, that they need" (Sherman, *44*).

Calcium is required in the translocation of carbohydrates and certain mineral elements in the plant. It is needed in the development of healthy cell-walls. According to Thatcher (*51*), experiments with algae have shown that in the absence of calcium salts mitotic cell division takes place, showing that the nucleus functions properly, but the formation of the new transverse cell-wall is retarded. This is one direct evidence that calcium is needed in cell-wall formation. Another is that calcium deficiency in the soil often results in the death of the terminal bud.

Calcium helps in neutralizing organic acids or regulating the acid-base balance within the plant. The calcium content of plants is an index of their feed value, calcium being needed in the development of the bones and teeth of animals.

In addition to being one of the essential plant-nutrient elements, calcium performs many important functions in the soil, affecting the latter physically, chemically, and biologically. The calcium content of the soil affects its physical structure. Soil colloids saturated with calcium are flocculated, while those deficient in calcium are generally deflocculated. This is why soils high in lime content are usually in better tilth, more granular and porous, and less easily puddled than soils low in lime content. Soils with good tilth are easier to cultivate and have better aeration and drainage than soils with poor tilth.

Added as a liming material, calcium neutralizes the acidity of acid soils and corrects the toxic conditions usually caused by soil acidity. In this way calcium affects the availability of soil mineral elements as already explained under the topic "soil reaction." Below pH 6.5, the availability of phosphate is very much affected by the calcium content of the soil. In calcium-deficient soils, phosphorus is usually comparatively unavailable to plants although the total phosphate content may be relatively high. Especially below pH 6.0, the tendency to form calcium phosphate, which is soluble in carbonic acid and therefore readily available to crops, decreases, and increasing amounts of phosphate combine with hydrated oxides of iron and aluminum, forming compounds with very low phosphate availability. Liming, therefore, not only increases the pH value of the soil, but also increases the availability of phosphorus through the formation of calcium phosphate which has greater availability than the phosphates of iron and aluminum.

In nitrification occurring in the soil, "the oxidation of ammonia to nitrous acid by nitrosomonas and other related species, and of nitrite into nitric acid by nitrobacter is markedly retarded— by soil acidity. This is due to the sensitivity of these organisms to the acidity which develops when the nitrous and nitric acids are not neutralized, as is the case naturally in an acid soil. That is why the application of lime to distinctly acid soils often greatly stimulates nitrification and thus the production of readily available nitrogen"—Truog (*53*).

Among the effects of liming the soil on plant composition, the following had been reported in literature (*46*): (a) the CaO content of cabbage leaves had been increased (from 4.42 per cent to as much as 7.53 per cent), (b) besides increasing the yield of tomatoes to more than double, their vitamin C or ascorbic acid content had been almost doubled also (from 96 p.p.m. to 170 p.p.m.), and (c) corn grain showed an increase in protein content of 40 per cent due to application of lime alone.

In sugar cane, the main effect of liming the soil is increased yields in cane and in sugar as well as the tendency to increase the juice purity. Among the various experiments on liming sugar cane soil conducted in Occidental Negros, one that gave

highly profitable result was that reported by Locsin (*26*). The yield in the control (no lime) was 80.62 piculs of sugar, while that in the limed area (3 tons per Ha.) was 116.85 piculs, giving an increase in yield of 36.23 piculs of sugar per hectare due to liming.

Among the many soil types analyzed so far for available calcium by the Peech and English method in our laboratory, those that rated high in crop productivity gave about 2,000 to 6,000 p.p.m. of available calcium on the average.

An experiment to find out the effect of ammo-phos and lime on the yield of upland rice (Dumali) grown on Buenavista silt loam at San Ildefonso, Bulacan, was conducted by Madamba and Hernandez (*28*) of the Division of Soil Survey and Conservation. From the published results of the experiment and the unpublished data of about 2 cavans yield in the unlimed control (no ammophos also), it may be estimated that the increase in yield of upland rice due to the six tons of lime applied per hectare was about 20 cavans. Even without statistical treatment an increase in yield of about 20 cavans over the control which was about 2 cavans only, was certainly significant. The pH of the soil where the experiment was conducted was 4.8 and the available calcium content was 617.5 p.p.m.

Unpublished results on liming experiments on two other soil types conducted by our laboratory showed that with the same variety of upland rice (Dumali) not one of the several rates of liming (even up to 240 T./Ha.) gave statistically significant increase in yield. This may be explained by the fact that both soils used in the experiments had rather high available calcium contents to start with. One, Buenavista clay, had a pH value of 6.17 and an available calcium content of 3,800 p.p.m. The other, Carmona clay, had a pH value of 5.39 and an available calcium content of 3,600 p.p.m.

Table 10 shows that the available calcium contents of Occidental Negros soils vary from traces in Tupi fine sandy loam to 28,600 p.p.m. in Faraon clay, steep phase. It may be seen also from this table that the two most productive soil types in the province, namely, San Manuel loam and Isabela clay, have 3,000 p.p.m. or more of available calcium. If we consider 2,000 p.p.m. as the minimum limit of sufficiency for available calcium, most of the soil types in Occidental Negros (19 out of 30) need liming for most crops, especially for sugar cane. In some cases, even if the available calcium is over 2,000 p.p.m., where the pH value is much below 6.2, the need for liming for sugar cane is still indicated.

Magnesium.—Another essential element for plant growth, magnesium is a constituent of chlorophyll and of most seeds. It appears to be needed in the translocation of starch, and in the formation of fats and oils, and "to function as a carrier of phosphorus." Magnesium deficiency in plants is shown by characteristic discoloration of leaves —purplish-red leaves with green veins in cotton, chlorotic leaves in legumes, and striped leaves in corn, with the veins remaining green and the other portion becoming yellow.

In citrus "symptoms of magnesium deficiency occur on mature leaves at any season of the year. Irregular yellow blotches start along the midrib of leaves near the fruit and eventually coalesce to form an irregular yellow band on each side of the midrib. This area rapidly enlarges until only the tip and the base of the leaf are green, the base showing a more or less inverted V-shaped area pointed on the midrib. In more advanced stages the entire leaf may become yellow." Other findings at the Citrus Experiment Station in Florida, U.S.A., have shown that in citrus, magnesium deficiency causes a reduction in the total crop, in the size of the fruit, and in the sugar, acid, and vitamin C contents of the juice. (Camp *et al*, *15*).

On the magnesium-deficient soils of Florida, the addition of magnesium-bearing fertilizers, principally dolomitic limestone and magnesium sulfate is now a common practice. The increase in crop yield due to the addition of magnesium is so great that the standard fertilizer for citrus in Florida contains a certain percentage of magnesium [Anonymous (*5*).] A state survey of the fertilizer practice in Florida in 1944 showed that in 41 cases or estimates, proper fertilization had increased the average yield of citrus more than fourteen times as compared with that of the control; estimated yield of citrus fruits per acre, without fertilizer, 24.4 boxes; with fertilizer, 358.5 boxes [National Fertilizer Association (*36*)].

Philippine soil types that rated high in crop productivity and which had been analyzed so far by the Peech and English method in our laboratory gave about 600 to 1,700 p.p.m. of available magnesium on the average. However, for certain species of citrus [pummelo or *Citrus maxima* (Brun.) Merr.], symptoms of magnesium deficiency had been observed on soils

that contained even as much as 950 p.p.m. of available magnesium.

Table 10 shows that about one half of the Occidental Negros soil types (14 out of 30) were deficient in available magnesium as determined by the Peech and English method.

Iron.—Although the total iron content of an average agricultural soil goes as high as five per cent (50,000 p.p.m.) or more, the amount of available iron (to plants) is very small. Several representative soil types from various parts of Luzon which rated high or at least medium in crop productivity had been analyzed for available iron in our laboratory following a modified Peech and English method. The results obtained ranged from about 2 to 30 p.p.m. of available iron. With this range of available iron as basis no soil type in Occidental Negros may be considered as seriously deficient in available iron.

Manganese.—Agricultural soils generally contain very small amounts of total manganese, less than 0.1 per cent (1,000 p.p.m.), but the requirements of plants are so small that they are usually satisfied. Examples of the manganese contents of the following plants as reported in the literature (*10*) are: cabbage leaves, 34 p.p.m.; radish roots, 29 p.p.m.; rice grains, 23 p.p.m.; and tomato fruits, 46 p.p.m. Representative soil types from various parts of the Philippines which were rated high or at least medium in crop productivity had been analyzed for available manganese by the Peech and English method. The available manganese contents varied from about 15 to 250 p.p.m.

Leaf symptoms of manganese deficiency had been observed on ladu and szinkom mandarin oranges (*Citrus nobilis* Lour.) growing on a certain soil type in Batangas Province which was found to contain traces only of available manganese. It may be seen in Table 10 that only two soil types, namely, Tupi fine sandy loam and Pulupandan sandy loam have traces only of available manganese.

SUMMARY

Negros Occidental is part of the Western Visayan Group. Bacolod the capital and chartered city is 290 statute miles southeast of Manila.

The recent alluvial plains and rolling lands on the western side of Negros are geologically young and were formed from volcanic deposits. The eastern and southern sides are considered geologically old and consist of limestone formation.

The wide plains on the western part of the province have poor drainage. When used for sugar cane, drainage ditches are constructed. The rolling uplands on the northern and middle portions of the province have excessive external drainage which has caused severe soil erosion. These rolling lands are also cultivated mostly to sugar cane. The rolling and hilly areas between Binalbagan and Himamaylan as well as the rolling lands in the Tablas Plateau are wide grasslands. The central mountainous region which is still covered by thick forest has good drainage condition.

The principal rivers that drain the province are the Ilog, Binalbagan, Bago, Malogo, and Himugaan.

The different towns in the province are well supplied with potable water by means of pumping from dug wells or from dammed rivers.

"Buglas" was the first name of the province before the Spaniards arrived. Andres de Urdaneta, upon landing on Escalante in 1569 named the island Negros, because of the presence of the tribes of Negritos. Spanish control of the island of Negros began later and with the increasing population more towns were established. Because of abuses, the people revolted resulting in the defeat of the Spaniards. However, the struggle for independence did not stop, for no sooner had the island been under the sovereignty of America in 1898 a renewed peaceful campaign for freedom was made, until in 1946, the independence of the Philippines was finally recognized. But before attaining independence, the Japanese occupation of the island took place which meant the loss of many lives, properties, and industries of the province.

The province has good roads making almost all towns accessible by land transportation. Sea and air means of travel are also well established.

Sugar manufacturing is the most important industry. Lumber, alcohol, fish, and other agricultural crops also contribute much to the prosperity of the province.

The three types of rainfall that prevail in this province are the first type in the western part, the fourth type in the northern end, and the third type in the eastern side. Agricultural practices like time of planting and varieties of crops are highly influenced by these differences in climatic conditions.

Sugar cane is the principal crop. Rice, coconut, corn, and tobacco are also grown on a fairly large scale. Almost 26 per cent of the area of the province in 1938 was cultivated

to crops. Fertilizers are generally applied to sugar cane but rarely on rice or other crops. Cultivation on the up-rolling lands has somehow contributed to severe soil erosion. Erosion control measures are needed on these areas. Irrigation is necessary but is seldom done. Comparatively very few farms are artificially irrigated.

Almost two-thirds of the landowners in the province are holders of land ranging in size from 1 to 5 hectares. Likewise, two-thirds of the number of farms are operated by tenants.

The soils in the province were grouped according to relief and nature of the parent rock material into (1) soils of the flat lowlands, (2) soils of the uplands, (a) soils derived from sedimentary rocks, (b) soils derived from igneous rocks, and (3) soils of the hills and mountains. There are 13 soils types covering about 18.71 per cent of the area of the province classed under the flat lowlands, 7 soil types covering about 12.28 per cent classed under soils derived from sedimentary parent material, 12 soil types with an area of about 25.84 per cent are soils derived from hard igneous parent material, and the soils of the hills and mountains cover about 43.17 per cent of the area of the province. The two most important soils are the Silay series of the flat lowland and the Guimbalaon series of the rolling upland.

The surface soil of the Silay series ranges in texture from sand to clay and varies in color from gray to brown to almost black. The soil is generally acidic which is partly due to the residual effect of ammonium sulfate fertilizer. The substratum is a compact sandy clay loam layer which is locally called "bakias". Silay series has poor drainage because of the presence of this compact layer in the substratum.

Guimbalaon series, on the other hand, is a red soil whose surface texture ranges from sandy loam to clay. Iron concretions and boulders are usually present on the surface layer. The substratum consists of partially weathered rock materials mixed with clay soil. Internal drainage is good. This soil is highly acidic. It is planted mostly to sugar cane at the application of from 400 to 500 kilos per hectare of Warnerphos fertilizer.

The mechanical analysis of each soil type is presented to show its composition with respect to the relative quantities of sand, silt, and clay fractions that make up the soil. The

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result of this analysis is used to check the field naming of the types.

The morphology and genesis of the soil types were also discussed to show in brief the influence of parent materials, climate, time, man's activities, and relief of the land upon the formation or development of soils. The different soil types found in the province were also grouped into eight classes based upon the degree of profile development and nature of the parent material of the rock.

The productivity ratings of the different soil types were likewise presented to show the relaionships between soil characteristics and yield of crops.

The common as well as the scientific names of all plants mentioned in this report are listed for reference purposes.

The pH values of the surface soils of Occidental Negros ranged from 4.30 (those of Cadiz gravelly loam and Victorias clay loam) to 7.85 (that of Faraon clay, steep phase). These extremes in pH values are accompanied by a wide variation in available calcium contents. While Cadiz gravelly loam and Victorias clay loam have 700 and 900 p.p.m. of available calcium, respectively, Faraon clay, steep phase, has 28,600 p.p.m. of the same constituent. Considering their low pH values and their low available calcium contents, many of the soil types in Occidental Negros need liming at least for sugar cane and corn.

About two thirds of the identified soil types in Occidental Negros are quite low in total nitrogen contents, in spite of the reported current practice of applying 300 to 500 kg. of ammonium sulfate or of ammophos per hectare in the areas where sugar cane is grown. The application of nitrogenous fertilizers is reflected, however, by the fairly normal or medium supply of available nitrogen of most of the soil types in the province.

The ten most productive soil types for sugar cane in Occidental Negros have available phosphorus contents ranging from 18 to 83 p.p.m. and the rest of the soil types where sugar cane is grown have less than 10 p.p.m. of available phosphorus. This shows that the native fertility of the soil is a great factor in the crop productivity of such soil. Of the thirty soil types identified in the province, only five have more than 30 p.p.m. of available phosphorus. In spite of the common application now of ammophos, a phosphatic fertilizer, on sugar cane crops of the province, the soils of Occidental Negros, in general, have

lower available phosphorus contents than those of the soils of some other provinces already surveyed, namely, Laguna, Bataan, and La Union.

The available potassium contents of the soils of Occidental Negros vary from as low as 20 p.p.m., that of Faraon sandy loam to 305 p.p.m., that of Guimbalaon clay. The two most productive soil types of the province for sugar cane, namely, San Manuel loam and Isabela clay, have over 200 p.p.m. of available potassium, and the seven most productive soil types with productivity ratings of 165 or over for sugar cane, have over 125 p.p.m. of available potassium. About one-third of the soil types of the province, however, have less than 100 p.p.m. of available potassium and most probably are in need of potassic fertilizers for most agricultural crops.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN NEGROS OCCIDENTAL PROVINCE

Common name	Scientific name	Family name
Abaca	*Musa textilis* Nee	Musaceae
Agho	*Leucaena glauca* (Linn.) Benth.	Leguminosae
Agingai	*Rottboellia exaltata* Linn.	Gramineae
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceae
Api-api	*Avicennia marina* (Forsk.) Vierh var. *alba* (Bla.) Bakh.	Verbenaceae
Apitong	*Dipterocapus grandiflorus* Blanco	Dipterocarpaceae
Avocado	*Persia americana* Mill.	Lauraceae
Bacuit	*Oryza minuta* Presl.	Gramineae
Bakauan	*Rhizophora mucronata* Lam.	Rhizophoraceae
Bamboo	*Bambusa spinosa* Roxb.	Gramineae
Banana	*Musa sapientum* Linn.	Musaceae
Bangkal	*Nauclea orientalis* Linn.	Rubiaceae
Batao	*Dolichos lablab* Linn.	Leguminosae
Binayuyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceae
Black pepper	*Piper nigrum* Linn.	Piperaceae
Boho	*Schizostachyum lumampao* (Blanco) Merr.	Gramineae
Bongalon	*Sonneratia caseolaris* (Linn.) Engl.	Sonneratiaceae
Cabbage	*Brassica oleracea* Linn. var. *capitata* Linn.	Cruciferae
Calansi	*Schizostachyum* spp.	Gramineae
Camote	*Ipomoea batatas* (Linn.) Poir.	Convolvulaceae
Cassava	*Manihot esculenta* Crantz	Euphorbiaceae
Chico	*Achras sapota* Linn.	Sapotaceae
Coconut	*Cocos nucifera* Linn.	Palmae
Coffee	*Coffea* spp.	Rubiaceae
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineae
Corn	*Zea mays* Linn.	Gramineae
Cotton	*Gossypium hirsutum* Linn.	Malvaceae

Cowpeas	*Vigna sinensis* (Linn.) Savi.	Leguminosae
Derris	*Derris elliptica* (Rox.) Benth.	Leguminosae
Eggplant	*Solanum melongena* Linn.	Solanaceae
Ferns	*Acrostichum aureum* Linn.	Polypodiaceae
Gabi	*Colocasia esculenta* (Linn.) Schott.	Araceae
Garlic	*Allium sativum* Linn.	Liliaceae
Ginger	*Zingiber officinale* Rosc.	Zingiberaceae
Ipil	*Instia bijuga* (Colebr.) O. Kuntze	Leguminosae
Jackfruit	*Artocarpus heterophyllus* Lam.	Moraceae
Lañgarai	*Bruguiera parviflora* (Roxb.) W. & A. Prodr.	Rhizophoraceae
Lanzones	*Lansium domesticum* Cerrea	Meliaceae
Lauan	*Anisoptera thurifera* (Blanco) Blume	Dipterocarpaceae
Lettuce	*Lactuca sativa* Linn.	Compositae
Libato	*Basella rubra* Linn.	Basellaceae
Luya-luya	*Panicum repens* Linn.	Gramineae
Maguey	*Agave cantala* Roxb.	Amaryllidaceae
Mango	*Mangifera indica* Linn.	Anacardiaceae
Mariacapra	*Ipomoea pes-caprae* (Linn.) Roth	Convolvulaceae
Molave	*Vitex parviflora* Juss.	Verbenaceae
Mungo	*Phaseolus aureus* Roxb.	Leguminosae
Mustard	*Brassica integrifolia* (West) O. E. Schultz.	Cruciferae
Narra	*Pterocarpus indicus* Willd.	Leguminosae
Nipa	*Nypa fructicans* Wurmb.	Palmae
Onion	*Allium cepa* Linn.	Liliaceae
Orange	*Citrus aurantium* Linn.	Butaceae
Pakol	*Musa errans* (Blanco) Teodoro	Musaceae
Pandan	*Pandanus tectorius* Sol.	Pandanaceae
Papaya	*Carica papaya* Linn.	Caricaceae
Patani	*Phaseolus lunatus* Linn.	Leguminosae
Patola	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceae
Paua	*Schizostachyum fenixii* Gamble	Gramineae
Peanut	*Arachis hypogaea* Linn.	Leguminosae
Pechay	*Brassica chinensis* Linn.	Cruciferae
Pensamientos	*Stachytarpheta jamaicensis* (Linn.) Vahl.	Verbenaceae
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceae
Pummelo	*Citrus maxima* (Burm.) Merr.	Rutaceae
Raddish	*Raphanus sativus* Linn.	Cruciferae
Rice	*Oryza sativa* Linn.	Gramineae
Riquiriw	*Acanthus* spp.	Acanthaceae
Santol	*Sandoricum koetjape* Merr.	Meliaceae
Siniguelas	*Spondias purpurea* (Linn.) Urb.	Anacardiaceae
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae
Soybean	*Glycine max* (Linn.) Merr.	Leguminosae
Squash	*Cucurbita maxima* Duchesne	Cucurbitaceae
Sugar cane	*Saccharum officinarum* Linn.	Gramineae
Talahib	*Saccharum spontaneum* Linn.	Gramineae
Tobacco	*Nicotiana tabacum* Linn.	Solanaceae
Tomato	*Lycopersicum esculentum* Mill.	Solanaceae

Tugue	*Dioscorea esculenta* (Lour.) Burkill.	Dioscoreaceae
Ubi	*Dioscorea alata* Linn.	Dioscoreaceae
Upo	*Lagenaria leucantha* (Duch.) Rusby.	Cucurbitaceae
Yakal	*Hopea plagata* (Blanco) Vidal	Dipterocarpaceae

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