REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
BUREAU OF SOILS
MANILA

Soil Report 33

SOIL SURVEY OF MASBATE PROVINCE PHILIPPINES

RECONNAISSANCE AND EROSION SURVEYS

BY

ISAAC J. ARISTORENAS
Chief of Party

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Members

MANILA
BUREAU OF PRINTING
1964

818706

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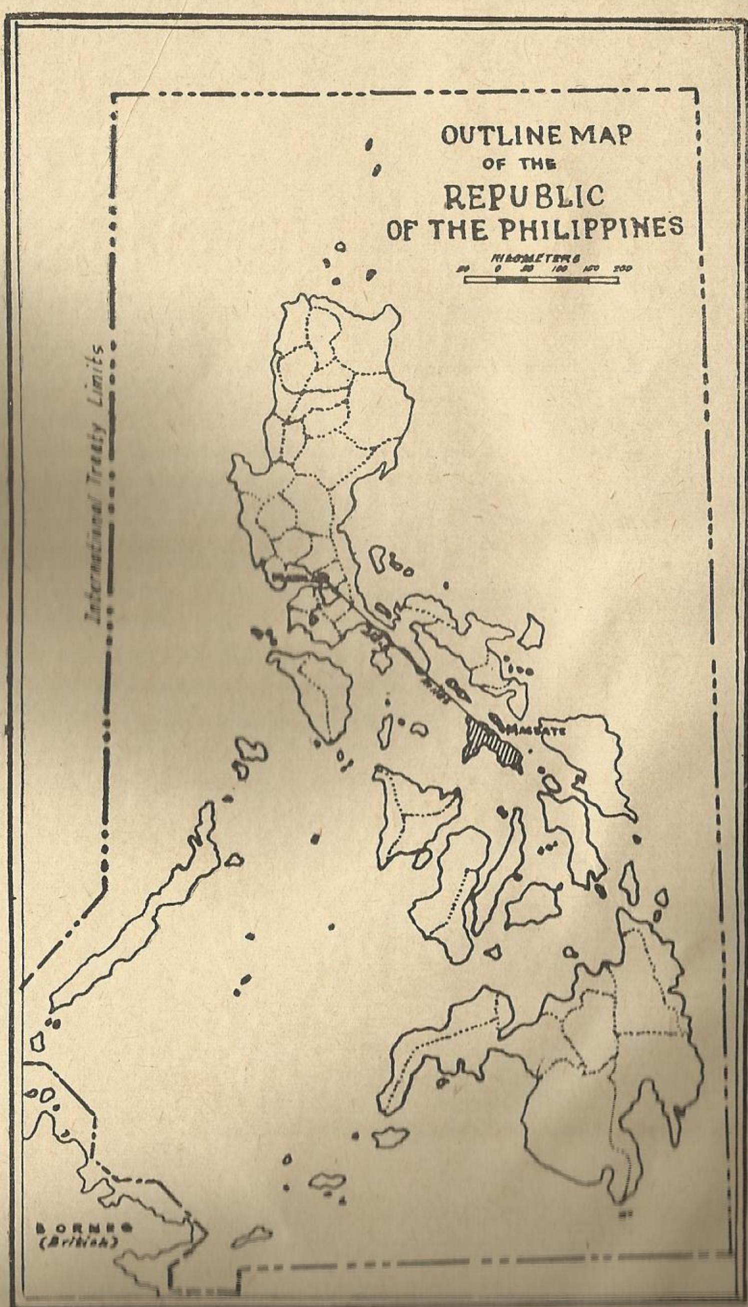

Figure 1. Outline map of the Philippines showing the location of Masbate Province

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WITH A DISCUSSION ON THE CHEMICAL CHARACTERISTICS AND FERTILIZER REQUIREMENTS OF THE SOILS OF MASBATE PROVINCE

By

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MANILA
BUREAU OF PRINTING
1964

818796

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ILLUSTRATIONS

TEXT FIGURES

HOW TO USE THE SOIL SURVEY REPORT

Soil Surveys provide basic data for the formulation of land-use programs. This report and the accompanying map present both general and specific information about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or in only some particular parts thereof. In either case, he will be able to obtain the information he needs. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers under three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. An attempt has been made to meet the needs of all these three groups by making the report comprehensive for reference purposes.

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

Readers interested chiefly in specific areas, such as particular locality, farm, or field, include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm-loan agencies. These readers should (1) locate on the map the tract concerned; (2) identify the soils on the tract by referring to the legend on the margin of the map and seeing the symbols and colors that represent them; and (3) locate in the table of contents under the section on soils the page where each type is described in detail, giving information on its suitability for use and its relation to crops and agriculture. They will also find useful specific information relating to the soils in the sections on Productivity Ratings, Land Use and Soil Management, Chemical Characteristics of the Soils, and Water Control on the Land.

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

—Adapted from the U. S. D. A.

INTRODUCTION

The systematic way of measuring the capacity of the country to produce her needs is obtained from the soil survey report which furnishes a working knowledge on how and when to use our soils, what system or systems of cultural and soil managements or type of land-use should be followed under any condition in order to get the maximum yield or benefits per unit area at a minimum cost. The results and interpretations of the soil survey report are the only authentic and reliable bases which could justify any change or changes in our farming methods, land-use planning, managements and to initiate or institute agricultural reforms for the protection of that live portion of the earth's covering.

There are four primary objectives of a soil survey; namely, (1) to determine the morphology of the soils, (2) to classify them according to their characteristics, (3) to show their distribution on the map and (4) to describe their characteristics particularly in reference to the growth of various crops, grasses and trees. The ultimate purpose is to provide accurate soil maps necessary for the classification, interpretation and extension of data regarding agricultural production, the classification of rural lands, and for the factual basis in the development of sound program of rural land-use whether planned by public or private agencies, or by individuals. The ultimate aim of such a study is to improve our agricultural practices and methods, ameliorate and uplift our economic life and to save our soils for posterity.

The soil classification and erosion surveys of Masbate were undertaken from April 7 to July 30, 1949, inclusive, by the Division of Soil Survey and Conservation (now the Bureau of Soils) under Dr. Marcos M. Alicante and during the incumbency of Hon. Mariano Garchitorena as Secretary of Agriculture and Natural Resources. The soil report was updated and edited by Mr. Primo V. Jarmin, Soil Survey Supervisor, and proofread by Mr. Juan N. Rodenas, Soil Technologist of the Bureau of Soils.

SUMMARY

The island province of Masbate consists of Masbate, Ticao, Burias, and several small islets south of the Bicol Provinces. Masbate, the capital, is 212.5 aerial miles or 362 nautical miles from Manila.

Masbate is a two-pronged shaped with continuous range of hills rising from narrow plains and valleys on the western part. It is rugged and mountainous. The high peaks are Mt. Simbahan (697 m.), Mt. Ulac (593 m.), and Mt. Bagulipat (562 m.). The big rivers drain towards the shallow Asid Gulf; the high cliffs and abrupt ranges with deep water shores are found in the northeastern section where good ports are centrally located.

The vegetation comprises forest, grasses, and halophytes. The commercial forests cover an area of 64,930 hectares or 15.97 per cent of the total soil cover. The grassland area is almost three-fourths of the whole province and it is used extensively for cattle raising. The halophytes cover the coastal and swampy areas generally under sea water during high tides.

Civil government was established in 1901 and later made a subprovince of Sorsogon until it was restored as an independent province in 1921. It has 15 municipalities with a population of 285,000 in 1948.

Masbate is accessible either by boat or plane. Masbate, the capital, is linked by roads from Aroroy to Placer and principally by water transportation from other neighboring towns and island barrios.

Water system is inadequate and it is found only in big municipalities. The people are practically dependent on rain and spring wells for their water supply. Elementary schools are found in all the towns and barrios while higher institutions of learning are confined in the municipality of Masbate. Majority of the people profess the Roman Catholic while a few are protestants and other faiths.

The two major industries are farming and cattle raising. Some of the minor industries are fishing, lumbering, and mining. Fishing is seasonal and very thriving in the southern coastal areas. Lumbering is concentrated around Mt. Ulac and mining is within the Aroroy–Milagros area.

Masbate has two types of climate—the Intermediate type A with no pronounced maximum rain period and short dry season from one to three months obtaining within the Masbate

proper, and the Fourth type, which is characterized by no pronounced maximum rain period and no dry season as found in Ticao and the Burias Islands. Typhoons and strong winds occur from September to December.

The principal crops of the province are coconuts, rice, corn, and root crops. The province has a total farm area of 122,498.44 hectares with a yearly farm produce valued at 14,961,670 pesos. Livestock farming is another major industry with a total investment of 4,535,295 pesos in 1948. The industry suffered a great loss during the war. But rehabilitation has been done fast with government aids through the introduction of imported breeds from India and Australia.

The total farm area of 122,498.44 hectares in Masbate is classified as cultivated land, idle land, pasture land, and forest land. Farms are operated by owners, part-owners, managers, and tenants. Tenants are further classified as share-tenant, cash-tenant, or share-cash tenants. The important types of farms are the coconut farms, corn farms, palay farms, root crop farms, livestock farms, and other farms.

The soils of Masbate are classified into three classes; namely, the soils of the swamps and marshes, soils of the plains, and the soils of the uplands. The soils of the swamps and marshes cover an area of 16,928 hectares or 4.16 per cent of the total soil cover of the province. They are found along the coastal areas represented by hydrosols and covered with halophytic vegetations. The soils of the plains are found along the borders of big rivers and valleys covering an area of 32,548 hectares or 8.02 per cent of the total soil cover. The soils of the uplands are undulating to rolling and hilly to mountainous with a total area of 357,525 hectares or 87.82 per cent of the total soil cover.

The soils of the plains and uplands are classified into profile groups. Soils of the plains are classified under Profile Groups I and III. The beach sand falls under Profile Group I while the Mandawe loam, Macabare clay loam, Panganiran clay, and the Sorsogon clay loam fall under Profile Group III. The soils of the uplands are under Profile Groups VIII and IX. Under Profile Group VIII are the Ubay clay; Ubay clay, steep phase; Ubay sandy clay loam; Himayangan sandy clay loam; Batuan clay; Bolinao clay; Sevilla clay; Cataingan clay; and Cataingan sandy loam. Under Profile Group IX is the Faraon clay.

The productivity ratings of the important crops in Masbate are based on the deductive method by assigning a rating to a

specific and representative crop grown in a particular soil type. The average yields of each crop were used to compare the standard ratings of 100 for each group.

Soil erosion or the wearing away of the land surface by running water, wind or other geological agents is classified as (*a*) normal soil erosion and (*b*) accelerated soil erosion. Accelerated erosion is subdivided into sheet, rill and gully erosion.

The important factors affecting soil erosion are climate, topography, soils and the vegetative cover. Erosion varies with the season and amount of precipitation. Slope is the most important factor affecting erosion and the amount of run-off is determined by the water holding capacity and permeability of the soil, while the vegetative cover varies greatly in their capacity to hold run-off and tends to prevent and check soil erosion.

The immediate factors responsible for soil erosion in Masbate are the (1) burning and over grazing of grassland areas, (2) planting of steep slopes to row crops, (3) plowing up and down the slope, and the (4) "kaingin" method of farming. Soil erosion in Masbate are characterized as (1) no apparent erosion, (2) slight erosion, (3) moderate sheet erosion, (4) serious erosion and (5) severe erosion.

Soil erosion in the lowlands is practically very little, while the poorly drained soils like the hydrosols are free from the effects of erosion and may even have depositions. The soils of the uplands are subject to varying degrees of erosion although they are of the same topographic conditions. This is due to the present land use and management practices of the land and the physical characteristics of the soils.

The destructive effects of soil erosion are: (1) loss of the rich topsoil or the entire solum, (2) destruction of croplands, (3) increase in drought hazards, and the (4) siltation or sedimentation of the land.

Some of the important measures that will materially control soil erosion are: (1) the dissemination of conservation ideas to the farmers, (2) controlling the cultivation of steep slopes and eroded areas including those utilized for pastures, (3) checking the "kaingin" method of farming, and (4) the adoption of effective soil management and farming practices on sloping areas.

I. RECONNAISSANCE SOIL SURVEY

DESCRIPTION OF THE AREA

Location and extent.—The province of Masbate consists of three big islands of Masbate, Ticao, and Burias, and several other groups of islets, lying directly south of the Bicol Peninsula. These groups of islands are the connecting links between the islands of Luzon, Leyte, and Cebu on the southeast and Panay on the southwest. This island province has an area of 407,001 hectares. It lies exactly in the center of the Philippine Archipelago between latitudes 11° 43′ north and 12° 36′ north, and longitudes 123° 09′ east and 124° 05′ east.

Masbate, the capital of the province, is noted for its well-protected port with Ticao Island standing guard against any weather hazard from the northwest. It is 212.5 aerial miles or 362 nautical miles from Manila (Fig. 1).

Relief and drainage.—The general terrain of the province presents a surface configuration ranging from slightly undulating to rolling, and from hilly to mountainous. The rugged topography is more or less concentrated in the northeastern and northern quarter of the province with characteristic cliffs and canyons typical of a rugged ranch country. The most prominent peaks or mounts along the northwest and southwest central axis are the Conical Peak (697 meters), Mount Ulac (593 meters) and Mount Bagulipat (562 meters).

Narrow to broad hydrosols, flat coastal plains, and alluvial fans are frequent indentures of the rugged and irregular coastlines. The most extensive hydrosols of the province are found in Uson on the northeast, and at barrios Calachuchi, Malbug, and Guiom of Milagros; and at Daraga and Placer proper in the south of the southeastern prong.

To the south, southeast, and southwest the roughness of the country gradually recedes to blunt hills, rolling to undulating and sloping areas. In these sections of the islands there were few cliffs compared to the other side of the Masbate mainland. The same conditions of relief could be described to the other two carrot-shaped islands of Burias and Ticao.

The principal criteria indicative of drainage system are the landforms and topographic features. The drainage condition of an area is therefore fully expressed by its relief. The mainland of Masbate have many natural drains which are characteristically narrow and limited in length on account of the narrowness of the island. Rivers, creek, streams, and canyons radiate from the semi-central cordillera and chains of ranges running generally northwest-southwest to the coastal region. Most of the water in the region, however, drains to the south, southwest, and northwest of the country because most of the rivers and streams empty in these sections where the slopes are more gentle and gradual. In the north and northeast where there is a frequency of cliffs and ranges the rivers and streams are few, short, and narrow.

The principal drains in the north and northeast are the Baleno, Mobo, Mabunga, Sta. Cruz, San Pedro, and Dumorog Rivers. In the south of the southwestern prong there are the Tinaclipan, Tagpo, Napayawan, Caslog, Lanang Rivers, and their tributaries. Due to the abundance of these natural drains and favorable gradient of flow the water easily find its way to the sea. The rate of flow is geater in light soils where percolation and seepage are more rapid. Floods seldom occur in these areas. Like the mainland, the islands of Burias and Ticao have a similar pattern of drainage system although they are fewer in number. During heavy rainfall all the excess water easily drains through the streams and rivers at a fast velocity due to its favorable and short gradients.

Water supply.—The water supply of the province may be rated as poor to fair. Except in a few centers of population the procurement of potable and safe water is quite difficult. There are few towns in Masbate which have their own water system by gravity. Such "poblaciones" are Masbate proper, Milagros, and Mobo in the mainland; San Fernando and San Jacinto in Ticao Island, and San Pascual in Burias Island. Aside from these six municipalities, the rest depend on surface and dug wells, springs and rivers as the source of water supply.

The quality of water throughout the islands varies from poor to rich in mineral contents. Where water is geologically limestone in origin, it is found to be rich in lime. Generally, the quality of water is hard. There seems to be a scanty supply of water throughout the islands, especially in the southern half. In remote barrios, community wells and springs are the only sources of drinking water.

Figure 2. Sketch map of Masbate showing the natural drainage pattern.

Geology.—Masbate owes its unique two-pronged shape to the junction of the two prevailing anticlinical trends of the Visayan Islands and Central Luzon. The inner series, as described by

Becker, belongs to the western arm of Masbate which is continued in the eastern Panay, Guimaras, and the Cagayanes, and is parallel to the curves formed by Palawan and the Culion Group to the west, and the Negros, Zamboanga Peninsula, and Sulu line to the east. The trend of the larger arm of the island is continued through Central Leyte and eastern Mindanao and is parallel to the outer line formed by Samar and Southern Luzon.

A fairly continuous range of hills rises steeply from a narrow plain on the western prong. The maximum elevation of this range is about 600 meters at Mount Gantal. The larger arm of the island is not a continuous range but is broken by two transverse valleys; one between Milagros and Port Palanog and the other one, south in Uson. Except for these two troughs, the province is extremely rugged and mountainous. The highest mountain in the island is Mount Simbahan (697 m.) which lies 11 kilometers south of Baleno and 18 kilometers southeast of Aroroy. The two high peaks, Mount Ulac (593 m.) and Mount Bagulipat (562 m.) are in the mountainous country southeast of the Milagros–Masbate trough. A peculiar feature of the relief of this part of the island is the course of the Malbug River which rises near the northeastern coast and flows southeast parallel to the coast near Uson. Then it makes a sharp turn at right angle to its former direction and flows southeast into the Asid Gulf. The two largest rivers are the Asid and the Malbug which drain into the shallow Asid Gulf.

The crests of the mountain ranges lie near the northern shore where there is a considerable stretch of plain and piedmont country on the southwestern side of the main prong of the island. Similarly, the greatest depths near the shore are to be found along the northern coast, especially between Naro Bay and Point Bugui, where there is a depth of 911 meters at a point less than 3 kilometers north of Bagubau Point. For this reason, most of the good ports are located in the north, northeast, and east coast of the mainland, like Port Barrera in Aroroy, Port Palanog in Masbate, Naro Bay in Dimasalang; and Port Cataingan and Port Mandaon, on the west.

Vegetation.—The vegetational complexes of Masbate Province comprise three main types; namely, forests, grasses, and the halophytes. Its distribution, characteristic habitat and coverage are very distinct from each other.

The forest vegetation consists of two kinds, the commercial and the non-commercial. They are either primary or secondary

forests. The commercial forest has a coverage of 64,930 hectares of primary and secondary forests or 15.97 per cent of the total soil cover of the province. Of these two classes of forests, several groups of commercial timbers are available for logging purposes, such as *narra, palosapis, tabigue, dao, molave, ipil, tangile,* white lauan, red lauan, and *kalumpit.*

The commercial forest resources are not very extensive in the whole area. First class timbers of the Molave type are said to be found in the island of Burias around Mount Engañoso. Other classes of commercial timbers are abundant in the south-east-central section of the mainland, somewhere around Mount Ulac, Conical Peak, and Bagulipat areas. A commercial saw-mill is also located within the Mount Ulac area. Secondary forests composed of *ipil-ipil,* rattan, and other soft woods are found in the northwestern and southeastern-central regions of the mainland.

The most extensive vegetal cover of the province is the grass type or the "parang" type of vegetation. It occupies almost three-fourths of the province. This piedmont country had distinguished the province of Masbate as one of the leading live-stock regions of the Philippines. In fact, cattle raising was once the most lucrative industry in Masbate.

The grass cover consists mostly of cogon, *talahib,* red top (torotanglad), vetiver, *amor seco* and other grasses common to pasture lands with cogon predominating. *Binayoyo* trees, brushes, and underbrushes are scattered on this area. This type of vegetation covers the greatest portion of the mainland, the whole of Burias and the northern section of Ticao Island.

The halophytes are generally the coastal and swampy vegetation of the salt water marshes fringing the shores. They are composed of nipa palms, *tabigue, bakauan, api-api, bangkal, alipata, dungon late,* and others. These trees are good sources of firewood, housing materials, tan barks and other uses. Nipa thatches are commercially prepared from nipa palms in sections where nipa stands are good. Masbate Province is supplying tan barks to the different provinces in the Visayan Islands where *tuba* is produced abundantly. Tan bark is also used in dying fish nets.

Organization and population.—The islands of Masbate, Ticao, and Burias were explored by Captain Luis Enriquez de Guzman in 1569. This exploration work was continued by Captain Andres de Ibarra. Through commerce and religion, Spanish influence became implanted over the early inhabitants of the Islands.

The island of Masbate, like Sorsogon Province, was at first a part of Albay. In 1846, it was separated from Albay and Guiom was made the capital while Ticao became a commandancia-politico militar.

TABLE 1.—*The actual soil cover of Masbate Province in 1946.*

Kind	Hectares	Percentage
Commercial forest	64,930	15.97
Non-commercial forest	17,829	4.38
Open and cultivated lands	310,692	76.33
Swamps (fresh marshes and salt water)	13,550	3.32
Total	407,001	100.00

During the early part of the revolution, Masbate, a sister province of Sorsogon, had also remained peaceful. The calmness of the people did not, however, last long. Through the influence of various uprisings in different places, like Samar and Albay, the people of Masbate, too, revolted against the Spanish rule, resulting in the killing of a Spanish *alferez* stationed there. A revolutionary government was established in Masbate for sometime.

Civil government, however, was organized on March 18, 1901. Several years later, Masbate lost her status as a province and was annexed to Sorsogon as a sub-province. Restoration of Masbate as an independent province came later through the passage of a bill creating same in 1921.

At present, the province is composed of twelve municipalities upon its creation in 1949, namely, Aroroy, Baleno, Balud, Cataingan, Cawayan, Dimasalang, Mandaon, Masbate (capital), Milagros, Mobo, Placer, and Uson. According to the Census of 1948, the province has a population of 211,113.

Prosperity in Masbate dates back as early as 1837. In that year, many settlers were attracted to the island by the news of the abundance of gold in the neighborhood of the present town of Aroroy. Chinese traders in considerable number flocked in the harbor of Aroroy to join the gold rush. From that time on, the growth of population was gradually increasing. This natural steady increase in population was sometimes accelerated by the immigration of families from the surrounding provinces. In those early times, the province offered several opportunities for better living because of her mining industries and extensive virgin lands. The population of Masbate is build up by a con-

glomeration of Filipinos having different creeds, customs, and dialects.

TABLE 2.—*Table showing the growth of population in Masbate from 1918 to 1948.*

Year	Population	Year	Population
1918	67,513	1937	171,200
1926	100,300	1938	178,700
1927	105,900	1939	186,300
1928	111,700	1940	194,200
1929	117,600	1941	202,100
1930	123,700	1942	210,200
1931	130,000	1943	218,600
1932	136,500	1944	227,000
1933	143,100	1945	235,700
1934	149,900	1946	244,500
1935	156,800	1948	285,000
1936	163,900		

Transportation and Market.—Although the accessibility of any place in the province is not very difficult, yet the facilities and means of communication are not as good and as fast as those in the Bicol Region.

As an island province, all sections or places along the coast are accessible by any form of sea transportation from the most crude banca and sailboats to landing barges, motor boats, and motor vessels, from any point of Masbate to other coastal places of other island provinces. The port of Masbate is a regular port of call for two shipping companies, namely, the General Shipping Company and the Maritima Lines Company whose routes are from Manila to Leyte and Samar. Several motor vessels are plying regularly between Masbate and Bulan, Sorsogon, via Batuan, San Fernando, and San Pascual in Ticao Island. There is another vessel plying between Masbate and Cebu via Cataingan. Several types of sailboats are used in carrying out the island to island and barrio to barrio trades.

Daily air transportation is available in Masbate except on Sundays. Regular plane trips from Manila to Tacloban call at Masbate, and vice versa. Plane trips between Masbate and Manila via Bulan, Legaspi, and Daet, are also available every Tuesday, Thursday, and Saturday. This facility provides the province with a much faster communication and contacts with the different cities of the archipelago aside from those offered by radio and telegrams.

Masbate, which is almost twice the size of Sorsogon, lacks the necessary road for faster communication and transportation, and ultimately for a more rapid agricultural development. Accessibility of important inland and coastal barrios and towns is indeed very wanting.

Figure 3. Road map of Masbate Province.

The province has a total road length of 222.6 kilometers of national and provincial roads aside from the unmaintained vecinal roads to some barrios. The different towns traversed by these road facilities are from Masbate to Milagros, Aroroy and part of Mandaon, in the northwestern part of Placer, and in the northeastern and eastern section of the mainland; and from Barrios Lagundi through Batuan, San Fernando, and San Jacinto in Ticao Island.

Land transportation is plying regularly between Masbate and the different municipalities traversed by these roads. The types and classes of vehicles range from jeeps to weapon carriers and to the latest passenger trucks. In remote areas, horses, carabaos, bull carts, and sleds are the only means used in transporting farm products.

The post office, tele-communication, and radio services are being carried out efficiently in the province and also in other provinces. Air mail services are included in those of the post-office. The above facilities are available in almost every town of the province. In addition, Milagros and Masbate have telephone connections.

Cultural Development and Improvement.—The most significant cultural feature of the province is the establishment of schools, either of the primary or elementary level, in every barrio or town. Public and private high schools and vocational schools are strategically distributed throughout the province so as to serve as many students as there are in the different regions.

To safeguard the health of the growing population, a provincial hospital is established in the capital of the province. Private and public clinics are also present. The Bureau of Health runs also a dispensary in every municipality.

Almost all the people of the province profess the Roman Catholic religion as compared to the followers of other religions, such as, the Protestants, Seventh Day Adventists, and others. Churches or places of worship are found in every town, in big barrios, and centers of population.

Industries.—Aside from the two major industries of the people which are farming and cattle raising, the other sources of livelihood are fishing, lumbering, mining, shoemaking, slipper manufacturing, and other minor home industries.

Fishing is seasonal and a very lucrative industry of the province for the present. Commercial fishing is mostly done in the southern and southwestern part of the province, although the waters around Masbate are known to be rich and fertile fishing grounds. Every fishing season, the fishermen from Samar, Leyte, Cebu, Negros, Panay, and Romblon flock to the southern and southwestern coastal towns, like Mandaon, Balud, coastal barrios of Milagros, Placer, and Cauayan. Several kinds and sizes of fishes are caught in these regions. Most of these fishes are dried and sent to other provinces, especially in Manila. Crustaceans are abundant in the hydrosol areas, especially in Milagros.

Lumbering is also one of its profitable industries. There is only one sawmill in the province with an extensive concession around Mount Ulac. Small concessioners usually use human power in lumbering. Several classes of lumber, ranging from first to fourth group, are found in the province. First class lumbers are generally used for furniture.

Mining as a source of the people's livelihood is not as profitable now as it was before the war. Rehabilitation of the mining industry is still expected.

Shoes and slippers as well as *bakia* making are also good sources of income. Leather is sometimes prepared by local tanneries or supplied from Manila. A good number of people are engaged in these industries.

Other minor home industries, like mat and hat weaving, pot making, and baking, usually augment family income.

CLIMATE

Climate may be defined as a composite or generalization of the variety of day-to-day weather conditions which are expressed by a combination of several atmospheric elements; namely, temperature, precipitation and humidity, winds, and air pressure. Weather varies from day to day and climate differs from place to place, because of variations in the amount, intensity, and aerial distribution of several weather and climatic elements, more particularly temperature and precipitation. The causes of these variations are due to climate controls, such as, (*a*) latitude or sun, (*b*) distribution of land and water, (*c*) winds, (*d*) altitude, (*e*) mountain barriers, (*f*) the great semi-permanent high and low pressure centers, (*g*) oceanic currents, (*h*) storms of various kinds, and a number of other minor ones. It is due to these controls, acting with various intensities and in different combinations, that changes in temperature and precipitation are produced, which in turn give rise to variations in weather and climatic conditions. Thus, we have several types of climate.

Figure 4. Sketch map showing the type of climate in Masbate Province.

While climate plays an active part in the formation of soils, it also affects the physiological functions of all economic plants, drainage characteristics, and to a certain degree, the nature of landforms.

There are two types of climate in the province; namely, the Third type and the Fourth type.

The third type of climate is characterized by one having no pronounced maximum rain period with short dry season lasting only from one to three months. The dry spell usually extends from February to May. This type of climate covers the whole of the Masbate mainland. Under this type, precipitation plays the most active part, yet sometimes it is considered the limiting factor. Rainfall ranges from 1,500 to 2,000 millimeters annually. Statistics on mean annual rainfall for the province is shown in the following table.

TABLE 3.—*The average monthly and annual rainfall observed in Masbate for a period of fifteen years (intermediate type A or Third Type of climate).*[1]

Month	Masbate Station (15-year period)	
	Rainy days	Rainfall (mm.)
January	16	181.8
February	11	139.3
March	9	55.7
April	5	36.9
May	8	79.1
June	11	135.5
July	17	189.3
August	15	162.8
September	16	185.7
October	15	143.3
November	16	183.5
December	17	220.5
Annual	156	1,713.4

Basing upon the figures in table 3, it is noted that the months having the least amount of rainfall are March, April, and May. While there is a fluctuation of rain period in any of the other months, the maximum rainfall was recorded in July, September, and December.

The fourth type of climate, which covers the whole island of Ticao and Burias, is characterized by one having no pronounced maximum rain period and no dry season. Both cyclonic and northeast monsoon rains as well as thunderstorms are experienced in this type of climate; not a single dry month occurs during the year.

[1] Data obtained from Census of the Philippine Islands, Volume 1, 1948.

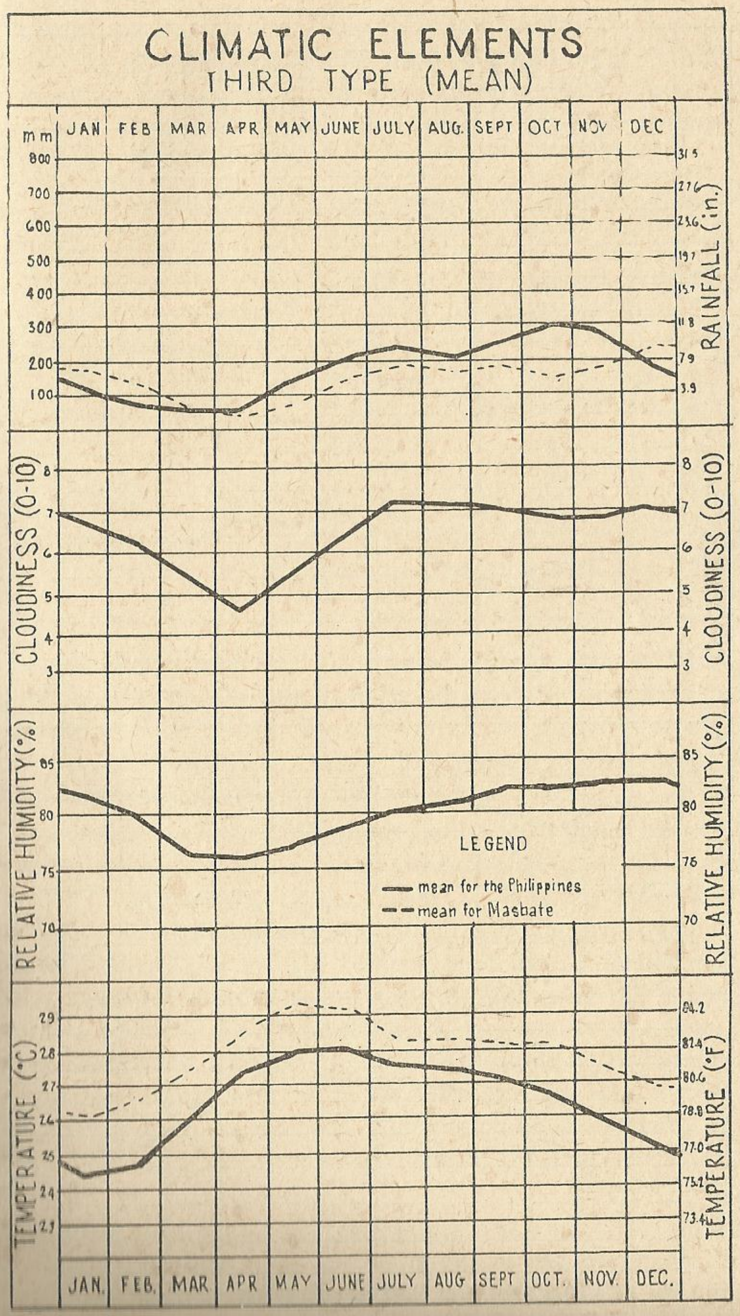

Figure 5. Graph of the third type of climate of the Philippines and of Masbate, Masbate.

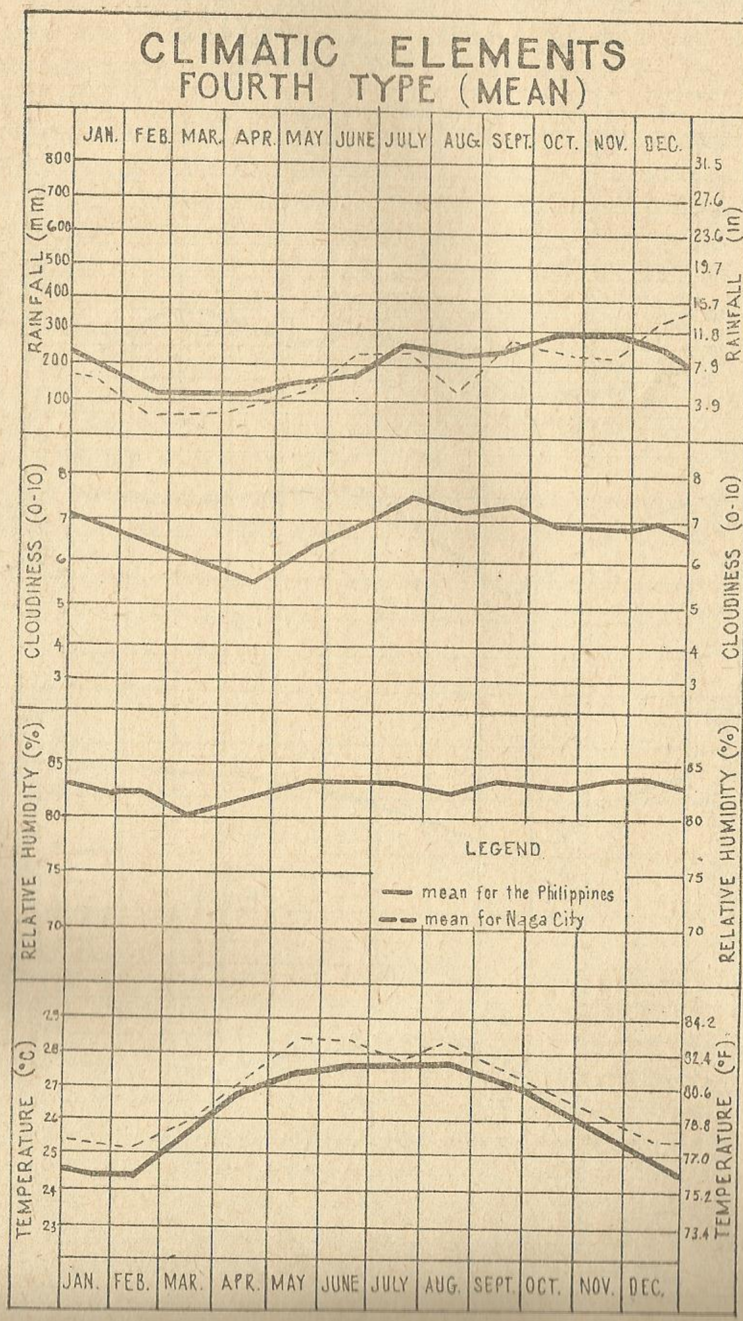

Figure 6. Graph of the fourth type of climate of the Philippines and of Naga City.

Inasmuch as Burias and Ticao Islands do not have observation stations, the observations taking place near the areas which are also enjoying the same climatic type are used, like Naga, Camarines Sur. Statistics on rainfall for this type of climate are shown in the following table.

TABLE 4.—*The average monthly and annual rainfall observed in Naga, Camarines Sur, representing the fourth type of climate*[1]

Month	Naga Station, Camarines Sur (14 years)	
	Rainy days	Rainfall (mm.)
January	11	131.4
February	8	82.9
March	7	59.1
April	6	84.2
May	10	127.1
June	14	202.6
July	18	254.6
August	15	156.9
September	17	298.5
October	15	271.6
November	15	266.9
December	17	338.5
Annual	153	2,254.3

The normal rainfall for this type of climate ranges from 2000 to 3000 millimeters annually. Based on the 14 years' figures the months of February, March and April have generally the lowest recorded rainfall. While September to November have high rainfall; December has the highest rainfall.

Temperature.—The Philippines is lying within the belt of maximum insulation and it is to be expected that the temperature will be uniformly high. There is likewise little seasonal variations with reference to the changes in the noon sun's position and little variations in the length of days and nights from year to year. The annual temperature range or difference between the warmest and coolest months is usually less than 5°C. It becomes evident from the very small temperature ranges that it is not the excessively high monthly average but rather the uniformity and monotony of this constant succession of hot months with no relief that characterized the tropical rainforest climate.

It is often said that a tropical climate is characterized by extraordinary regularity on the sequence of its diurnal monthly and annual changes of temperature as applicable to all stations in the Philippines.

[1] Data obtained from Census of the Philippine Islands. Volume 1, 1948.

As a rule, it seems that the annual minimum temperatures of the stations in which cloudy and rainy weather prevailing in winter are not so low as those of the stations situated in the central and western parts of the islands. This is particularly apparent in the Visayas and Southern Luzon.

There are also several factors which influence the ranges of temperatures in a locality, such as latitude, wind direction, rainfall, relative humidity, and wind pressure.

Under the third type of climate, there is no marked fluctuation of figures throughout the year. Even during the months of lowest rainfall, the rise in temperature over the coolest month (January) is less than 4.1°C. For a comparative temperature study by months, the following table is given.

TABLE 5.—*The means of the monthly and annual extreme temperature during the 11-year period of the third type of climate.*[1]

Month	Temperatures from 1909–1918		
	Maximum	Normal	Minimum
	°C	°C	°C
January	31.1	26.2	21.8
February	32.4	26.6	20.9
March	33.4	27.6	22.0
April	34.6	28.6	22.8
May	35.3	29.3	23.7
June	35.2	29.2	23.3
July	34.2	28.4	23.0
August	33.5	28.4	23.0
September	33.6	28.2	22.9
October	33.5	28.1	23.0
November	32.5	27.5	22.3
December	31.7	26.9	22.4
Mean annual	35.6	27.9	20.6

Going over the monthly figures, it is evident that there is a regularity of succession and very gradual rise of temperatures in the maximum, normal, and minimum for the province.

Under the fourth type of climate, the difference in the range of temperatures with that of the third type is very insignificant. It could be noted also that the temperature obtaining under the third type of climate is a little higher than the fourth type despite the fact that the rainfall in the fourth type is much higher than the third type.

The temperatures observed in Naga, Camarines Sur, are presented here to represent the data for the fourth type of climate prevailing in Ticao and Burias Islands.

The monthly temperatures typified under the fourth type of climate are characteristically approaching that of the tempera-

[1] Census of the Philippine Islands. Volume 1, 1918.

tures of the third type of climate in its regularity of succession. The rise and fall of temperature is more gradual in the fourth type than in the third type of climate.

Under the fourth type of climate, the hottest months are April, May, and June and the coolest are December, January, and February. Rainfall seems to have less influence on temperature.

TABLE 6.—*The means of the monthly and annual extreme temperatures under the fourth type of climate from 1908 to 1918*[1]

Month	Temperatures for Naga Station, Camarines Sur		
	Maximum	Normal	Minimum
	°C	°C	°C
January	32.2	25.1	17.7
February	32.7	25.0	17.0
March	33.9	25.9	17.2
April	35.0	27.0	18.9
May	35.9	28.2	20.0
June	35.5	28.2	21.5
July	34.8	27.9	21.9
August	34.8	28.1	22.0
September	34.4	27.7	21.8
October	34.0	27.0	20.0
November	33.2	26.3	19.3
December	32.5	25.6	18.4
Annual mean	36.1	26.8	16.4

Winds and storms.—The prevailing winds and their directions in the Masbate mainland may be relatively the same as that of Cebu and Iloilo, all of which are being under the same type of climate. The winds that prevail most during the year are those from the north-east northeast, north-northeast, southwest-west-southwest, northwest-north-northwest, and west-west-north-west. The annual percentage of calmness for Masbate is similar to that of Iloilo which is 12. This may be on account of a higher percentage of prevailing winds in the province.

The frequencies of typhoons or strong winds passing over the province occur during the months of September to December. The prevailing wind directions are west-northwest and west ranging from 8 to 18 miles per hour velocity.

Relative humidity.—Relative humidity is the most convenient expression for the amount of vapor in the air. It determines the needs of organisms for water and also control evaporation.

Generally, relative humidity in the Philippines is high in the atmosphere. The quantity of water vapor is due to (1) the extraordinary evaporation from the surrounding seas, (2) the richness of vegetation, (3) the different prevailing winds in the

[1] Census of the Philippine Islands. Volume 1, 1918.

different seasons of the year, and finally, (4) the abundant rainfall of a tropical country. The first two items may be considered as general causes of the great humidity which are generally observed in all the islands throughout the year, while the other two items may influence in a different degree the humidity of the different months of the year and of the different regions of the archipelago. Thus, in the wet season when the rain are so abundant in the eastern part of the Philippines owing to the prevailing northeasterly winds, the humidity must be greater there than in the western part where a dry season prevails. On the contrary, although the rain is quite evenly distributed from June to October throughout the archipelago, rain is more abundant in the western part of the Philippines, which is more exposed to the prevailing westerly and southwesterly winds. Hence, the humidity of the air is greater in the western part than in the eastern part of the archipelago.

The mean annual relative humidity of Masbate ranges from 76 to 80.3 per cent, under the third type or Intermediate A type of climate, while in the fourth or Intermediate B type of climate, where the islands of Ticao and Burias belong, is relatively the same as the mainland.

AGRICULTURE

The islands of Masbate, Burias, Ticao, and many other smaller islands lying west and southwest of the southernmost province of the Bicol Regions composed the province of Masbate. These groups of islands lie almost exactly in the center of Philippine archipelago. The province has an actual soil cover of 407,001 hectares. Of this total area, 64,930 hectares are commercial forests; 17,829 hectares are non-commercial forests; 13,550 hectares are swamps, fresh water marshes, and mangroves; and 310,692 hectares are open and cultivated lands.

The people of Masbate had been engaged in agriculture long before the arrival of the Spaniards in the island. The inhabitants depend principally on agriculture as their means of livelihood, and to some extent, on forest products and fishing. The inhabited coastal region were planted to coconuts, rice, corn, and many other root crops. With the occupation of the island by the Spaniards, the livestock industry was introduced. The islands formerly devoted to crops and other clearings were converted to grazing lands. The cattle industry flourished and made Masbate one of the leading cattle exporting regions in

the Philippines until the outbreak of World War II. Because of the disastrous effects of the war, the livestock industry practically perished and except for a few pastures, the rest were neglected and abandoned. The abandoned pastures suited to agriculture are now being cultivated and planted with rice, corn, and other crops. Dry farming is generally practiced in these areas due to the topography of the land.

CROPS

Masbate, which was once one of the leading cattle regions of the Philippines before the war, is fast becoming more of an agricultural province. The total farm area in 1948 was 122,498.44 hectares with a total farm produce valued at 14,691,670 pesos. The important crops are coconuts, corn, rice, sweet potato, cassava, sugar cane, ubi, tobacco, abaca, and root crops.

TABLE 7.—*Area, production, and value of produce of ten leading crops of Masbate in 1948.*[1]

Crop	Area (*Hectare*)	Production	Value (*Pesos*)
1. Coconut	27,964.32	84,765,027 nuts	5,571,979.00
2. Corn	31,370.54	300,090 cav	3,166,900.00
3. Rice	15,382.80	249,859 cav.	2,452,503.00
4. Sweet potato	5,394.46	9,361,670 Kg.	1,025,659.00
5. Cassava	2,913.76	4,947,976 Kg.	491,692.00
6. Sugar cane	75.55	3,209 tons	232,537.00
7. Ubi	517.87	876,587 Kg.	129,537.00
8. Tobacco	522.77	121,777 Kg.	111,957.00
9. Gabi	485.89	424,977 Kg.	76,567.00
10. Abaca	88.60	37,065 Kg.	30,720.00
Total	84,716.56	----------------	13,290,051.00

Coconut.—Coconut is the leading export product and the most extensively grown crop in the island based on the area planted and value of production. Most of the coconut plantations are located along the coastal regions, on the hilly areas in the interiors, and along the rivers. The total area planted to coconuts in 1948 was 27,964 hectares or 40.02 per cent of the total farm area of the province. The production for the same year was 84,765,027 nuts valued at 5,571,979 pesos. Of the total 3,252,159 number of trees, 2,411,174 are bearing trees or 74.14 per cent of the total number. In the same year, 11,446 trees were tapped for *tuba* which gave a produce of 2,371,271 liters of juice valued at 367,580 pesos.

[1] Data from Agricultural Census of the Philippines, 1948.

Corn.—Corn is second to coconuts in value of production. However, it covers the widest area planted of all the cultivated crops. In 1948, the total area planted to corn was 31,370.54 hectares or 44.74 per cent of the cultivated area with a total production of 300,090 cavans valued at 3,166,900 pesos. In the southern part of the province in the Cataingan area where the people are mostly Cebuanos, corn is found in great abundance it being the staple food of these people. Even in the rice-eating regions, corn is principally substituted for rice during times of scarcity or high price of this cereal. Corn is grown throughout the year as wet and dry season crops. The farmers do not practice crop rotation and it is a common practice to interplant corn with upland rice. Corn is commonly grown in level uplands, in undulating and moderately rolling areas, and in the *kaingin* clearing in hill slopes. Corn plantings in *kaingin* are temporary. After two or three croppings, these areas are abandoned due to low yields especially after the thin topsoils have already been eroded. The common varieties planted are the Cebu white, yellow flints, and the glutinous corn.

TABLE 8.—*Area, production, and value of produce of corn in Masbate in 1948*[1]

Cropping	Area	Production	Value
	Hectare	*Cavans*	*Pesos*
First crop	17,652.18	183,456	1,934,734
Second crop	9,499.93	81,197	859,657
Third crop	4,218.43	35,437	372,509
Total	31,370.54	300,090	3,166,900

Rice.—Rice is the staple food of the majority of the people and it is grown in almost all the farms in the province. It is the third most important crop based on the area planted and production. In 1948, the total area planted to rice was 15,382.80 hectares or 22.01 per cent of the total cultivated area of the province. Of this area, 5,878.78 hectares were lowland rice fields of which 383.55 hectares were irrigated and 5,495.23 were non-irrigated. The production for the same year was 249,859 cavans valued at 2,452,503 pesos. The upland rice fields cover wider area than the lowland rice fields principally due to the natural topography of the land. Upland rice fields cover slightly rolling and low hilly areas while the lowland rice fields are found on level or nearly level plains and valleys between hill slopes. Lowland rice fields are mostly non-irrigated and are entirely dependent on rain for its water supply. A very insignificant area with irrigation water depends mostly on dammed creeks and small river tributaries. The common lowland rice varieties grown in Masbate are *Quezon rice, Elon-elon, Inapostol, Milagros, Modbod, Kinalwayan,* and *Guinangang*. The important upland rice varieties are *Macan Tago, Bisaya, Baranay, Kinanda, Binondoc, Magintic, Guios, Pinili Puti,* and *Pinili Pula.*

[1] Data taken from Census of Agriculture, 1948. Bureau of the Census and Statistics, Manila, Philippines.

Sweet potato.—Like cassava, sweet potato is grown widely in the province as a substitute for either rice or corn in time of cereal shortage or crop failures. It is also economically used as animal feeds. In 1948, the total area planted to this crop was 5,394.46 hectares or 7.68 per cent of the total cultivated area with a total produce of 9,361,670 kilograms valued at 1,025,659 pesos. Sweet potato is grown as a secondary crop in friable and sandy alluvial soils and in *kaingin.*

Cassava.—Cassava is another important root crop of the province which is used as a substitute for rice and corn in times of cereal shortage. In 1948, the total area planted to cassava was 2,913.76 hectares or 4.18 per cent of the total cultivated area of the province. Cassava farms are found mostly in undulating and rolling areas or newly cleared *kaingin.*

Sugar cane.—Sugar cane is only grown for home consumption in Masbate. There is no sugar central in the province and sugar cane juice are extracted by native sugar cane crushers for the manufacture of muscovado sugar and *basi.* Only 75.55 hectares or 0.10 per cent of the cultivated area is being utilized for sugar cane. The area and production are as follows: 48.23 hectares for *panocha* and *muscovado* sugar with a produce of 2,429 tons valued at 210,101 pesos; 26.31 hectares for chewing cane valued at 20,752 pesos; and 1.01 hectares for *basi* with a production of 20,497 liters valued at 2,049 pesos.

Fruits.—Fruits are not abundant in Masbate and there is no commercial orchard farm like those found in Batangas and Laguna. The fruits sold in the market are produced from backyards, small patches of orchards, and hill slopes. Banana is the most common fruit sold in the market. *Latundan, bungulan,* and *butuan* are the common varieties grown in the province. Aside from bananas, jackfruit, pili, papaya, mango, cacao, kapok and *calamansi* are also found in Masbate.

TABLE 9.—*The production of five leading fruit trees and value of produce in 1948.*[1]

Fruit tree	Production	Value in pesos
1. Banana	1,036,376 bunches	696,952.00
2. Jackfruit	476,880 fruits	122,117.00
3. Pili	218,989 kilos	65,613.00
4. Papaya	572,021 fruits	55,328.00
5. Kapok	108,063 kilos	45,527.00
Total		985,537.00

Vegetables.—Vegetables are not grown commercially and this accounts for its limited supply in the markets. The supply of vegetables are coming from Manila and other provinces, while only a small quantity comes from backyards and home gardens. The vegetables commonly grown as garden crops are onions, eggplants, tomatoes, mustard, lettuce, ampalaya, arrowroot, blackpepper, ginger, mungo, peanut, squash, and upo. Cabbage is quite difficult to grow in the province.

Other plants of economic value.—Some plants of economic importance are cogon, nipa, *anahao*, *buri*, and bamboo. Cogon covers practically all the lands not cultivated to crops and pasture lands. It is the principal feed for livestock. Nipa is abundant along the hydrosol areas. It is a very important source of roofing materials. *Anahao* and *buri*, aside from being used as housing materials, are wooven into bags for rice storage and mats used in drying palay. Bamboo has varied uses and is principally preferred in light building construction.

AGRICULTURAL PRACTICES

The farmers of Masbate depend mostly on the carabao as its main source of power and the native plow and harrow as the principal implement for cultivation. The use of modern farm machineries to till the land is only limited to a few farmers. The Masbate farmers, like the ordinary farmers throughout the Philippines, are conservative in their way of farming. But there is now a marked change in their attitude towards better farming practices as disseminated by the various government agencies under the Department of Agriculture and Natural Resources. Demonstration and experimental field tests in various

[1] Data taken from the Census of Agriculture, Bureau of the Census and Statistics, 1948, Philippines.

places have shown the farmers the actual difference in field performance and yields of crops grown under different tests subjected to the use of better propagating materials and seeds, application of the right kind and amount of fertilizers and soil amendments, application of insecticides and fungicides to lessen incidence of pests and diseases, and the use of better farm tools and implements for land preparations.

Kaingin system of farming is predominant even in the forest zones of the interiors, much more so where it is inhabited by Cebuanos who are usually noted for this system of farming. This method of farming is very destructive as it promotes rapid erosion of the rich topsoil in sloping and rolling areas. It should be totally discouraged to prevent further soil destruction and the common practice of abandoning their clearings and moving to new virgin lands after two or three consecutive plantings. The thin topsoil that is being washed away depletes the land of its fertility, causing poor production on the land, so that the farmers could hardly subsist on the produce. The only conservation measure that the farmers have been practicing unconsciously is the building of dikes in lowland rice fields to conserve the water in the paddies and to minimize the loss of soil from higher areas. Irrigation system are few.

LIVESTOCK AND POULTRY INDUSTRY

Before World War II the livestock industry of Masbate Province was much more developed than crop farming. The area devoted to pasture was 100,552 hectares or 24.69 per cent of the total soil cover of the province. Cattle raising was the most important industry of the province. Masbate Province ranks with Bukidnon as the major cattle producing region of the Philippines. Ships call at Masbate ports to load livestock and poultry products for Cebu and Manila markets. Cattle and carabaos are the major animals for export. The other livestocks found in the province of lesser importance are buffaloes, horses, goats, hogs, chickens, ducks, geese, and pigeons.

Because of the war, a great number of herds was commandered by the enemy and slaughtered for consumption during the occupation period. The industry suffered a great set back. Pastures were neglected and abandoned. It will take years before the industry could be rehabilitated to attain its pre-war status. After the war, the animals that survived served as the foundation stock of the present industry. Attempts made to rehabilitate the livestock industry by the Bureau of Animal

Industry were carried out with the introduction of Red Scindi and Nellore breeds from India as a first step in the rehabilitation program. More importations are made with FAO aids to secure foreign breeds from Australia, India, and the United States. The common breeds of cattle found in Masbate ranches are Nellore, Red Scindi, and the natives, mostly of beef type. Dairy farming is not so popular in the province as in Australia and the United States. Cattle are shipped to Manila and Cebu markets.

TABLE 10.—*The kind, number, and value of livestock in Masbate Province in 1948.*[1]

Kind of livestock	Number	Value (*Pesos*)
Cattle	5,302	409,474
Carabaos	32,406	2,706,137
Hogs	44,938	1,184,825
Horses	3,856	215,038
Goats	1,593	10,535
Buffaloes	74	9,118
Sheep	28	168
Total	88,197	4,535,295

TABLE 11.—*The number and value of poultry in Masbate in 1948*[1]

Kind of poultry	Number	Value (*Pesos*)
Chicken	284,267	219,727
Ducks	2,706	4,064
Geese	16	78
Turkeys	15	114
Pigeons	27	19
Total	287,031	224,002

FARM TENURE

Farmers or farm operators in the province are classified into four classes; namely, (1) owners or farm operators who work on all the land they own, (2) part owners or farm operators who own part and rent or lease other parts of the land they work on, (3) managers or farm operators who supervise the work of the farm for land owners and receive wages or salaries or share of the crops for their services, and (4) tenants or farm operators who rent or lease from others all the land they work on. The tenant class is further subdivided into three groups; namely, (*a*) share tenant or those who rent the land they work on and pay as rent a share of the crop or crops grown, (*b*) cash tenant

[1] Data taken from Census of the Philippines, 1948.

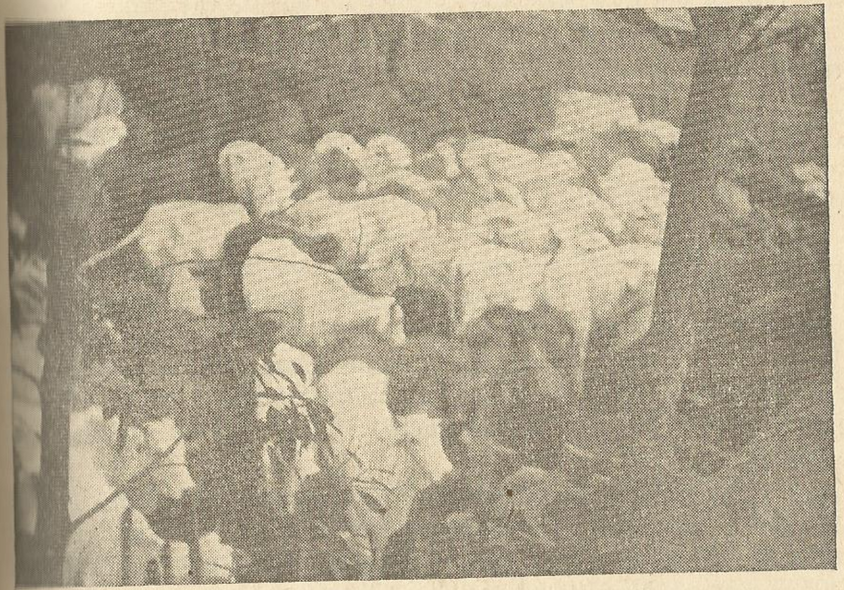

Figure 7. The animals that survived the war served as the foundation stock of the present livestock industry of Masbate.

or those who rent the land they cultivate and pay as rent a specified amount of money or a definite quantity of crop or crops grown, and (*c*) share-cash tenant or those who rent all the land they work on and pay as rent a share of the crops in addition to a specified amount of money.

TABLE 12.—*Number, area, and percentage of farms in Masbate Province by tenure of farm operation*[1]

Operator	Number	Per cent	Area (*Hectare*)	Per cent
Owners	15,495	67.47	86,460.49	70.59
Part owners	519	2.26	3,984.98	3.25
Managers	5	0.02	106.83	0.09
Tenants:				
Share tenants	3,987	17.36	16,310.96	13.31
Cash tenants	63	0.27	1,969.69	1.61
Share-cash tenants	10	0.24	153.61	0.12
Other tenants	2,888	12.58	13,511.88	11.03
Total	22,967	100.00	122,498.44	100.00

The farmers of Masbate, like those of the other provinces in the Philippines, have their system of sharing products between tenants and landowners.

The following conditions are generally practiced in the sharing of major crops, like corn, coconuts, and palay:

[1] Data from Census of the Philippines, 1948.

(1) In a newly opened lowland ricefields, the tenant builds the dikes and for first two or three years, he gets all the harvests from the land he works on.

(2) In old lowland ricefields, with paddies already constructed, if the tenant owns the work animals, farm implements, supplies, labor, seeds, and other expenses, he gets two-thirds of the harvest and one-third goes to the landowner, after deducting the seeds from the harvest.

(3) If the tenant supplies the labor and other farm expenses and the landowner furnishes the work animals and seeds, the tenant and the landowner share equally.

(4) If the tenant suplies the labor alone and the landowner provides the work animals, seeds, and farm expenses, the tenant receives one-third of the harvest and two-thirds goes to the landowner.

(5) In the upland ricefields, it is a common practice for the tenant to pay the landowner as rent for the use of the land two cavans of palay for every hectare of land cultivated or for every one cavan of seed planted. Sharing in the case of corn is very similar to that of palay.

In coconuts the sharing systems are:

(1) If the tenant takes care of the plantation during the fruiting stage, shoulders the expenses incurred for clearing the plantation, gathering of nuts, and making of copras, he receives half of the sales of the produce.

(2) If the tenant takes care of the plantation during the fruiting stage and the expenses incurred in clearing the plantation, gathering of nuts, and the making of copras are shouldered by the landowner, the tenant receives only one-third of the sales of the produce.

(3) If the tenant plants the coconut seedlings in the plantation, he receives ₱0.50 to ₱1.00 per coconut tree after two to three years from the date of planting.

TYPES OF FARMS

There are twelve kinds of farms classified in the province, namely:

(1) Coconut farms—50 per cent or more of the cultivated area is planted to coconuts.

(2) Corn Farms—the area planted to corn is equal to 50 per cent or more of the cultivated land.

(3) Palay farms—the area planted to lowland and upland palay is equal to 50 per cent or more of the cultivated land.

(4) Root crop farms—50 per cent or more of the cultivated area is planted to root crops.

(5) Fruit farms—the area planted to fruits is equal to 50 per cent or more of the cultivated land.

(6) Abaca farms—50 per cent or more of the cultivated land is planted to abaca.

(7) Sugar cane farms—50 per cent or more of the area cultivated is devoted to sugar cane.

(8) Tobacco farms—the area planted to tobacco is 50 per cent or more of the cultivated land.

(9) Vegetable farms—the area planted to camote, mungo, soybeans, tomatoes, sitao, cowpeas, patani, beans, cadios, onions, radishes, eggplants, cabbages, gabi, watermelons, and potatoes is 50 per cent or more of the cultivated area.

(10) Livestock farms—have (*a*) an area of ten (10) hectares or more, (*b*) more than ten (10) heads of cattle, horses, goats, and sheep, and (*c*) less than 20 per cent of the total farm area utilized for the production of crops, fruits or nuts.

(11) Poultry farms—more than 300 chickens or 200 ducks are being raised in an area of not less than 2 hectares of land.

(12) Other farms—could not be classified under anyone of the above farms.

TABLE 13.—*The types of farms, number, and percentage of each in Masbate Province in 1948.*[1]

Type of farm	Number of farm	Per cent
1. Coconut	5,031	32.57
2. Corn	4,502	29.06
3. Palay	1,902	12.32
4. Root crop	438	2.40
5. Fruit	199	1.23
6. Abaca	16	0.10
7. Sugar cane	12	0.08
8. Tobacco	4	0.02
9. Vegetable	3	0.02
10. Livestock	1	0.01
11. Poultry	1	0.01
12. Other farms	3,386	22.18
Total	15,495	100.00

SOIL SURVEY METHODS AND DEFINITIONS

Soil survey is an institution devoted to the study of soils in their natural habitat. It consists of (1) the determination of

[1] Data from Census of the Philippines, 1948.

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

The soils, their landscape and the underlying formations are examined in as many sites as possible. Borings with the soil auger are made, test pits are dug, and exposures such as road and railroad cuts are studied. An excavation or road cut exposes a series of layer or horizons in succession called collectively the soil profile. The horizons of the profile as well as the parent material beneath are studied in detail, and the color, structure, porosity, consistency, texture, organic matter content, root penetration, and presence of gravels and stones are noted. The reaction of the soil and its lime and salts contents are determined. The drainage, both external and internal, and other features such as relief of the land and climate, as well as the natural and artificial features, are taken into consideration and the relationship of the soil and the vegetation and other environmental features are studied.

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

A series is a group of soils that have the same genetic horizons, similar important morphological characteristics, and having similar parent material. It comprises soils having essentially the same general color, structure, consistency, range of relief, natural drainage conditions, and other important internal and external characteristics. In the establishment of a series, a geographic name is selected, usually that of the locality where the soil was first identified. For example, the Cataingan series was first found and mapped in the vicinity of Cataingan proper, province of Masbate.

A soil series has one or more soil types which are defined according to the texture of the upper layer of the soil known as

surface soil. The class name such as sand, loamy sand, sandy loam, silt loam, silty clay loam, clay loam, or clay, is added to the series name to give a complete name to the soil. For example, Cataingan clay is a soil type under the Cataingan series. The soil type, therefore, has the general characteristics as the soil series except for the texture of the surface soil. The soil type is the principal mapping unit. Because of certain specific characteristics, it is usually the unit to which agronomic data are definitely related.

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

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

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

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

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

THE SOILS OF MASBATE

The soils of Masbate maybe divided into three general classes; namely, (1) soils of the plains, (2) soils of the uplands, and (3) miscellaneous land types. Each of this land type is further subdivided into several independent soil bodies—as soil series, soil type, and phases—based on their individual and distinct characteristics as exhibited by each. The soil type is the unit of classification and study in the field and to which plant behaviors and responses are correlated.

These soils are classified and mapped as follows:

I. Soils of the Plains:

1. Mandawe loam
2. Sorsogon clay loam
3. Batuan clay
4. Macabare clay loam
5. Panganiran clay

II. Soils of the Uplands:

1. Ubay clay
2. Ubay sandy loam
3. Ubay clay, steep phase
4. Cataingan clay
5. Cataingan sandy loam
6. Sevilla clay
7. Bolinao clay
8. Himayangan sandy clay loam
9. Faraon clay

III. Miscellaneous land types:

1. Hydrosol
2. Beach sand

SOILS OF THE PLAINS

The plains of the province are limited only as small notches along the coast bordering the big rivers and narrow interior valleys. Most of these narrow coastal and alluvial plains are found in the northwestern, northern, and northeastern sections of the Masbate mainland extending from Aroroy district to Cataingan, and a small portion in Barrios Daraga and Masbaranon, Placer, in the southeastern prong.

The texture of the soils in these plain areas ranges from fine sandy loam, silty clay, sandy clay to clay. The variation in soil textures may be due to the degree of profile development, quantity, grade, and class of alluvium deposited and

TABLE 14.—*Soil types, their areas and present uses in Masbate Province.*

Soil type No.	Soil types	Area in hectares	Per cent	Present uses and/or vegetation
1	Hydrosol	16,928	4.16	Nipa, bakauan, and other halophytic plants.
118	Beach sand	5,704	1.41	Coconut, cogon, and big trees
612	Mandawe loam	3,692	0.92	Coconuts, peanuts, corn, and lowland rice.
613	Sorsogon clay loam	632	0.16	Coconuts, bananas, nangka, guayabano and mango.
214	Batuan clay	19,464	4.78	Under "parang" type of vegetation.
614	Macabare clay loam	260	0.06	Lowland rice, coconuts, bananas and root crops.
465	Panganiran clay	2,796	0.69	Coconuts, sugar cane, lowland rice, corn, tobacco, and root crops.
173	Ubay clay	86,273	21.16	Upland rice and corn; grazing land.
224	Ubay sandy loam	29,532	7.26	Upland rice, corn, coconut, bananas, and root crops; cogon and binayoyo; grazing land.
354	Ubay clay, steep phase	69,384	17.03	Upland rice, corn, cogon, binayoyo
357	Cataingan clay	66,444	16.35	Upland rice, corn, tobacco, coconuts, camote and other root crops.
358	Cataingan sandy loam	1,864	0.46	Upland rice, some portions under "parang" type of vegetation.
174	Sevilla clay	57,416	14.13	Grazing land; ipil-ipil and second growth forest; cleared portions are planted to rice and corn.
615	Himayangan sandy clay loam	31,176	7.64	Primary and secondary forests; perennial crops, corn, camote and cassava.
153	Bolinao clay	6,636	1.63	Upland rice, corn, peanuts, camote, cassava, bananas, coconuts, citrus, and other fruit trees
132	Faraon clay	8,800	2.16	Upland rice, corn, cassava, jackfruit, coconuts, bananas; cogon and forest trees.
	Total	407,001	100.00	

the parent materials. The subsoil and subsequent layers are generally heavier in texture, better structural development and consequently poorly drained. It must be mentioned also in this connection that the sources of alluvium are the surrounding uplands.

Most of the soils of the plains are devoted to the production of annual crops suitable to the area. For coarse-textured soils, peanuts, tobacco, corn, upland rice, and root crops are commonly grown. For fine-textured lowland soils, corn and lowland rice are predominantly planted. Perennial crops like coconuts, bananas, and fruit trees grow normally in any type of soil in the plain.

There are five soil types mapped under the soils of the plains of Masbate. These soils have a total area of 26,844 hectares or 6.61 per cent of the total soil cover of the province.

MANDAWE SERIES

The series is composed of soil types which usually meanders with the rivers. It is an alluvial formation made up of sediments carried down from the uplands and deposited on the flat lowlands by floods. The series was first studied and delineated in the province of Cebu. In Masbate, it is not found as extensive as that in Cebu. It appears as very narrow coastal and alluvial flood plains like deep notches in the northern coastal region.

Mandawe loam is the only soil type classified and mapped under the series. The typical characteristics of the series as found in Cebu and Masbate are manifested by the Mandawe loam.

Depth (cm.)	Characteristics
0–20	Surface soil, light brown to dark brown; coarse blocky; loam; moderately friable and slightly hard. Very gradual boundary between horizons. Free from coarse skeletons.
20–50	Upper subsoil, dark brown to dark grayish brown; coarse blocky; clay loam; slightly compact and hard. Free from coarse skeletons.
50–120	Lower subsoil, yellowish brown; moderately coarse and columnar; clay loam; slightly compact and hard. Free from gravels.
120–150	Mottled brown to yellowish brown; moderately coarse columnar; clay loam; slightly compact and hard. Sometimes gravelly.

Mandawe loam (612).—This soil type is an alluvial and narrow soil body or strip of flat lowlands which meanders or borders the Baleno and Rio Guinobatan Rivers in Aroroy, the lowlands bordering the Mobo and Mabunga Rivers in Mobo, and the Sta. Cruz River in Dimasalang. It has an aggregate area of 3,692 hectares or 0.92 per cent of the total soil cover of the province.

The soil type has a fair external and internal drainage under normal climatic conditions. The rivers are their natural drains. It has a light brown to dark brown, coarse blocky, loam, moderately friable and slightly hard when dry surface soil. The surface soil is about 20 centimeters deep, underlain by two subsoil layers, B_1 and B_2, which are dark brown to yellowish brown, coarse blocky to columnar clay loam, slightly compact and hard when dry. The substratum is mottled brown to yellowish brown, slightly compact and hard clay loam. The compactness and textural heaviness of the subsoil and substratum layers vary directly with the depth.

Mandawe loam is generally devoted to the growing of coconuts, peanuts, corn, and lowland rice. As noted, the limiting factors in the production of annual crops are poor cultural managements, moisture content, drainage, and flood hazards. But the farmer's neglect to use the soil properly is the principal cause of low production. The yields of corn and peanuts in this type of soil are 15 cavans and 20 sacks to a hectare, respectively, under normal condition.

Successful farming in this type of soil could easily be attained through better land preparation or cultural methods, using better seeds, proper timing of planting, and keeping good moisture condition. Its productivity and adaptability to crop production are very favorable to good yields.

SORSOGON SERIES

The soils under the Sorsogon series generally belong to a profile group of soils composed of young alluvial fans, flood plains and other secondary deposists having a slightly developed profile underlain by consolidated materials. These groups have a characteristically slightly compact subsoil horizon. The alluvium from which the soils have developed is the clay silted sand washed down from the surrounding uplands.

The general landscape of the series ranges from nearly level to gently undulating and slightly sloping relief. Elevation ranges from sea level to almost 200 feet above sea level. The landscape is well dissected by rivers and creeks. The drainage is rather poor in the coastal areas and fair inland especially along the rivers and creeks. The internal drainage is also poor in flat relief and fair to good in elevated sections.

Sorsogon clay loam (613).—This is the only soil type mapped under the Sorsogon series. The profile characteristics typical of the series are exhibited by the Sorsogon clay loam as follows:

Depth (cm.)	Characteristics
0–35	Surface soil, light brown, grayish brown to yellowish brown clay loam; fine granular to coarse columnar. Slightly plastic to soft when wet and friable and crumbly when dry. Smooth and abrupt boundary to the next layer. Sometimes few gravels are present. Mottlings intensify with depth. Fair in organic matter content.
35–65	Subsoil (B_1), grayish brown to rusty brown sandy clay loam. Structureless to cloddy and compact. Slightly plastic when

	wet and crumbly to brittle when dry. Boundary is abrupt and smooth to the next layer. Coarse skeletons are 80 per cent stones.
65–85	Subsoil(B_2), orange brown to grayish brown mottled gray with fine red streaks; medium sandy loam to loamy sand. Structureless, porous, and very friable. Smooth and diffused boundary from the next layer. Free from stones and gravels.
85–130	Subsoil(B_3), grayish brown to light brown with streaks of rusty red, brick red, and red; fine sandy loam. Coarse granular to coarse columnar, slightly compact but soft when wet and crumbly to friable when dry. It is separated from the next layer by a clear and smooth boundary. Free from stones. There are plenty of insect burrows and root tunnels.
130–165	Substratum(C_1), grayish black to black, speckled brown, black, white, and red sandy clay. Medium to coarse columnar, compact and sticky when wet. Cloddy, brittle, and hard when dry. Abrupt and smooth boundary separates this layer from the lower substratum. Free from coarse skeletons.
165 and below	Substratum(C_2). These are layers of stones, gravels, and bouldery clay to sandy clay. Gray mottled reddish brown layer and stones with orange red coating or tinge are found in this horizon. Stones, gravels, and boulders increase with depth.

The soil series was first studied and classified in the province of Sorsogon. It is an extensive lowland soil along the coastal region usually made up of continuous strips of hydrosols and rolling uplands. In Masbate, it occurs as a narrow flat strip along the Mayngaran River, indenting the Masbate harbor. The only soil type mapped under the series in Masbate is the Sorsogon clay loam.

The area covered by the soil type is, however, negligible compared with the other lowland soils mapped in the province. It is presently planted to coconuts with few fruit trees like bananas, *langka, guayabano,* and mangoes. The production of these crops in this soil is fair. The stand of crops in this soil indicates that it is of medium fertility. Perennial crops are mostly grown in the Sorsogon clay loam.

PANGANIRAN SERIES

The Panganiran soil is one of the most fertile lowland soils in the province developed from alluvium washed down from the surrounding hills and limestone uplands. These areas are generally contiguous to limestone piedmont country. The relief is

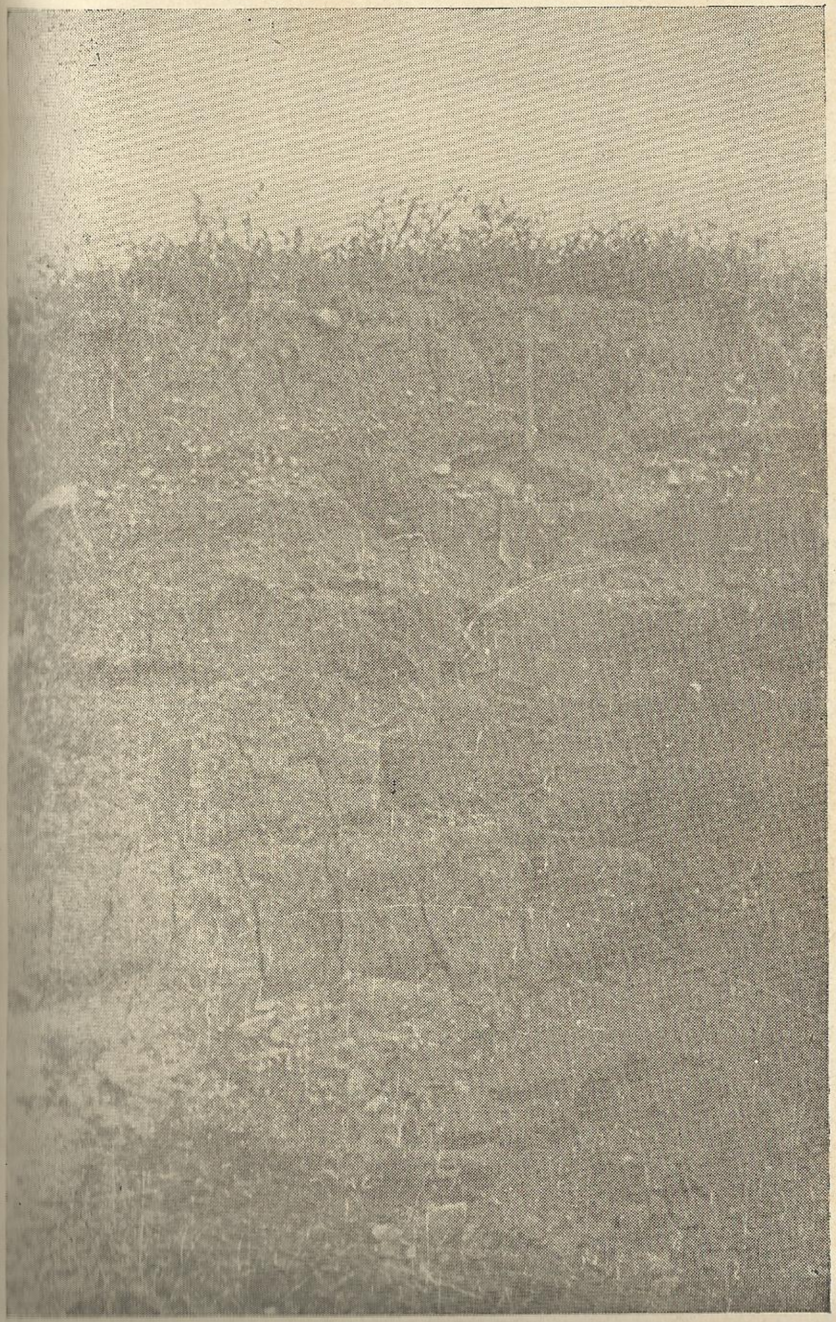

Figure 8. Profile characteristics of Sorsogon clay loam, an alluvial soil in Masbate.

PLATE 2

generally flat to almost level. The soil is not very extensive and it is usually found along the coastal indentures. The elevation ranges from 20 to 100 feet above sea level.

Drainage is generally fair. Sometimes the water table is high being reached only at 130 centimeters depth. The internal drainage is quite poor it being a heavy soil.

The surface soil is grayish black to black, medium blocky to columnar clay, cheesy, plastic when wet and slightly compact, crumbly to brittle when dry. The boundary to the lower layer is diffused and wavy and free from coarse skeletons. It is moderately high in organic matter content and well penetrated by roots. The depth ranges from 35 to 40 centimeters.

The subsoil is grayish brown, speckled gray, and yellowish brown, medium columnar, heavy clay, sticky and plastic when wet, and brittle to hard and cloddy when dry. It is separated by diffused and wavy boundary to the next layer, and free from coarse skeleton. The depth ranges from 60 to 70 centimeters. The lower subsoil is similar in color, structure, and consistency, with the upper subsoil, except that it is heavier in texture. The substratum is massive gravelly clay, very sticky when wet, slightly compact and hard when dry. It is separated by abrupt and wavy boundary. The depth is 100 centimeters below.

The soil is mostly utilized for diversified farming. Sugar cane, rice, corn, camote, vegetables, bananas, coconuts, and other crops are grown in this soil with a fair to good stand.

In Masbate, the Panganiran soils are found to be contiguous to calcareous and upland areas like the Cataingan soils. They appear as narrow coastal valleys fringing the southeastern coast of the province in the flat areas of Barrio Domorog and Gakit in Cataingan, and Barrio Pinangapugan in Uson.

Panganiran clay (465).—This is the only soil type mapped under the Panganiran series. It is an alluvial soil with flat to almost level relief.

The profile characteristics of the series are manifested by the Panganiran clay.

Depth (cm.)	Characteristics
0–40	Surface soil, dark gray to black; clay; medium blocky to columnar; cheesy and plastic when wet; slightly compact and crumbly to brittle when dry. Diffused and wavy boundary from the upper subsoil. Free from coarse skeletons. Moderately high in organic matter content. Well penetrated by roots.
40–70	Subsoil (upper), grayish brown to yellowish brown; heavy clay; medium columnar; sticky and plastic when wet and brittle to hard when dry. Boundary is diffused and wavy. Free from coarse skeletons.
70–100	Subsoil (lower). The characteristics are similar to that of the upper subsoil except that it is heavier and more dense.
100–150	Substratum, dark gray to gray; gravelly clay; very sticky and plastic when wet and hard and compact when dry. Limestone gravels are usually present.

There is an impeded movement of water from the surface soil to the substratum it being a heavy soil. Thus, the internal drainage is poor while the external drainage is fair due to the presence of intermittent streams dissecting the area.

The physical characteristics of the Panganiran clay are similar to any other heavy soil. It is a deep alluvial soil with a high water holding capacity. It has also a high capacity to store plant food nutrients. Because of its high organic matter content the field is easily prepared. Its adaptability to any annual crop cannot be over emphasized.

The soil is presently utilized to general farming. Crop diversification is well practiced in the area. Crops like sugar cane, rice, corn, tobacco, camote, cassava, bananas, coconuts, and other crops are grown in this soil with fair yields. Under upland condition the average yield of rice is about 15 to 25 cavans of palay to a hectare. Crop failures in the Panganiran clay may be attributed to poor soil management, soil acidity, lack of irrigation, and poor drainage.

Liming is quite necessary not only to neutralize soil acidity but also to improve the physical condition of the soil. Systematic crop rotation should be followed to maintain the high organic matter level and to improve the chemical and biological processes of the soil. Panganiran clay is not very extensive in area. It usually occurs as intermittent indentation of the coastal region of the province in the southeastern part. It has an aggregate area of 2,796 hectares or 0.69 per cent of the total soil cover of the province.

BATUAN SERIES

Batuan soils were first classified and mapped in the province of Bohol. The soils are represented by an almost level to slightly undulating areas northwest of Dayhagan River and between Masbaranon, Placer and Casabangan, Cataingan, in the southeastern tip of the province with the characteristic "haycock" hills over the area.

The soils are derived from the heavy creep soils eroded from the uplands and the weathering of the underlying calcareous sandstones, limestones, and shale. The impervious calcareous rock beneath retards the internal drainage of the area to such an extent that in some undulating sections sheet erosion is gaining a headway exposing the parent rocks.

The soils as found in Masbate are characterized by a dark brown to almost black and grayish brown clay surface soil, with a depth of 15 to 20 centimeters. It is medium to coarse granular, slightly sticky and plastic when wet and a moderate amount of concretions are present in the lower zone. It is crumbly when dry. Resting on a brown subsoil is reddish brown to strong brown, columnar, cheesy clay. The soil boundary is smooth and abrupt. The substratum is yellowish brown, highly weathered calcareous sandstone, shale, and limestone. Due to cultivation and moderate sheet erosion, concretions are present on the surface soil with a light brown to dark brown buckshots.

The vegetal cover of the area is mostly cogon and other grasses. Like the Cataingan soils, the relief, aside from having "haycock" hills, is further modified by numerous ant-hills scattered on the area. Batuan clay is the only soil type mapped under the series.

Batuan clay (214).—The typical profile characteristics of the series are exhibited by the Batuan clay as follows:

Depth (cm.)	Characteristics
0–20	Surface soil, dark brown, grayish brown to almost black and mottled brown clay. Black to light brown buckshot-like concretions are present. Boundary is abrupt and smooth. Good in organic matter content.
20–40	Subsoil, brown to orange yellow; cheesy columnar clay. Concretions are absent.
40–below	Substratum, yellowish brown, highly weathered sandstone and shale. Below this layer is weakly calcareous sandstone and shale. Coarse skeletons are absent.

The almost level coastal areas northwest of Placer between Barrios Masbaranon and Casabangan at the southeastern tip of the mainland and that area northwest of Dayhagan River in Aroroy are mapped under the Batuan clay.

The external and internal characteristics of the soil show the probability of converting the area into potential rice lands if irrigation is possible. The solum is underlain by a massive to laminated sandstone and shale that it can hold much of the water that falls on the area if the land is properly diked. Under the climatic condition prevailing in Masbate, any annual crop, especially rice and corn, will thrive in this soil.

The area, however, is not as extensive as that found in Bohol Province. The land was previously utilized for livestock farming. At present a considerable portion remains as fallowed land. The "parang" type of vegetation predominates the area. As practiced everywhere in Masbate, the grass is burned from time to time. This prevents the accumulation of organic matter and also promotes erosion.

This soil type is considered as the best cropland soil in the northwestern section of the province as far as the slope of land and climate are concerned. The solum does not only provide a good foothold for plant roots but also contains more plant food nutrients.

Batuan clay covers an area of 19,464 hectares or 4.78 per cent of the total soil cover of the province.

MACABARE SERIES

The series was first identified in the province of Sorsogon. It is an alluvial soil formation coming from the rolling uplands and in part deposition as influenced by tidal action.

The soil is characterized by a brownish gray, brown to reddish brown with brick red sandy loam to clay loam. It is coarse granular to columnar, soft to slightly sticky and plastic when wet. It is cloddy, brittle, and hard when dry. The upper subsoil is yellowish gray, light brown to yellowish brown with brown and black sandy loam to loamy sand. The lower subsoil is light brown, grayish brown mottled brown with coarse to medium sand and gravels. It is structureless and loose. The solum is resting on a grayish white mottled rusty and light brown coarse to medium sand below 150 centimeters deep. Animal burrows are abundant in the solum.

The soil generally covers a flat coastal plain dissected by small streams. Drainage is poor to fair as influenced by the water tide. The water table is around 130 centimeters high. The area is being utilized for the production of lowland rice, coconuts, bananas, root crops, and grasses which thrive well under slightly saline medium.

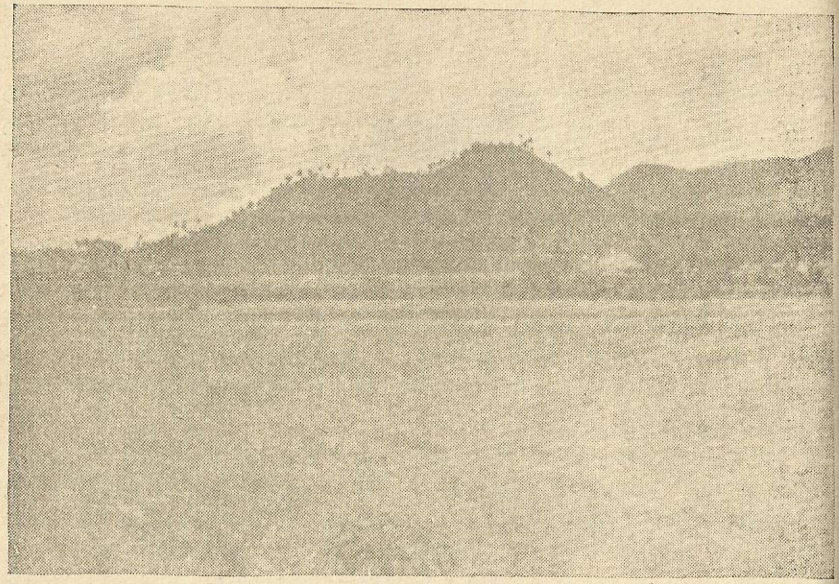

Figure 9. Landscape of the Macabare soils on a flat coastal plain.

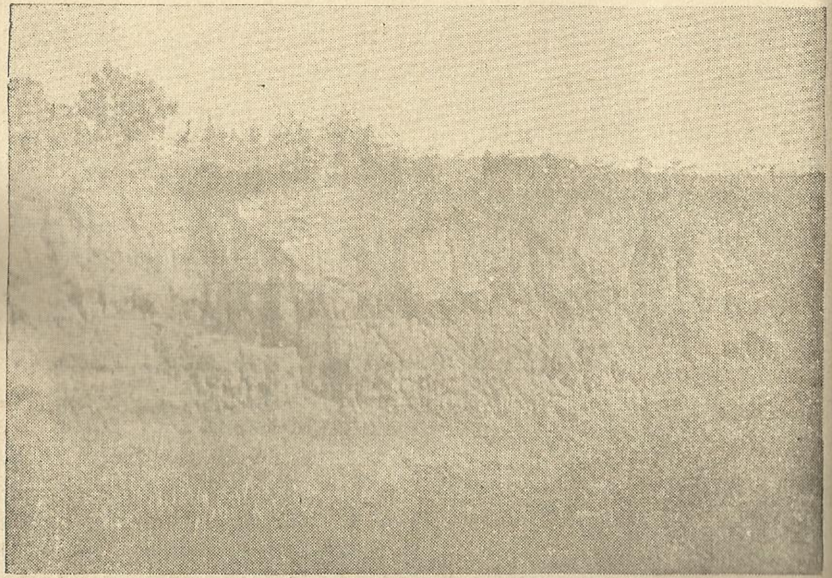

Figure 10. A typical profile of the Macabare series.

PLATE 3

Macabare clay loam (614).—The soil characteristics typical of the Macabare clay loam are described below.

Depth (cm.)	Characteristics
0–30	Surface soil, brownish gray to reddish brown and mottled crange brown, coarse columnar clay loam. Cloddy and brittle when dry. Boundary to the lower layer is clear and wavy. Insect burrows are abundant. Free from coarse skeletons.
30–80	Subsoil (upper), yellowish gray to yellowish brown with speckled gray orange and mottled dark brown, reddish brown and black; sandy loam or loamy sand. Structureless, slightly compact, friable, and loose. Gravels are sometimes present. Diffused and wavy boundary separates this layer from the lower layer.
80–150	Subsoil (lower), grayish brown, mottled light brown with white and reddish brown coarse and medium sand and gravels. Structureless, loose, porous, and friable. It is separated by a clear boundary from the substratum.
150 and below	Substratum, grayish white with mottled rusty and light brown, coarse and medium sand.

The Macabare clay loam was mapped in San Fernando, Ticao Islands, and Masbate. The lowland area in the San Fernando proper is generally devoted to coconuts and lowland rice. The extent of the soil type is approximately 260 hectares or 0.06 per cent of the total soil cover of the province.

The soil is deficient in plant food nutrients as shown by the stand of the crops. The average production of lowland rice in this soil varies from 18 to 20 cavans of palay per hectare. Macabare clay loam is also very low in organic matter content as indicated by the color, compactness, and cloddiness of the surface soil. These components have been lost through continuous cropping, burning, leaching, and cultivation. There is no system of crop rotation being practiced in the area. These deficiencies could be corrected temporarily for fast results by the application of commercial fertilizers. However, there are also ways of restoring back this land to a higher fertility level through a well-planned system of crop rotation, green manuring, application of organic fertilizers and soil amendments like guano, lime, animal manures, and compost. The process, however, requires a much longer period of time to attain.

Areas planted to perennial crops like coconuts and bananas show sign of normal growth. This could be explained by the fact that the root systems of these crops spread and penetrate deep enough to get the plant food nutrients carried down through leaching. The feeding zone of these crops is much wider than the annual crops.

Soils of the Uplands

The soils of the uplands cover all the undulating, rolling, and hilly to mountainous areas. These soils are generally devoted to cattle raising. The stand of grasses, which are mostly cogon, is quite poor as reflected by the soil condition due to over-grazing. Erosion is very active in such over-grazed areas so much so that gravels, stones, and even boulders outcropped the badly eroded sections.

The drainage conditions of the upland soils are usually very good to excessive. Most of the water drain to the nearby rivers and creeks as surface run-off or seepage at various degree of corrosiveness depending upon the texture of the soil, length and degree of slope, and volume of running water.

Upland soils are generally residual in nature developed from the sedimentary rocks like sandstone, calcareous and dolomitic limestone, shale, and conglomerates, and rocks of igneous variety. These parent materials or rocks acted upon by the active and passive factors of soil formation at different intensities give rise to upland soils having a distinct characteristics, a different life history, and a basic differentiation.

UBAY SERIES

This series was first mapped in the province of Bohol and was also found in Masbate. It covers almost one-half of the entire province. The soil was first studied in an undulating to rolling and hilly areas representing the lower and upper land terraces with "parang" type of vegetation such as cogon and vetiver grass predominating. The soils under the Ubay series are characterized by a light reddish brown, grayish brown to gray and black granular to lump clay, clay loam and sandy loam surface soils ranging in depth from 20 to 25 centimeters. The subsoil is brownish red to dark brown; columnar clay to gravelly clay; underlain by yellowish brown to brick red gravelly clay substratum resting on shale, sandstone, and conglomerate. Large amount of concretions are present in the layer below the subsoil and in the substratum. The concretions are soft and orange-coated.

Ubay series is the largest group of soils delineated in Masbate. It occupies roughly those area southwest of the Conical region; Barrios Alas, Tagpo, and Lanpian up to Cabuluan River; a great portion of the coastal region of Balud municipality from Mananca River southwestward; a great portion of Milagros municipality up to Malbug River extending inland to the western foot of Mt. Bagulipat; areas between Guiom River and Nainday River meandering inland in the southeastern prong; and those gently rolling areas of Barrios Dacu, Macabug, Laguna, Diot, and Umabay in the northeastern section of the mainland.

Ubay clay (173).—At optimum moisture content, the surface soil is granular, crumbly, and slightly compact clay. The subsoil is clay to gravelly clay, coarse granular to columnar, moderately compact and cloddy. It has a fair root penetration. But due to its compactness water has difficulty in percolating downward although the texture of the soil has an affinity to absorb.

The surface soil is generally shallow ranging in depth from 5 to 25 centimeters. The maximum depth is found in almost all level valley areas. By virtue of its slope and the nature of the solum, water is easily lost as surface run-off and seepage. Consequently, annual crops grown in the area, like upland rice and corn, suffer badly during the prolonged dry spell. The supply of plant food nutrients and organic matter are critically low in this soil as manifested by the stand of the crops, except in a few isolated places where the yields are high.

The suitability of this soil to farm crops could hardly be determined on account of several factors unfavorably existing. For lack of a good source of water this soil cannot be irrigated. The farming practices commonly followed in most cultivated areas are rather exploitative in nature. They lack the proper system of cropping which will ultimately build up the soil for a lasting basis. Field data show that upland rice production in some of these areas range from 20 to 40 cavans of palay per cavan of seeds planted.

A great portion of the area is devoted to grazing lands. It has an aggregate area of 86,273 hectares or 21.16 per cent of the total soil cover of the province. Grasses are occasionally burned during the dry season with the sole object of insuring good grass growth in the wet season. Consequently, the burning of the grass exposes the area to the agents of soil erosion.

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Sheet erosion claimed the greatest portion of the surface soil together with its humus and soluble plant food nutrient elements.

All areas not cultivated should at least be placed under a good leguminous cover throughout the year. A good system of crop rotation and better land use should be practiced. Commercial fertilizers and soil amendments should be applied judiciously in order to build up the organic matter content and to improve the physical, chemical and biological conditions of the soil.

Ubay clay, steep phase (354).—To identify the different soils in areas wherein due to their relief, soil conditions, and other factors, may render them unfit for extensive or intensive agriculture, the steep phase is conveniently used. The Ubay clay, steep phase is represented by cogonal areas which are roughly rolling, hilly, and mountainous. It is severely eroded with plenty of igneous and dolomitic rock boulders as outcrops. The area is well dissected by deep ravines, intermittent rivers and creeks. Because of its slope from 50 to 150 per cent, it is considered unfit for agricultural crops.

Most of the areas are under the "parang type" of vegetation with cogon and *binayoyo* trees predominating. Majority of the lands are utilized for grazing and the cultivated sections are planted to upland rice and corn. It is on these areas where erosion is very active for the reason that no conservation measures have been practiced to prevent or minimize accelerated erosion. Soil erosion has been increased greatly by the plowing up and down the slope of the land. As a consequence, crop yields have gone down year after year as a result of soil fertility depletion.

It is more practical to utilize this soil phase for cattle raising. Soil management should be done in such a way that grazing should be properly rotated to avoid over grazing; the area should always be under thick vegetal cover throughout the year to safeguard soil and moisture losses, and at the same time to increase the organic matter content of the soil; to improve the quality and quantity of forage grasses by fertilization and application of soil amendments rather than by burning; all soil conservation measures adapted to the soil, slope, and climatic conditions should be strictly observed; and all areas where the slopes are too steep for grazing land should be reforested to have a natural reservoir for moisture and simultaneously to improve the watershed for intermittent streams.

In sloping areas where upland farming is more practicable, the application of conservation measures necessary for such slopes should be adopted. Terracing, contour farming, and strip cropping are some of the practices suited for upland farming. The planting of perennial crops like fruit trees provided with good cover crops of legumes are necessary in this kind of land.

Ubay sandy loam (224).—The soil type covers the moderately undulating to gently rolling coastal areas contiguous to other Ubay soils. It occurs in two less extensive places. The area on the west facing the Looc and Nin Bays embraces the barrios of Gabi, Arayat, Canomoy, Manapnap, Buri, and Looc in the southwestern prong. While in the southeastern prong, it is that area between the Malbug River and Guiom River. It has an area of 29,532 hectares or 7.26 per cent of the total soil cover.

The external and internal characteristics of the Ubay sandy loam are similar to Ubay clay except in the texture of the surface soil which is sandy loam. The surface soil is rather deep, averaging about 40 centimeters. It is very friable, structureless, and slightly compact. Root penetration is deep. The organic matter content of the soil varies in the different places, but it is generally fair. The soil is easily placed in good tilth because of its good physical conditions.

The vegetal cover of the Ubay sandy loam is mostly cogon with few *binayoyo* trees scattered on the area. The land is generally utilized for grazing purposes, while a good portion is cultivated to upland rice, corn, coconut, bananas, camote, cassava, peanuts, and other food crops with fair yields. The cultivated areas represent a small percentage of the total hectarage of the soil type and a greater portion falls under the cogonal land. As a result of frequent cultivation, the surface soil becomes gravelly due to constant exposure of the subsoil concretions. Sheet erosion is found to be serious on cultivated rolling areas. Cogon does not, however, provide a good cover to prevent soil erosion. Erosion is further accelerated by faulty cropping system and the adoption of destructive farming practices which are very conducive to soil washing. Furthermore, the lack of a proper system of crop rotation depletes the soil at a very rapid rate. Soil conservation practices are practically unknown to all farmers, except in some lowland and flat upland areas which are incidentally terraced for lowland rice culture.

Figure 11. A typical landscape of Ubay soils. Relief is undulating to rolling.

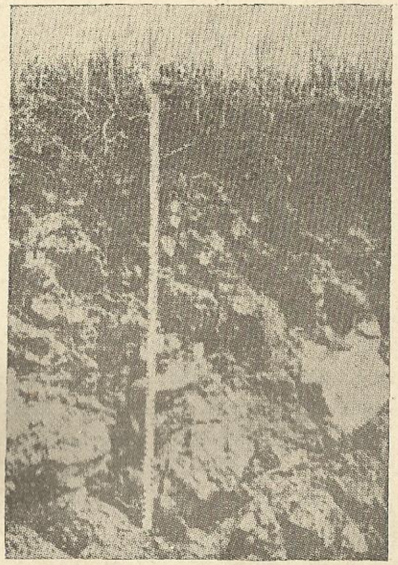

Figure 12. A profile of Ubay series.

PLATE 4

There is no definite system of farming in the area. The primitive methods of cultivation and soil management resulted in the rapid exhaustion of plant food nutrients in this soil. Provisions or measures in whatever form should be practiced in order to replenish and rehabilitate this soil, thus preventing it from becoming submarginal. Crops like rice and corn are heavy feeder of plant food elements, and when planted in this soil should be rotated with leguminous crops planted on the contour.

CATAINGAN SERIES

This is a residual soil of the transverse valley in the southeastern prong, developed from sedimentary rocks like calcareous limestones and gravelly sandstones at various stages of weathering. The relief ranges from undulating to moderately rolling. Minor surface configuration is evident by the presence of many anthills scattered over the grassy areas.

As the name implies, the soil series was first identified in Cataingan, Masbate. It is black, dark gray, brownish gray to reddish brown; fine granular to prismatic silty clay to clay; slightly sticky and plastic when wet, but friable to very crumbly when dry. Fair to good in organic matter content. The surface soil is from 10 to 15 centimeters deep. The upper subsoil is brownish black, reddish brown to grayish brown; heavy, cheesy, columnar clay with a depth of 15 to 40 centimeters from the surface. The layer has plenty of reddish brown and dark brown iron buckshot-like concretions. The lower subsoil is lighter in color, coarse to medium columnar and gravelly clay. Limestones and quartz-like gravels are present. In other places, rounded and smooth-surfaced stones and boulders are also found. The depth ranges from 40 to 60 centimeters. The solum rests on a brownish orange and grayish white gravelly clay admixed with 70 per cent highly weathered limestones and sandstones. It has a good external to fair internal drainage.

The Cataingan series is very similar to the Sevilla soils in all respects except for the presence of buckshot-like iron concretions in the upper subsoil of the former.

There are two soil types mapped under the series; namely, Cataingan clay and Cataingan sandy loam.

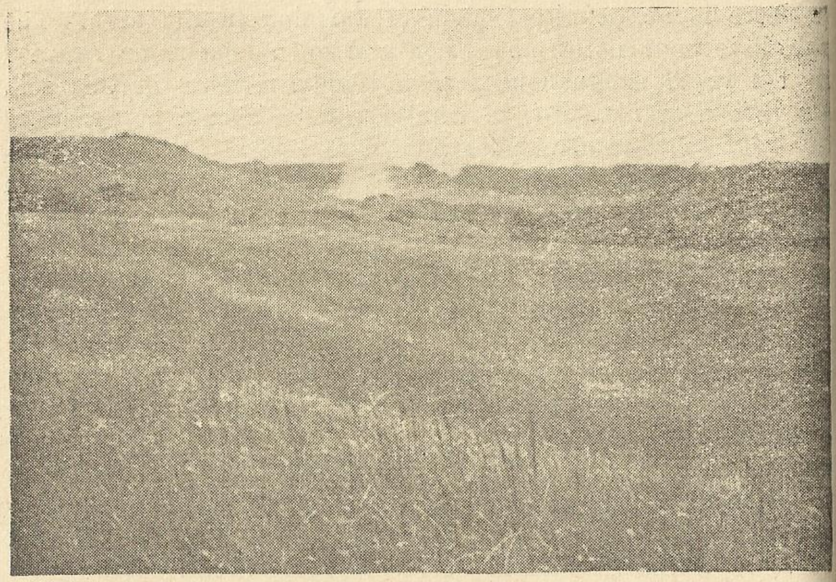

Figure 13. Diversified farming in Ubay soils is destructive due to lack of erosion control measures. Erosion class 2.

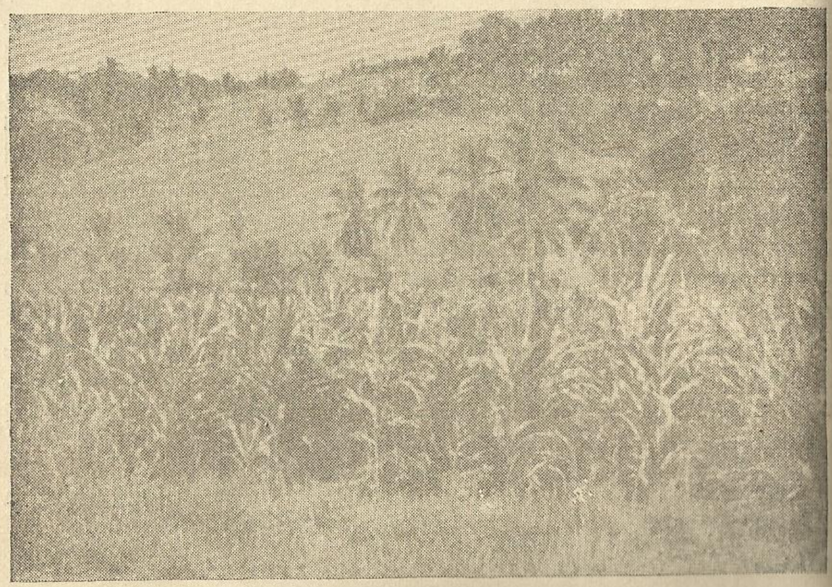

Figure 14. Stand of crops on Cataingan soils. Erosion class 2.

PLATE 5

Cataingan clay (357).—This is the most extensive and productive upland soil in Masbate. The following profile characteristics are typical of the Cataingan clay.

Depth (cm.)	Characteristics
0–15	Surface soil, black to dark gray and brownish gray to reddish brown; fine granular to prismatic clay. Slightly sticky and plastic when wet and crumbly when dry. Fair in organic matter. Diffused and wavy boundary to the lower layer.
15–40	Subsoil (upper), brownish black to grayish brown with mottled orange and brown; heavy, cheesy, and columnar clay. Sticky and plastic when wet. It is slightly compact, cloddy, and brittle when dry. It is separated by a clear and wavy boundary. Buckshot-like concretions are present.
40–60	Subsoil (lower), yellowish brown to grayish brown; gravelly clay; coarse columnar to medium blocky. Slightly compact, brittle and hard when dry. The boundary is diffused and wavy. Plenty of limestones and quartz-like gravels. In other places, water-worn stones and boulder deposits are also found.
60–150	Substratum, orange brown to grayish orange, mottled light gray and grayish white; blocky; gravelly clay admixed with plenty (70%) of weathered limestones, sandstones, and water-worn stones.

Cataingan clay covers almost entire Ticao Island, the islets of Masbao, Magkaragit and Deagan, including that broad transverse valley from Barrio Sta. Cruz in Dimasalang to Cataingan proper on the northeast; Sta. Cruz and Nainday Rivers on the northwest contiguous to Batuan hydrosol and beach sand areas, and extending to Barrio Domorog in the south, joining the Cataingan boundary to Barrio Paljo in the southeast. The soil type has a total area of 66,444 hectares or 16.35 per cent of the total soil cover of the province.

Although the Cataingan clay has a characteristically shallow surface soil, it is still considered the best producing soil for rice and corn in the province. The solum is sufficiently deep with good amount of organic matter and plant nutrients as shown by the vigorous conditions of the plants. The soil is easily prepared to good tilth at optimum moisture condition. Granulation is good, permitting good aeration and a high capacity for water absorption. Some areas intensively cultivated to annual crops are beginning to show signs of decreased yields primarily due to soil erosion, over cropping, and lack of good cropping system.

Most of the areas are devoted to the production of corn, rice, tobacco, coconut, camote, cassava, peanuts, bananas, and other fruit trees with fair to good yields. Upland rice produces an average yield of 20 to 45 cavans of palay per cavan of seeds planted; tobacco, ten (10) quintals to a hectare; and corn, 15 cavans shelled corn to a hectare.

Erosion hazard in this particular soil type is chiefly attributed to clean culture farming being practiced by the people. However, the effects of erosion is not very much felt owing to its gentle and gradual relief. Its effect is somehow being manifested by the constant decline in crop yields year after year. In order to safeguard and minimize the soil from being washed away and at the same time maintain its fertility at a high productivity level, the soil conservation way of farming should be followed by every farmer in the province. Plowing up and down the slope should be replaced by contour plowing. Cover-cropping, green manuring, and crop rotation should be practiced. Planting should be adjusted according to the season so that the soil will have a good cover during the heavy rain periods. Fertilizers and soil amendments should be applied to supplement the plant food elements in the soil.

Cataingan sandy loam (358).—This soil type is adjacent to Batuan clay and Sevilla clay including those areas southeast of Cataingan clay. It has an undulating to moderately rolling relief, good to excessive drainage, and covered with "parang" type of vegetation. The approximate area is 1,864 hectares or 0.46 per cent of the total soil cover of the province.

The internal and external characteristics of the soil are similar to the Cataingan clay in all respects except in the texture of the surface soil. Cataingan sandy loam has a light-textured surface soil with a depth of about 20 centimeters. It is porous, very friable and structureless with a fair amount of organic matter content. Erosion is quite active when the land is under cultivation. This accounts for the presence of gravels and stones on the surface soil.

The Cataingan sandy loam has a rather low fertility level basing upon the stand of crops. Upland rice suffered greatly from lack of moisture during long dry spells. Soil moisture is easily lost through surface run-off, evaporation, seepage, and transpiration being light soil and rather low in organic matter. In other words, it is a droughty soil. Judging from

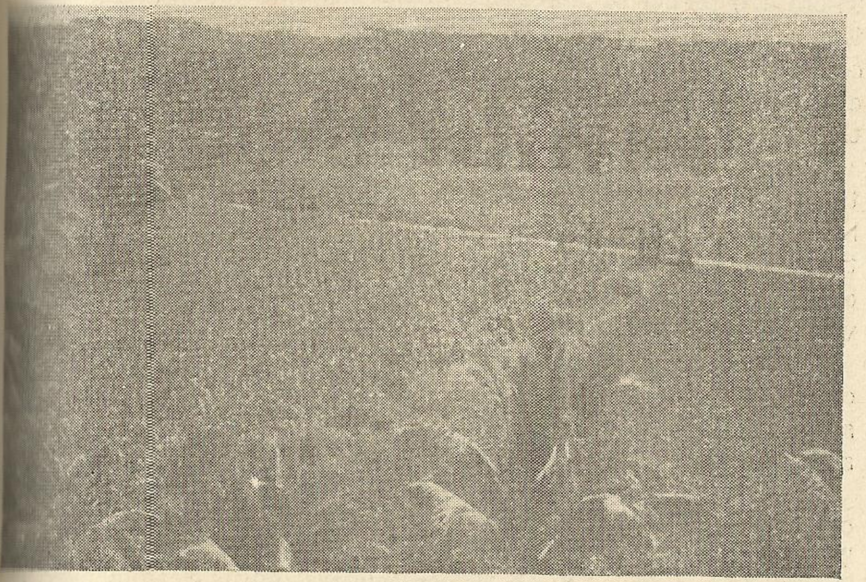

Figure 15. A well-planned diversified farm on a Cataingan soil. It is one of the most productive upland soils. Erosion class 1.

the present land use and farming practices being applied in the management of the land, it is quite safe to forecast that in a few years time these areas will be given up or abandoned. Crop yield in this soil is alarmingly low.

This kind of soil requires immediate attention and better land use program of crop production to restore its original usefulness. The process, however, requires a longer period of time, the soil being badly "sick" already. Strip cropping is the best system to introduce, that is farming by strips and following a system of crop rotation.

SEVILLA SERIES

The soils under the Sevilla series are residual in formation, developed from the weathering of calcareous shales, sandstones, limestones, and sedimentary rocks, either laminated or massive. The series was first established in the province of Bohol and found later to exist in Albay, Sorsogon, and Masbate.

The soil is characterized by a dark brown to black granular and crumbly clay surface soil with a depth of 30 to 55 centimeters. Sometimes limestone outcrops are present on the surface soil. This is underlain by yellowish brown, light orange brown; slightly compact, brittle, and hard clay subsoil layer, There are plenty of limestone gravel deposits and less penetration of roots in this layer. The depth ranges from 55 to 100 centimeters. The solum rests on a yellowish brown sticky clay admixed with limestone gravels and fragments of weathered calcareous shales and sandstones.

The relief varies from flat upland to gently rolling and hilly to mountainous with characteristics narrow valleys dissected by intermittent streams and ravines. The vegetative cover of the area is generally cogon with scanty *binayoyo* trees and others. In some places, the hills and mountains are covered with molave and second growth forest.

Surface drainage is good to excessive. The hillsides under cultivation are sometimes severely eroded so much so that limestone gravels and boulders are very much exposed on the surface soil.

Sevilla series is found in different places, usually along the coasts which are geologically of sedimentary rock formation. The surface soil is shallower than the one found in Bohol. The depth ranges from 25 to 35 centimeters only. Sevilla clay is the only soil type under the series.

Sevilla clay (174).—This soil type is found in areas where the relief is strongly rolling to hilly and mountainous. It embraces the island of Burias, northwestern tip of Masbate adjacent to Batuan clay, and the poblaciones of Uson and Dimasalang and narrowing down to the south up to Barrio Malaran. Sevilla clay covers an area of 57,416 hectares or 14.13 per cent of the total soil cover of the province.

The typical profile characteristics of the series are exhibited by the Sevilla clay.

Depth (cm.)	Characteristics
0–35	Surface soil, dark brown to almost black; slightly compact, waxy, and granular clay; sometimes few calcareous gravels and cobblestones are present in this horizon. Fair in organic matter content and well penetrated by roots. Boundary is diffused and wavy.
35–100	Subsoil, yellowish brown to brown; granular; cheesy to sticky clay; with few limestone gravels and precipitates. In some places gravels are sometimes absent. Few roots penetrate this horizon. It is separated by a diffused and wavy boundary from the substratum.
100–200	Substratum, yellowish brown; sticky clay; admixed with considerable amount of limestone gravels and fragments of weathered calcareous shales and sandstones.

The Sevilla clay, like any other limestone soil, has a solum that is highly granular, crumbly, and friable at optimum moisture content. It has a high water holding capacity with proper amount of organic matter. The solum is favorable for good aeration and tilth. Hence, it will make a good medium for plant growth but because of its relief, certain limitations must be observed. Only those areas with gently rolling topography in Burias Island and the Uson-Dimasalang zone are safe for agricultural purposes. The good stand of crops are indications that Sevilla clay is highly fertile and will last under good soil managements.

The soil type is generally utilized for grazing land with small areas cultivated to crops. Most of the grazing lands are already suffering from sheet erosion because of the customary practice of burning the cogonal areas during the dry season. In places where the topography is too steep, the area is being cleared for upland rice and corn planting.

Frequent cultivation and plowing up and down the slopes accelerate soil removal at a very rapid rate on hilly areas after every heavy rain, thus one could easily recognize the heavily eroded portion. Whereas, if the land is grown to perennial crops like coconuts the loss of certain portions of the surface soil is minimized. The thick growth of cogon and underbrushes in the plantation somehow reduces the velocity of run-off, acting as cushion and reducing the scouring effect of the moving water due to volume and slope. The same conditions exist in areas covered with *ipil-ipil* and other second growth forest.

The soil type is suited to all kinds of crops and fruit trees as shown by the stand of the native vegetation. Contour farming, crop rotation, crop diversification, and other farming practices should be applied to minimize soil erosion.

BOLINAO SERIES

The Bolinao soils are typically residual. They belong to the red soil groups of the Philippines, developed in place from coralline limestone. They are generally found bordering the coastline. The series was first identified in Pangasinan Province.

In Masbate, the soil appears with slight variations from the normal profile characteristics. It differs in the color and texture of the surface soil. It is reddish brown, brown to grayish brown heavy clay, granular, slightly sticky and plastic when wet, weakly friable and crumbly when dry. The solum rests upon a substratum which is usually a consolidated coralline limestone with reddish yellow and orange yellow color. In some places, the substratum is a partially weathered coralline limestone rock thickly laminated but usually massive.

This soil has a strongly sloping to rolling and hilly to flat upland relief with good surface drainage and fair internal drainage. It is generally an upland coastal soil with some limestone boulders as outcrops.

The natural cover is mostly cogon with few trees and secondary growth forest. Bolinao clay is the only soil type mapped under this series in Masbate.

Bolinao clay (153).—This soil type is mapped in the northeastern coastal region of the Masbate mainland and Ticao Island. It is not as extensive as any other upland soil in the province. It embraces the coastal areas of Barrios Mabunga, Calpi, Batuhan, Bantique, Cawayan, Pilot and Poblacion in Masbate; Barrios Rizal, Cacao, Tagdogan, Pinamihagan, and San Jacinto in Ticao Island. The coverage of the soil type is 6,636 hectares or 1.63 per cent of the total soil cover. This soil type has the following profile characteristics.

Depth (cm.)	Characteristics
0–25	Surface soil, reddish brown to light brown and brown to almost red; friable; and fine granular clay. In badly eroded areas limestone boulders are present as outcrops.
25–80	Subsoil, brownish gray, orange brown to light reddish brown; gravelly clay to clay; and coarse granular. Sticky and plastic when wet; crumbly, brittle, and hard when dry. Slightly compact. Boundary is smooth and gradual.
80–below	Substratum, massive or laminated coralline limestone partially weathered with reddish orange to orange yellow coating.

The solum of the Bolinao clay provides a good foothold for crops. The surface soil, being friable and fine granular clay loam, contains a fair amount of organic matter. It is easily prepared to good tilth under optimum moisture condition. The soil is sufficiently deep for planting any annual crop and the subsoil possesses a high water holding capacity because of its heavy texture, good granulation, and slight compactness. The internal drainage is fair due to its good structure.

Presently, the soil is devoted to the production of both annual and perennial crops, such as upland rice, corn, peanuts, camote,

cassava, bananas, coconuts, citrus and other fruit trees with fair to good stand under favorable climatic conditions.

Erosion is one of the most dangerous hazards in the cultivation of this soil. In cultivated areas where the slope is conducive to soil erosion the loss of surface soil after heavy rain is very rapid. Improper soil management is responsible for soil removal, not to mention the loss of plant food nutrients through crop removals and seepage. The non-agricultural portions of the soil type are under cogon and primary and secondary forests. The "kaingin" system of farming is intensively being practiced to open up these areas. Consequently, this method of farming on the hillsides is abandoned after a period of two or three years due to soil depletion. All primitive farm practices should be changed so as to attain good production and maintain soil fertility. Contour farming, terracing, and systematic crop rotation are some of the measures that will prevent further losses of topsoil, humus, and plant food nutrient elements in the soil.

HIMAYANGAN SERIES

The series was first mapped in the province of Leyte. They are residual soils developed in place from the weathering of non-calcareous shale. The drainage is generally good. The natural vegetal cover is of the "parang" type of vegetation.

The surface soil is light brown to yellowish gray, coarse granular sandy clay loam, friable, and slightly compact. It is poor to fair in organic matter content. The upper subsoil is dark brown to grayish brown, poor coarse granular, and slightly compact loam. The lower subsoil is yellowish red to gray, poor coarse granular, slightly friable, and brittle clay loam. The solum rests on a yellowish gray to light gray structureless, compact, and massive sandy shale. Sometimes sandstones are present.

This soil embraces those coastal rolling and hilly mountainous areas in the north and northeast of the mainland from Aroroy proper to the foothills of Conical Peak to Barrios Ulilang Cawayan and Magdalena and narrows down to join the ranges of Mounts Ulac and Bagulipat running northwest to the shores.

The only soil type mapped under the series in Masbate is the Himayangan sandy clay loam.

Himayangan sandy clay loam (615).—This soil type is contiguous to Ubay soils which have practically similar parent materials, vegetal cover, and relief. It has an area of 31,176 hectares or 7.64 per cent of the total soil cover.

The typical profile characteristics of the soil type are as follows:

Depth (cm.)	Characteristics
0–20	Surface soil, light brown to gray; poor coarse granular; gravelly sandy clay loam. Mellow when wet and friable and slightly compact when dry. Poor in organic matter. It is separated by a diffused and wavy boundary from the lower layer. Deep root penetration.
20–80	Subsoil (upper), dark brown to grayish brown; poor coarse granular to blocky clay loam. Slightly plastic and sticky when wet and slightly compact, cloddy, and brittle when dry. Easily penetrated by roots. Diffused and wavy boundary from the lower layer.
80–100	Subsoil (lower), yellowish red to gray clay loam; poor coarse granular; mellow when wet; friable and slightly compact when dry. Smooth and gradual boundary from the substratum. Sometimes weathered gravels of shales and sandstones are found in this layer.
100–below	Substratum, yellowish gray to gray with mottlings. Structureless, compact, massive sandy shale and sometimes sandstones are in the process of weathering.

The soil is mostly covered with second growth and primary forests, however, a small portion is under the "parang" type of vegetation. Surface drainage is excellent to excessive. Most cultivated areas are planted to perennial crops while corn, camote, cassava, and other food crops are planted only on small patches on steep hillsides. It is on this hillside farming where accelerated erosion is very rapid, causing a great loss of surface soil.

The solum exhibits a good coarse granular structure, slightly compact, generally crumbly and brittle when dry or at optimum moisture content. The solum allows an easy penetration of roots to as deep as the lower subsoil. Obviously, under favorable slope condition water could easily percolate through the solum and at the same time most of the precipitation could be saved under a good soil cover. But actually a great volume of rain water is lost as surface run-off due to steep slopes in rolling areas. To devote these areas to clean culture cropping would only mean accelerated soil erosion and loss of soil humus and plant food nutrients. This soil must be kept only for

perennial crops, like coconuts, fruit trees, and bananas, with good sod or cover crops to keep that good portion of the surface soil in place. Otherwise, it should be kept under forest as any kind of cultivation aside from permanent plantings will only result to soil destruction.

It has been noted that the province lacks the 60–40 agriculture-forest balance. The absence of a good forest cover is the contributing factor why most of the rivers and streams in Masbate belong to the intermittent type and are usually dry. In this connection, the Himayangan sandy clay loam area should be reforested rather than be opened for cultivation to annual crops. This is the most effective way of conserving water.

FARAON SERIES

The soils under this series are residual in origin and developed in place from the weathering of the soft and porous coralline limestone. The limestone rock is usually orange to dark yellowish gray and which becomes orange to yellowish gray upon weathering. The topography is generally strongly rolling to hilly.

This series is characterized by a black, medium granular, slightly hard, and brittle clay surface soil underlain by a dark yellowish gray, moderately fine granular, and strongly plastic clay subsoil. The solum rests on a yellowish gray, soft and weak, coarse granular, highly weathered limestone rock layer on a grayish to white, porous, soft and brown coralline limestone.

The external drainage is excellent to excessive due to its relief while the internal drainage is rather poor to fair. Faraon soils in Masbate are easily eroded in cultivated areas due to their relief.

The vegetative cover of the soil is mostly cogon and forest trees, like *ipil*, molave, and *ipil-ipil*. Cultivated areas are usually planted to corn, upland rice, cassava, jackfruit, coconuts, bananas, and other fruit trees.

Faraon clay (132).—The typical profile characteristics of the series are exhibited by the Faraon clay, as follows:

Depth (cm.)	Characteristics
0–30	Surface soil, black clay; medium granular; soft; very strongly plastic when wet and slightly hard and brittle when dry. Fair in organic matter content. Sometimes limestone rocks

	are found on the surface as outcrops. Separated from the next layer by a smooth and abrupt boundary.
30–45	Subsoil, dark yellowish clay; moderately fine granular; strongly plastic when wet and cloddy and hard when dry. Separated by a clear and smooth boundary from the next layer, some admixtures of weathered limestone rocks are found in this layer.
45–60	Substratum (upper), yellowish gray; weathered limestone rocks; soft; and weak coarse granular. This layer is sometimes absent.
60–150	Substratum (lower), grayish white; porous coralline limestone rocks; soft; and easily breaks.

In Masbate, Faraon clay covers those strongly rolling and very hilly areas at the southeastern coastal region from Barrios Domorog to Casabangan in Bugtong Island and the tip of the southeastern prong. It has an area of 8,800 hectares or 2.16 per cent of the total soil cover of the province.

The surface soil is generally shallow due to frequent soil washing. It is almost black, granular, and blocky clay; sticky, and plastic when wet and crumbly, brittle, and slightly compact when dry. At average depth, the subsoil is orange gray to brownish clay having the same physical characteristics as to structure, consistency, porosity, and coarse skeletons as those of the surface soil. Sometimes the solum has weathered limestone gravels as concretions. In eroded areas, coralline limestone boulders appear intermittently or in abundance as outcrops and which may hamper any farming operation. In spite of the presence of these surface outcrops, the area is being cultivated through the "kaingin" system of cultivation. This practice, however, causes rapid soil depletion.

A better land use program should be adopted in this soil to safeguard further soil losses by devoting it to permanent crops, like coconuts, fruit trees, and forest trees. The slope is critically too steep for any annual crop cultivation, especially in places where limestone outcrops are found in abundance. All permanent crops to be planted should be provided with a good cover crop so as to effectively stop or minimize accelerated soil erosion and at the same time build-up the soil of this particular soil type.

Limestone soils like the Faraon clay are decidedly good for fruit trees, like citrus, bananas, and chicos, under normal condition and proper soil management.

Miscellaneous Land Types

HYDROSOL

All indentures around the coastal regions of Masbate which are generally under water almost throughout the year are mapped as hydrosol areas. These are usually affected by changes in the height of sea water and are under halophytic growth. Hydrosols are found extensive in Barrios Lumbia and Pinangapugan in Uson; Barrios Daraga and Poblacion in Placer; Barrios Guiom, Malbug, and Nainday in Cawayan; Barrio Calachuchi in Milagros; Barrio Tagpo in Mandaon; Barrio Lanang in Aroroy; and, at Mobo proper.

These hydrosols are generally characterized by a brackish aqueous horizon or surface water ranging in depth from 5 to 100 centimeters or more depending upon the rise and fall of the tide. Underneath this aqueous layer is the sub-aqueous horizon equivalent to horizon "A" in the normal profile. It is slimy, yellowish brown, grayish brown to gray, fine sandy clay, silty clay to clay with plenty of undecomposed organic matter. The depth ranges from 20 to 70 centimeters. The sub-aqueous layer is underlain by the basal horizon or "B" horizon of ashy gray, slimy, coarse sandy clay from 20 to 60 to more than 150 centimeters depth. The mangrove and nipa swamps fall under this class of soils.

The hydrosols of the province have an aggregate area of 16,928 hectares or 4.16 per cent of the total soil cover of the province. They have no particular economic value except for its dense vegetation of halophytic trees like *bakauan, api-api, bangkal, daluru, tabigue,* and *alipata* as sources of housing materials, firewoods, and tan barks. Nipa palms are also abundant in some hydrosols. They are good sources of thatching materials. There are also bright prospects for fishpond ventures in extensive hydrosols except in areas without live streams to regulate salinity.

BEACH SAND

The beach sand is generally bordering the coastal flat areas which are not very extensive and oftentimes fringing the coastline of the province as a narrow soil body. Like the hydrosol, it is formed as coastal indentations.

Beach sand is characterized by a grayish brown, grayish black to gray sandy mixtures sometimes admixed with white shells and coral gravels to some indefinite depth. That por-

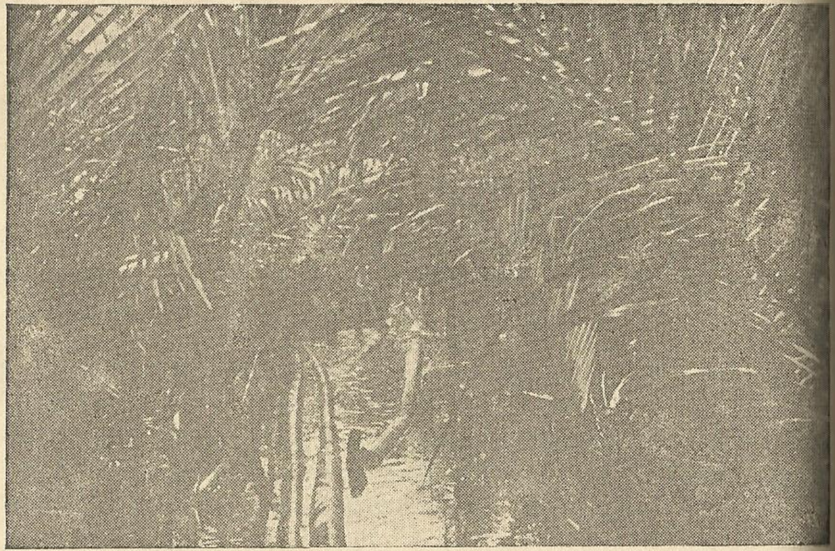

Figure 16. Nipa mangroves along coastal areas are good sources of thatching materials.

tion which is not reached by ordinary tide has an accumulation of organic matter which supplies food elements for coconuts. There are other kinds of vegetation like cogon and big trees. *Dap-dap* grows normally in this area.

The sandy strips are found extensively in Milagros and the southeastern coastal section of Masbate mainland.

GENESIS AND MORPHOLOGY

The soil is conceived as a natural body engendered from a variable mixture of broken and weathered minerals and decaying organic matter, which covers the earth in a thin layer and which may supply, when containing the proper amounts of air and water, mechanical support and in part sustenance for plants. To the soilsmen, it is a natural body occupying the surface of the earth, composed of mineral and organic materials and having distinct characteristic features of its own and a more or less definitely developed surface and subsoil horizons. The formation of this upper portion of the earth's crust is a natural process in which five interacting factors played an essential part; namely, climate, vegetation, relief, parent material, and time. And the characteristics of the product are primarily dependent on the (1) nature of climate,

(2) nature of vegetation and organic accumulation, (3) mineralogical, physical, and chemical composition of the soil material, (4) time that climate and vegetation are in action, and (5) topography and drainage of the land.

These factors on soil forming processes are interdependent upon one another and each one trying to modify the effectiveness of the other. Thus, the physical process is accomplished through the action of climate and plant and animal forces, including man and his activities; the chemical processes, such as hydrolysis, hydration, oxidation, carbonation, and solution decompose most of the parent rocks except those which recrystalizes into higher colloidal clay. The biochemical process refers to the accumulation of organic matter in the soil with the presence of organic life. Thus, we have the soil as the dynamic end product.

In the process of soil formation, these interdependent degrees and variable intensities under a given set of conditions never have the same character of the ultimate product. Climate and vegetation are known to be dominant over the relief, parent material, and time. Thus, we have the zonal soils having well developed profile characteristics. The dominance of relief and parent material over climate and vegetation gives rise to the intra-zonal soils or those having more or less developed profile. And soils having no developed profile characteristics either because of lack of time for the active factors to fully express themselves or due to extreme conditions of relief and parent material are known as azonal soils. Because of these interdependence the variabilities of reaction upon one another and at different degrees and conditions have created many classes and types of soils. As a result of these complex inter-relationships the soils have been classified into profile groups based on relief, profile development and mode of formation.

Fundamentally, the soils in the Philippines belong to the soil groups known as the red and yellow soils and laterites and lateritic soils of the tropics. Under the soil groups, we have soils of varied profile development and characteristics. Thus, for purposes of systematic classification and correlative study, the different soil series, soil types, and phases are categorically grouped as follows:

1. Soils of the swamps and marshes:
   a. Hydrosol

2. Soils of the plains:
   a. Profile group I
      (1) Beach sand
   b. Profile group III
      (1) Mandawe loam
      (2) Macabare clay loam
      (3) Panganiran clay
      (4) Sorsogon clay loam
3. Soils of the uplands:
   a. Profile group VIII
      (1) Ubay clay
      (2) Ubay clay, steep phase
      (3) Ubay sandy loam
      (4) Himayangan sandy clay loam
      (5) Batuan clay
      (6) Sevilla clay
      (7) Bolinao clay
      (8) Cataingan sandy loam
      (9) Cataingan clay
      (10) Faraon clay

Profile group I represents all soils on recent alluvial fans, flood plains, and other secondary deposits having undeveloped profiles underlain by unconsolidated material. In Masbate, only the beach sand belongs to this group.

Profile group III represents all soils on older alluvial plains, alluvial fans or terraces having moderately developed profile and moderately dense subsoils underlain by unconsolidated material. These are generally deep soils in that they are not underlain by claypan or hardpan but the subsoils are moderately dense. All the lowland soils or soils of the plains, except the beach sand, are classified under this group. Their occurrence, however, is only limited to narrow strips indenting the coast. All of the soil types are of secondary soils developed from alluvial deposits brought down by water from the surrounding uplands. For that matter, all the layers in the profile represent a deposition period, degree of profile development undergone, and the nature of the alluvium deposited. The eluviation and illuviation processes have taken place pressed by the density of surface and subsoil layers.

All of the soil types and phases listed above are studied and correlated first in other places like Cebu and Sorsogon. Geographically they are mostly found along river banks and contiguous to the soils of the upland areas.

Profile group VIII are represented by all the soils on the upland areas developed on consolidated sedimentary rocks. These are soils that have been formed on stratified rocks such as sandstone, limestone, and shale. The topography is generally rolling to steep. In Masbate, the Ubay, Cataingan, Sevilla, Bolinao, Batuan, and Himayangan soils are good examples of this profile group. The soils are generally developed in place from the weathering of sandstone, shale, and limestone; the first two being the dominant sedimentary rocks either massive or stratified.

Among the soils studied under this group, the Cataingan series is a recent addition to the long list of upland soils. The Ubay, Sevilla, and Batuan soils were first studied in the province of Bohol; Bolinao soils in Pangasinan; and the Himayangan soils in Leyte Province. As correlated in Masbate Province, these soils seem to have expressed that they were the products of similar climate and more or less the same parent materials with vegetation, relief, and time as variants.

By geographic positions, the Himayangan soils are presumed to be the oldest upland soil in the area; the Bolinao, Sevilla, and the upper terraces of Ubay and Cataingan soils follow, while the upland soils in the lower terraces are the youngest.

These different soils developed generally from the sedimentary rocks or rocks which have been formed by the deposits of loose fragments or sediments such as sand, mud, gravel, and others which have been cemented together into solid rocks such as sandstones, shale, and limestone.

Sandstone is composed mainly of sand, either coarse or fine, cemented together into massive or stratified rocks by infiltered clay of lime and sometimes silica or iron. The degree of disintegration of the rocks depend upon the nature and solubility of the cementing materials. Poorly cemented or so thinly imbedded rocks will disintegrate readily upon exposure to climatic conditions.

Shale is consolidated mud, either clay or silt. It may contain lime that acts as cement or just a hardened mud as a result of the compression by overlying rocks. It is a nonresistant rock which disintegrates easily.

Limestone is a rock produced by the compacting of limy sediments derived from chemical precipitates of lime in the sea water or from fragments of shell.

These are the parent rocks which give rise to the different upland soils of Masbate after undergoing various stages of physical, chemical, and biological processes of soil formation. The changes undergone by these parent materials developed into clay soils. They vary in their productivity depending upon the kind of rocks from which they have developed. For example, soils that have developed from quartz sandstone containing a good proportion of other minerals are more likely to be fertile. Productive soils are more likely to develop also from highly calcareous clays and shale than from soils without lime and those with a high percentage of rock flour. High silica clay has a greater capacity for holding plant food nutrients than those with relatively low in silica content.

Many productive soils are developed from limestones. Some are very hard and are composed almost entirely of calcium carbonate or a mixture of calcium carbonate and magnesium carbonate as the dolomites. Others are soft, chalky, and contain either a high percentage of sand or clay. These impure limestones merge into calcareous sandstones and shales.

All of these materials are of varied composition, making up the bulk of the basic rock from which most of the upland soils of Masbate have developed. And the final products are the soils of Ubay, Cataingan, Sevilla, Himayangan, Batuan, Bolinao, and Faraon series.

LAND USE AND SOIL MANAGEMENT

The majority of the farmers have already abused their farms through indiscriminate cultivation and improper utilization of the land. Farms on the hillsides are cultivated to row crops, like rice and corn. Likewise, the "kaingin" method of cultivation is very rampant along mountainsides and wherever there is forest. This in turn exposes the soil to the eroding power of heavy rainfalls. In most upland soils, like the Ubay clay, Cataingan clay, Bolinao clay, and Sevilla clay, which, according to the proper land use, are suited only for permanent crops on account of their steep relief, are also being planted to clean-cultured crops, like rice and corn. Hillside farms are also being plowed up and down the slopes. Contour plowing, terracing, and strip cropping are not practiced in these farms. On the other hand, some lowland soils, like the Mandawe loam, Sorsogon clay loam, Macabare clay loam, and the Panganiran clay, are being planted to permanent crops like coconuts and fruit trees.

Improper soil management is the cause of the fast deterioration of soil fertility and low crop yields in the province. Corn, a soil depleting crop, has been planted year after year in the same farm. Cover cropping and crop rotation are practically unknown to the farmers. Proper land use and soil management practices should be inculcated in the minds of the farmers at the very start. The change from the old system to the soil conservation way of farming should be made gradual and effective to make them realize its far reaching effects in the future. They should be made to understand also the importance of planting cover crops with permanent crops on sloping lands to prevent soil erosion and conserve soil fertility and moisture. The farmers should also know the value of green manuring, application of organic matter, and commercial fertilizers.

WATER CONTROL ON THE LAND

Conservation of the soil resources require the adoption of sound land use principles and practices of agriculture as a whole. The attainment of this objective involves a widespread use of physical measures of land defense and the adjustment of certain economic and social forces tending to encourage exploitation of the soil. And out of these soil resources the moisture content of the soil oftentimes becomes a limiting factor in the full utilization of the land. Thus, the water control on the land becomes significant in the sense that it deals precisely on all field practices and practical measures tending to destroy the equilibrium between moisture and plants. Hence, conservation of moisture necessary for the agricultural crops is imperative. Water control on the land categorically covers all water problems attendant to the growing of crops successfully, such as (1) soil washing or erosion, (2) drainage, and (3) irrigation.

Soil erosion is as old as agriculture. It is an accelerated process of soil loss brought about by human interference or activities which destroy the equilibrium between soil building and soil removal. Upon the breaking down of our forests and other virgin lands harnessing them in any agricultural pursuit, the soil becomes exposed to the mercy of inclement elements of climate like rainfall and temperature, thus promoting water erosion as a progressive process aggravated by frequent cultivation, over grazing, and burning.

The role played by forests and other protective covering of the soil cannot be over-emphasized. They break the violence of rain, increase the absorptive capacity of the soil cover, prevent soil erosion, and check the runoff; and conversely increase the underground seepage. They materially retain growth and maintain the steady flow of water in the streams which acted as natural drains and, if properly dammed as reservoir, for irrigation purposes.

The need of the country for water conservation is necessary since all agricultural lands depend on rain for their moisture supply. This precipitation, which sometimes fluctuates annually, must be conserved in some way so as to have a steady supply of water for better plant growth. The fluctuation of soil moisture is adversely influenced by forest destruction and the absence of forests, especially in thinly covered areas as well as in extensive agricultural lands.

The province of Masbate is critically lacking good vegetative cover for water conservation purposes. Out of 407,001 hectares of soil cover, only 82,759 hectares and 13,550 hectares of commercial and non-commercial forests and swamps are under vegetative cover, respectively. All the rest or 310,692 hectares are open and cultivated lands. These figures showed relatively the need for reforestation program in the area or the adoption of measures which would improve the control of water for agricultural purposes. Actually, the agricultural forest balance of 40–60 is very much disturbed and is short of 74,364 hectares or 18.2 per cent of the timberlands to establish the above equilibrium ideal for any area. Under such conditions, approximately 76.2 per cent of the total area of Masbate is subject to all types of soil erosion due to the free flow of water. Thus, the climate of the province is of the third type. Generally, the protective covering of the province is of the "parang" type of vegetation, dominantly cogon, which unfortunately cannot hold much of the rain water falling over the area.

Field observations show that most of the soils mapped in the province are critically affected by soil erosion, especially in some upland soils, like the Ubay, Himayangan, Faraon, Sevilla, and Bolinao soils. The narrow lowland soils are being benefited or destroyed, depending upon the kind of sediments deposited. In the lowland areas, usually bordering the stony uplands, admixtures of sediments and inert materials are deposited over them. Because of this deposition, the productivity of the different soil types is greatly affected. For this reason, there is a necessity of controlling the water. Conservation measures, such as strip cropping, contouring, and terracing, may serve well for all upland soils except in steep, mountainous, and stony areas. Systematic land-use and crop rotation should be strictly followed in order to increase the fertility by organic deposition and water holding capacity of the soil. This will prevent excessive soil washing during the months of high precipitation.

The absence of forest balance in the area or its total destruction creates a modification of the local climate and this materially changes or alters the climatic elements in that area, especially precipitation and temperature. The presence of any thick vegetative cover is not a guarantee for increasing humidity, reducing surface-wind velocity, decreasing evaporation, and conserving soil moisture due to the fact that such cover may not possess that desirable protective covering of a forest.

At present, Masbate lacks the necessary forest cover which could be the reservoir for water. Instead, there are numerous intermittent streams which could hardly be harnessed for irrigation purposes. Irrigation is a necessity in the province but due to the absence of a good source, dry farming is resorted to. This makes the agriculture of the province uncertain.

Drainage in the area is unquestionably very good. The excess water easily finds its way through the natural open drains. It is generally a rare instance where one could find extensive water-logging areas in any place except in the swampy areas.

PRODUCTIVITY RATINGS OF THE SOILS OF MASBATE

One of the most promising developments in the field of soil science in the classification of the soil-plant relationship is soil productivity rating. It expresses the crop adaptabilities, behavior, and reactions to certain kinds of soil or soils in terms of actual values of the produce.

The productivity rating of any soil type incidentally helps simplify and supplement the soil characteristics as found in the field. "It commonly summarizes for a given soil type the effect on yield of the (1) surface and subsoil texture, (2) depth of surface soil, (3) reaction, (4) topography, and (5) drainage. And thus makes it possible to compare the capacity to produce of one soil type with another." The giving of a productivity rating to a soil is equivalent to appraising the quality of that soil as to its productive significance in a given area.

There are two methods formulated in obtaining the productivity rating of any soil type; namely, the inductive method, which considers the quality of the soil, available and potential amount of plant food elements, vegetational complexes, climatic hazards, and other factors affecting soil conditions; and the deductive method, which assigns a rating to the representative yields of the specific crops on a particular soil.

A more or less accepted and unique inductive method of rating the productivity of a soil is formulated by R. Earl Storie of the California Agricultural Experiment Station which has more or less a general application to all soils.

"This method of soil rating, known as the Storie Index, is based on soil characteristics that govern the land's potential utilization and productive capacity. It is independent of other physical and economic factors that might determine the desirability of growing certain plants in a given location."

Percentage values are assigned to the characteristics of the soil itself including the soil profile known as A; Factor B represents the texture of the surface soil; Factor C is for the slope and Factor X represents other conditions of the soil, exclusive of profile, surface texture and the slope; like drainage, alkali content, nutrient level, erosion, and micro-relief. The most favorable and ideal condition with respect to each factor is rated at 100 per cent. The percentage values or ratings for the four factors are multiplied, the result being the Storie index rating for that soil. After the percentage scale is obtained, the soil is classified into one of six grades, each grade representing a certain range in the percentage scale.

A better estimate of productivity might be obtained by listing the various factors affecting the productivity of a given soil, weighing them in each individual case, estimating the productivity in terms of crop yields or a general productivity index. The Storie Index has an advantage in that it is not based on any one crop, relatively simple and the different factors are broken down according to detailed classification with the use of the rating chart.

The combination of the Storie inductive method of rating soils and the deductive method, assigning a rating to a specific and representative crop grown on a particular soil, made up the ratings of the different soil types in the province. The average yield of the major crops of the province was used and compared to the standard rating of 100 for each group.

The following are the average yields per hectare established as standards of 100 per cent. The yields are based on normal soil managements—that is without the use of fertilizers:

Coconut	3,750 nuts
Corn	17 cavans (shelled)
Lowland rice	60 cavans
Upland rice	20 cavans
Camote	8 tons
Cassava	15 tons

TABLE 15.—*Productivity ratings of the soils of Masbate.*

Soil type	Coconut	Crop productivity rating index[1]				
		Corn	Lowland rice	Upland rice	Cassava	Camote
Beach sand	100					
Mandawe loam	80	90	80			
Sorsogon clay loam	75					
Batuan clay	75	60	50			
Macabare clay loam	75	60	50			70
Panganiran clay	80	70	90	90		
Ubay clay	80	80	60	45	50	60
Ubay sandy loam	80	75	55	45	70	80
Ubay clay, steep phase	80					
Cataingan clay	90	90	70	80		
Cataingan sandy loam	85	90	65	80	70	80
Himayangan sandy loam	75	35	30	20		
Sevilla clay	80	60	55	45	55	75
Bolinao clay	80	70	45	45	55	50
Faraon clay	80	40		45	30	35

[1] The average yield per hectare of the following crops has been established as standards of 100

THE CHEMICAL CHARACTERISTICS OF THE SOILS OF MASBATE PROVINCE

By Eusebio A. Afaga, Gloria B. Querijero, and Martin V. Tiangco [1]

The identification and classification of soils based mainly on morphologic and genetic studies in the field, supplemented by chemical investigation conducted in the laboratory, are essential for a better farm management and increased crop production. These various phases of investigation are necessary in order to plan and formulate efficient soil management practices.

The laboratory investigations give the following information: (*a*) soil reaction, (*b*) the presence or absence of plant nutrient elements, (*c*) the presence of toxic compounds, and (*d*) the lime and fertilizer requirements of the different soil types for different crops.

Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur are the major elements for they are needed by plants in large amounts for normal growth. The trace or minor elements are boron, iron, copper, manganese, zinc, and molybdenum. They are also essential elements in crop production although they are needed by plants in minute quantities. Carbon, hydrogen, and oxygen come from the air while the rest of the elements are derived from the soil. Poorer quality and lower yield of crops maybe due to a deficiency or absence of one or more of these plant nutrients. Too high concentrations of one or more of these elements, especially the trace elements, adversely affects the growth of plants. It is then necessary to have these elements proportionately present in accordance with the needs of the crops and the soil. They must be present also in their available forms, otherwise they cannot be readily absorbed or utilized by the plants.

Nitrogen, phosphorus, and potassium are usually present in critical or inadequate amounts in agricultural soils because these elements are removed by crops in considerable amounts. They are also easily depleted from the soil not only by crop removal

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but also by leaching, erosion and volatilization as in the case of nitrogen. The deficiency of these elements can be corrected by the application of manures and commercial fertilizers. Calcium and magnesium may occasionally be present in insufficient amounts. The loss of calcium is greater than that of magnesium because the soil colloidal matter carries a much larger amount of calcium than magnesium in an exchangeable form which is easily leached or carried away by drainage water. An average lime carries more calcium than magnesium. However, it should not be interpreted that magnesium is not an essential constituent of lime. Application of dolomitic limestone corrects the deficiency of these two elements. In severe deficiency of magnesium, the carbonate, chloride or sulfate or magnesium may be applied. Dolomitic limestone does not only supply calcium and magnesium needed by plants, but also corrects the acidity of the soil. Flower of sulfur or calcium sulfate (gypsum) corrects both sulfur deficiency and alkalinity of the soil. Continuous use of ammonium sulfate makes the soil acidic. Several brands of fertilizers carry some trace elements sufficient for plant needs. Application of ferrous sulfate and manganese chloride correct iron and manganese deficiency, respectively.

METHODS OF CHEMICAL ANALYSIS

The rapid chemical tests for the available nutrient elements were followed in the analysis of the different soil types of Masbate Province. The results obtained from these tests in past experiments showed distinct correlations of crop responses to lime and fertilizers applied in the soil. This is the reason why the rapid micro-chemical tests are preferred to the total determinations which are tedious, expensive, and time consuming. Nevertheless, total nitrogen was also determined as this element is readily converted into assimilable forms by microorganisms under a favorable set of conditions. The results of these determinations may serve as an index of the degree of fertility of soils.

The rapid micro-chemical tests are employed successfully by other countries. These tests are calibrated under Philippine conditions with actual results of lime and fertilizer experiments conducted in pots and in the field. For lack of comprehensive data from local experiments, the results obtained abroad are here cited.

The soil samples from Masbate Province were first air-dried and then pulverized with a wooden mallet. The pulverized soil was then passed through a 20-mesh sieve after which it is thoroughly mixed. Precautions were observed throughout the sampling operation to eliminate unnecessary contaminations of the soil samples.

A Beckman pH meter fitted with a glass electrode was used for the determination of soil reaction or the hydrogen ion concentration of the soil solution. 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.[1] Ammonia and nitrates were determined by Spurway method.[2] Truog method [3] was followed for the determination of available phosphorus. Peech and English method [4] was followed for the determinations of readily available potassium, calcium, magnesium, manganese and iron, using a Leitz photo-electric colorimeter which is provided with suitable filters.

INTERPRETATION OF CHEMICAL TESTS

Soil reaction or pH values.—The number of hydrogen and hydroxyl ions in soil solution determines its pH value. An excess of hydroxyl ions over the hydrogen ions results in an alkaline soil reaction, but when the condition is reversed, that is, the hydroxyl ions are exceeded by the hydrogen ions, the soil reaction is acidic. A neutral solution contains equal number of hydrogen and hydroxyl ions. The pH scale is from 0 to 14. A pH value of 7 is neutral. Above pH 7, the soil reaction is alkaline; below pH 7, it is acidic. As the pH value decreases, the number of hydrogen ions increases and as the pH value increases, the number of hydroxyl ions increases. Mathematically, the pH value is expressed as the logarithm of the reciprocal of the hydrogen ion concentration expressed in grams per liter of solution. A neutral solution, pH value of 7, contains 1×10^{-7} gram ion per liter. A change of one unit of pH value means a ten-fold change in the hydrogen ion concentration. Thus, a solution of pH 6 contains 10 times the hydrogen ion concentrations of a solution of pH 7. In the same manner, a solution of pH 5 has 10 times hydrogen ion concentrations of a

[1] *Association of Official Agricultural Chemists*, 6th ed. Washington, D. C. 1945, p. 27.

[2] G. H. Spurway, *Mich. Agri. Expt. Sta. Tech. Bull.* 132, 1939).

[3] Emil Truog, *J. Am. Soc. Agron.* 22, 872–882 (1930).

[4] Michael Peech and Leah English, *Soil Science*, 57, 167–195 (1944).

solution of pH 6 or 100 times the hydrogen ion concentrations of a solution of pH 7.

TABLE 16.—*Chemical analysis of the different soil types of Masbate Province arranged according to decreasing productivity rating for lowland rice.*[1]

Soil type	pH-Value	Available constituents in parts per million (p.p.m.)								
		Total N %	NH_3	NO_3	P	K	Ca	Mg	Mn	Fe
Panganiran clay	7.00	0.21	2	10	33	182	5000	480	96	1
Mandawe loam	7.40	0.07	2	10	10	205	8900	470	84	trace
Cataingan clay	6.35	0.14	10	5	22	210	4400	1220	61	trace
Cataingan sandy loam	5.35	0.07	10	2	4	244	300	trace	47	4
Ubay clay	5.00	0.14	10	5	181	126	1600	700	90	1
Sevilla clay	7.00	0.17	2	25	6	219	13200	1400	45	trace
Ubay sandy loam	5.15	0.11	2	10	5	166	1000	700	58	2
Batuan clay	6.60	0.14	2	trace	8	122	16000	2500	41	1
Macabare clay loam	6.60	0.24	2	2	21	160	2600	210	23	1
Bolinao clay	5.90	0.15	2	50	34	343	2800	210	39	1
Himayangan sandy clay loam	6.00	0.16	10	10	37	306	3400	700	71	2
Beach sand	7.20	0.11	10	2	21	257	22400	2100	9	trace
Sorsogon clay loam	5.80	0.21	2	trace	15	144	2600	470	98	3
Ubay clay, steep phase	4.90	0.15	10	5	17	310	1300	1400	90	3

[1] Refer to Productivity rating table 15.

What is the soil reaction of your soil? Is it acidic, neutral or alkaline? These questions are often asked by Soil Technologists to farmers whenever they complain about their poor harvests. These questions are important for soil reaction is a limiting factor in the behavior and availability of plant nutrient elements for plant nutrition. It is one of the outstanding physiological characteristics of the soil solution. Its importance in agriculture has long been recognized and emphasized.

The pH value of the surface soils of Masbate Province ranged from 4.90, that of Ubay clay, steep phase; to 7.40, that of Mandawe loam as indicated in table 16. Variation of the pH values of the different soil types in the province may be attributed to the following factors:

(*a*) *Parent material.*—Soils formed from rocks high in basic salts are generally alkaline, while soils developed from acid substances are acidic.

(*b*) *Influence of fertilizers.*—The residual effect of ammonium sulfate and flower of sulfur applications in soils is acidic. This is due to formation of acids which in turn affect base removal. Fertilizers such as calcium nitrate, calcium cyanide, sodium nitrate, and basic slag applied in the soil render the soil solution alkaline.

(*c*) *Rainfall.*—Regions subjected to a high intensity of rainfall usually have acidic soils due to base removal by leaching,

erosion, and drainage water. On the other hand, soils in regions with low intensity of rainfall have alkaline soil reaction. By capillary action, the soil solution rises up to the surface. Water is evaporated, leaving the basic salts behind.

TABLE 17.—*The pH requirements of some economic plants.*

Plant	Strongly acid pH 4.2–5.4	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
Abaca [1]	Y	X	X	X	Y	O
Caimito	Y	X	X	Y	O	O
Coffee [1]	Y	X	X	Y	O	O
Cowpea [2]	Y	Y	X	Y	Y	—
Corn [2]	Y	Y	X	X	Y	Y
Durian [1]	Y	X	X	Y	O	O
Peanut [2]	Y	Y	X	X	Y	—
Petsai [4]	Y	Y	X	X	X	X
Rice [1]	Y	X	X	Y	Y	O
Sugar cane [2]	O	Y	X	X	X	Y
Tobacco [2]	Y	X	Y	O	O	O
Sweet potato [2]	Y	X	X	Y	O	O
Cassava	Y	X	X	X	Y	Y
Pineapple	Y	X	Y	O	O	O
Banana [1]	Y	X	X	X	Y	O
Tomato	Y	Y	X	X	Y	Y
Onion [2]	O	Y	X	Y	Y	Y
Soybean [2]	Y	X	X	X	Y	Y
Orange [3]	—	Y	X	X	X	Y

LEGEND:

X—most favorable reaction.

Y—reaction at which plants grow fairly well or normal.

O—unfavorable reaction.

[1] Based from the soil reactions where they are grown with the productivity ratings of the soil types in 11 provinces. A pH range of 5.7 to 6.2 was found to be most suitable for the growth of upland rice, variety *Inintiw.* Rola, N. A. and N. L. Galvez. Effects of Soil Reaction on the Growth of Upland rice and on its Nitrogen, Calcium, Phosphorus and Iron Content. *Philippine Agriculturists 33*: 120–125. 1949.

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

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

[4] From Arciaga, A. and N. L. Galvez. The Effect of Soil Reaction on the Growth of Petsai plants and on their Nitrogen, Calcium, and Phosphorus Content. Philippine Agriculturists. 32: 55–59. 1948. Normal growth reported was pH 4.2 to 8.6. Optimum range was pH 5.9–8.6.

(*d*) *Percentage base saturation of the soil.*—This is the property of soils to absorb or hold base-former cations in proportion to its cations exchange capacity. If the percentage base saturation is low, the soil is acidic. The soil is neutral or alkaline when the percentage base saturation is 90 or above. There are also other factors which may cause the variations of pH values of soils.

According to Pettinger's chart for soil reaction,[1] the different soil types of Masbate Province fall under six classes; namely, (*a*) very strong acidity, (*b*) strong acidity, (*c*) medium acidity,

[1] Truog, Emil (Pettinger's chart). *Soil Science*, 64: 1–7 (1948)

(*d*) slight acidity, (*e*) very slight acidity, and (*f*) slight alkalinity. Ubay clay, steep phase and Ubay clay have soil reactions of very strong acidity, while Ubay sandy loam and Cataingan sandy loam fall under the strong acidity class. Sorsogon clay loam, Himayangan sandy clay loam and Bolinao clay have pH values ranging from 5.5 to 6.0 falling under the medium acidity class. Cataingan clay belongs to the slight acidity class. Macabare clay, Batuan clay, and Sevilla clay are under the very slight acidity class. Beach sand and Mandawe loam have a soil reaction under slight alkalinity class. Panganiran clay has neutral soil reaction.

Different crops have different pH value preference and different tolerance limits. Rice, pineapple, and tobacco grow most favorably in medium acid soils, pH 5.5 to 6.1. Their estimated pH tolerance limit is 4.8 to 6.9. Citrus, sugar cane, and alfalfa grow well in slightly acid to slightly alkaline soils; pH 6.2 to 7.8. These crops have a pH tolerance limit from 5.5 to 8.5. Tomato and corn can tolerate a wider range; pH 4.8 to 8.15. Optimum growth of these crops can be obtained in slightly acid to neutral soils; pH 6.2 to 7.

Table 17 shows the pH requirements of some of the economic plants. As far as soil reaction is concerned, the different soil types are suited for the following crops: Bolinao clay, Himayangan sandy clay loam are best suited for rice, pineapple, and tobacco. These crops may grow fairly well in Ubay clay, steep phase; Macabare clay loam; Batuan clay; Ubay sandy loam; Ubay clay; Cataingan sandy loam and Cataingan clay. Panganiran clay, Mandawe loam, Cataingan clay, Sevilla clay, Batuan clay and Macabare clay loam are suited for citrus, sugar cane, and alfalfa. Bolinao clay, Himayangan sandy clay loam, Sorsogon clay loam have soil reactions wherein citrus, sugar cane, and alfalfa may thrive fairly well. Tomato and corn grow best in Panganiran clay, Cataingan clay, Sevilla clay, Batuan clay and Macabare clay loam. Tomato and corn may also grow fairly well in Mandawe loam, Cataingan sandy loam, Ubay clay, Ubay sandy loam, Bolinao clay, Himayangan sandy clay loam, Sorsogon clay loam and Ubay clay, steep phase.

Referring to tables 15 and 16, Panganiran clay and Mandawe loam have pH values above the pH requirements or tolerance limits for rice, yet their productivity ratings are 90 and 80, respectively, for lowland rice; while Bolinao clay and Himayangan sandy clay loam, whose soil reactions are within the

pH preferences, have lower crop productivity ratings for the same crop. Hence, soil reaction is not the only basis for normal plant growth but also climate, soil type, availability of plant nutrients, presence of toxic substances, varietal characteristics of plants, purity of seeds, insects, pests and diseases, and farming practices must be considered.

The presence of available plant elements in soils depends on the soil reaction. Most of the nutrient elements are generally available at pH 6.5. Agricultural soils have pH range from 3 to 10. The general trend of the relationship of soil reaction to availability of plant food elements is shown in figure 17. This is a modified version of Pettinger's chart by Truog.[1] The chart is reproduced here with Truog's accompanying explanation.

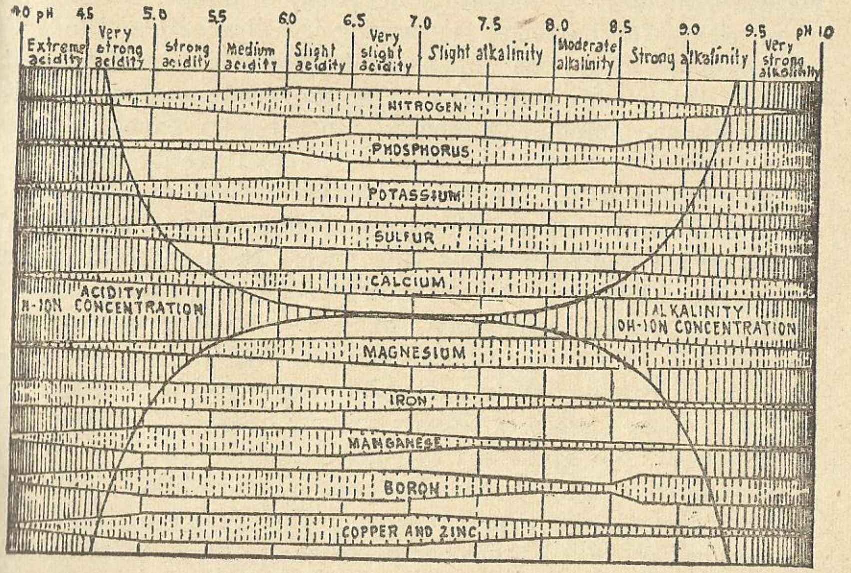

Figure 17. Chart showing general trend of relation of reaction to availability of plant nutrients

"The influence of reaction on the 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

[1] Truog, Emil (Pettinger's Chart.) Soil Science, 64, (1-7 (1948).

that if the reaction of a soil falls in this range a satisfactory supply of available nitrogen is assured. All it means is that as 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; moreover, certain crops having a low requirement may be fully satisfied with a low supply."

Organic matter.—Dead bodies and residues of plants deposited on or within the soil form the soil organic matter. It includes carcasses of animals, insects, worms, roots, stems, fruits and leaves, live and dead bacteria, protozoa and fungi, and excreta of animals and micro-organisms. This soil organic matter undergoes gradual decomposition, the rate depending on temperature, amount of moisture, aeration, drainage, availability of nutrients for bacterial consumption, soil reaction, kinds of organic matter, and the number and kinds of bacteria present. Some of the products of this process are water, carbon dioxide, free nitrogen, ammonia, methane, mineral salts, carbohydrates, proteins, fats, resins and waxes. The mixture of these different substances in the soil as a result of organic matter decomposition constitutes humus. Humus is a dark-colored, homogeneous and amorphous substance. It is colloidal in nature with a large number of negative charges and composed mainly of carbon, hydrogen, oxygen, nitrogen, sulfur and phosphorus. Humus can be mineralized and its mineral plant nutrient contents in their available forms are liberated during mineralization. Some of these nutrients liberated by the mineralization process and the weathering of minerals in the earth crust find their way in the drainage water, while the rest is absorbed by plants, thus preventing their complete loss into the ocean. As the plants decomposed and mineralized, nutrients in their available forms are liberated again for plant nutrition. Organic matter, therefore, functions also as storage for plant nutrients for the succeeding growing plants. Soil structure, water holding capacity, color and consistency are modified by humus. It also improves aeration and drainage; minimizes soil erosion; acts as cementing agent of soil particles, especially in light soils; and provides nutrients and homes for the soil micro-organisms. Humus influences also the availability of phosphorus. Humic acids and other organic acids formed during the decomposition of organic matter unite more readily

with iron and aluminum than phosphorus with aluminum or iron to form insoluble aluminum or iron phosphate. This selective affinity or combination of organic matter with iron and aluminum sets free phosphorus into its available form.

Soils with a high content of humus are generally more productive than soils having low organic matter. This generalization, however, is not always the case. Productivity of soils with a low content of humus can be high only it does not last so long as that of soils rich in organic matter.

A relationship exists between the amount of organic carbon and total nitrogen contents in soils. The nitrogen analysis may, therefore, be taken as an approximate index of the amount of organic matter. A low percentage of nitrogen and a high percentage of carbon indicates that the C : N ratio is wide. On the other hand, a high percentage of nitrogen and a low percentage of carbon will indicate a narrow C : N ratio.

Fresh plant materials that are commonly added to soils have C : N ratio from about 80 : 1 in mature straw and 12 to 20 : 1 in leguminous green-manure crops.[1] In any case, those ratios will narrow down to about 10 : 1. A normal agricultural soil is supposed to have a certain amount of carbon in proportion to nitrogen. This proportion is 10 : 1. When this normal ratio becomes wider, there is a relatively smaller amount of available nitrogen. When this condition arises, it is high time to turn in green manures or apply farm manures or nitrogenous organic or commercial fertilizers.

Ammonia and nitrates.—Nitrogen makes up 2 to 4 per cent of the average dry weight of plants. Numerous compounds found in plant tissues contain nitrogen. Being regarded as the most important factor in growth and reproduction, its deficiency in soils results in stunted growth and yellowing of the leaves of plants. An excessive supply of nitrogen on the other hand may cause the following adverse effects: (*a*) luxuriant growth, (*b*) susceptibility to plant diseases, (*c*) lodging in grain crops, like rice and corn, (*d*) lowering of the purity of cane juice in sugar cane, and (*e*) decreased in tensile strength of fiber plants, as in abaca and ramie.

The sources of nitrogen in cultivated soils are green and farm manures, crop residues, animal carcasses, and commercial fertilizers. Specific soil micro-organisms convert the nitrogen

[1] C. E. Millar and L. M. Turk, "Fundamental of Soil Science," John Wiley and Sons, Inc., New York, 1948, p289.

contained in nitrogenous organic matter into its available form. This conversion is called "nitrogen cycle" accomplished in three stages; namely, (*a*) ammonification—ammonia formation, (*b*) nitrification—oxidation of ammonia to nitrites and finally to nitrates, and (*c*) denitrification—reduction of nitrates to nitrites, ammonia, and finally to elemental nitrogen. Nitrates are formed under favorable conditions, such as good aeration, optimum temperature of 80—90° F, proper amount of moisture, presence of proper micro-organisms and balanced nutrient elements needed for optimum bacterial activities. Under favorable conditions, however, ammonia and nitrites prevail in the soil. Excessive nitrites are toxic to plants. Nitrogen in nitrate form is normally assimilated by plants; but rice, corn, and other members of the grass family absorb it in the ammonium form as well. These two forms are water soluble and they are leachable and easily lost in drainage or run-off water. The ammonium form may be fixed by the clay particles and released only when needed by the plants, while the nitrite form cannot be fixed in the same manner. For this reason, the nitrate form is more leachable and easier to be lost in the drainage water than the ammonium form.

The surface soils of Philippine cultivated lands have been analyzed for their total nitrogen content. The average result was 0.14 per cent. Mandawe loam, Cataingan sandy loam, and Beach sand contain nitrogen below the average. Soils analyzing 2 to 5 p.p.m. of ammonia and nitrates are considered low; 10 to 25 p.p.m. as medium or normal supply and 100 p.p.m. or more as very high or excessive. Table 16 indicates that all the soil types of Masbate contain low to medium amount of available ammonia and nitrates. The low nitrogen content of these soils calls for fertilization with nitrogenous fertilizers to insure higher yields, especially for leafy vegetables, pineapples and sugar cane.

Low analysis of ammonia and nitrates in soils are due to: (*a*) deficiency in organic matter, (*b*) lack of nitrogenous fertilizers, (*c*) high in organic matter content but slow rate of ammonification and nitrification processes and (*d*) leaching, soil erosion, and crop removal. Low test for ammonia may mean that it is used up by plants as fast as it is formed; that it is fixed in the base exchange complex; or that it is converted into nitrate form. Low analysis for nitrate may indicate that nitrification is slow; that it is leached or used up by plant and

organisms; and that the field is not fertilized with nitrate-carrier fertilizers.

Phosphorus.—Phosphorus is extremely essential in any form of life. In plants, phosphorus is indispensable as nitrogen itself. It is an important constituent of the protoplasm, especially the cell nucleus. Higher concentration of phosphorus is found in young and growing parts of plants, such as seedlings, buds, and root-tips than in any other parts of the plant. In the absence or deficiency of phosphorus the plants manifest stunted growth as the cells cease to grow and multiply.

Phosphorus, like nitrogen, is also associated with plant growth and reproduction. It promotes root, fruit, and seed development; hastens maturity and counteracts luxuriant growth due to excess nitrogen. In phosphorus shortage, there is no distinct change in color of the leaves as in the case of nitrogen deficiency. Darker and duller green leaves of most plants seem to indicate deficiency of phosphorus. In citrus and other fruit trees, their root systems and trunks fail to develop normally. Formation of fruits, seeds and emergence of corn silk are delayed. The other effects of phosphorus deficiency are: increased acidity of fruits, poorer quality of sugar cane juice, and reduced starch formation in root crops.

The availability of phosphorus for plant growth varies according to climate and soil. In conditions like those existing in Wisconsin, U. S. A., Truog[1] found out that the minimum limit for available phosphorus should be 37.5 p.p.m. for good and clayey soils and 25 p.p.m. for sandy soils. He also stated that for certain sections of southern United States where the climate permits a longer growing period than in the northern part, 10 to 15 p.p.m. of readily available phosphorus might be sufficient for a good crop of corn. Basing on data of several Philippine soil types, Marfori,[2] on the other hand, found out that 30 to 40 p.p.m. of readily available phosphorus as determined by Truog method seems to be the normal requirements for rice and other grain crops.

Table 16 shows that Panganiran clay, Ubay clay, Bolinao clay, and Himayangan sandy clay loam contain a sufficient supply of available phosphorus for optimum crop production. The rest of the soil types fall below the normal phosphorus

[1] Truog, Emil *Jour. Am. Soc. Agron.* 22, 784–882 (1930).
[2] Marfori, R. T. *Phil. Jour. of Science* 70, 133–142 (1939).

requirement for normal plant growth. The deficiency can be corrected by applying phosphatic fertilizer usually superphosphate.

Potassium.—The third important nutrient needed in large amount by growing plants is potassium. It is an essential element to plant nutrition. Unlike nitrogen and phosphorus, potassium is not a constituent of the plant protoplasm or the plant structure. It is indispensable in the production of sugar, starch, fat, and proteins in plants; yet these synthesized products do not contain appreciable amounts of potassium. Higher concentration of this element is found in the leaves, stems, barks, tops, buds, blossoms, and fruits. It gives firmness, well-developed fruits of citrus, pineapple, tomatoes and bananas. Millar and Turk [1] state that it increases plumpness in grains; strengthens stalks and stems of plants; and improves the burning quality, texture, and elasticity of tobacco leaves. Deficiency in potassium causes yellowing or reddish-brown discoloration of the leaves, spreading from the tips and margins toward the center, irregular necrotic spots on the leaves, undersizing and deformation of leaves, flowers, pods, fruits and tubers, lowering of plant resistance to pest and diseases, weakening of stalks and stems and wilting due to excessive transpiration, especially during dry season.

In a critical study of the fertilizer requirements of lowland rice on some Philippine soil types Marfori,[2] *et al.* found out that where the soil is highly deficient in available potassium, small application of potassic fertilizers generally will not give immediate significant increase in crop yield because of the fixation of the added potassium in the base exchange complex of the soil. However, large initial application 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 out 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 yields, using *Guinangang* rice as the plant indicator. On Marikina clay loam and San

[1] Millar, C. E. and L. M. Turk "Fundamental of Soil Science, John Wiley and Sons, Inc., New York 1943.

[2] Marfori *et al.* A critical study of fertilizer requirements of lowland rice on some Philippine soil types. *Phil. Jour. Soil Sci. Soc.* 1950.

Manuel silt loam which contain 132 p.p.m. and 161 p.p.m., respectively, of available potassium, repeated large applications of potassic fertilizers did not give at all any statistically significant increase in yield, using again *Guinangang* rice as the crop indicator. Experiments on potash fertilization on sugar cane in various haciendas at Victorias, Negros Occidental by Locsin,[1] reported that soils containing 85 p.p.m. or less of available potassium as determined by Peech and English methods, gave positive crop response to potash applications while soils containing 151 p.p.m. or more of available potassium gave negative crop response. According to Bray,[2] for most Illinois or Corn Belt Soils, corn or clover will not respond to potassium fertilization when the available soil potassium is 150 p.p.m. or more.

According to Interpretation of Chemical Analysis by Marfori, the supply of 100 to 150 p.p.m. of available potassium in soils as determined by Peech and English methods, seems to be sufficient amount for most crops. All the different soil types of Masbate contain adequate supply of nutrient element. However, Ubay clay, Ubay sandy loam, Batuan clay, Macabare clay loam, and Sorsogon clay require potassic fertilization for the maintenance of their potassium content.

Calcium.—Calcium affects the soil physically, chemically and biologically. In heavy soils or clay soils, the particles are closely associated to each other so that water and air movements are hindered. The addition of lime in acid soils encourages satisfactory crumb structure and greatly improves aeration and drainage. Calcium not only corrects soil acidity and toxicity of iron, aluminum and manganese because they are converted to inert compounds as their solubility decreases markedly, but also increases the availability of the natural and added phosphorus. It affects the availability of the other plant nutrients. At pH 6.5 most nutrient elements are rendered available. Calcium counteracts toxicity of the other elements, especially boron. Calcium stimulates enzymic processes, such as organic matter decomposition, nitrification, sulfofication, and humification. It promotes favorable conditions for normal growth and functioning of symbiotic and non-symbiotic fixing bacteria.

[1] Locsin, Carlos L. *Jour. Soil Sci. Soc.*, Philippines 2, 105–108 (1950)

[2] Bray, R. H. "Soil Test Interpretation and Fertilizer Use." University of Illinois, Dept. of Agron, AG, 1220. (1944).

Calcium is one of the major plant nutrients. Low available calcium in acid soils causes low yields, especially for crops that need a good supply of this nutrient element. Most garden crops and legumes require a good supply of calcium while grain crops and grasses generally use smaller amounts. Excessive amounts of calcium are injurious to crops that require medium to strongly acid soils for their growth.

Liming affects plant composition. It increased the calcium content of cabbage leaves from 4.42 per cent to as much as 7.53 per cent. Yield of tomatoes and their vitamin C content were increased and protein content of corn grains indicated an increase of 40 per cent. These various effects on plant composition were reported by Smith and Hester.[1] Increased yield of upland rice in the experiment performed by Madamba and Hernandez [2] was due to lime application.

A great number of the different soil types from various regions in the Philippines have been analyzed for their available calcium content. High productivity ratings are found in soil types analyzing 2,000 to 6,000 p.p.m. of available calcium. Table 16 shows that four of the soil types of Masbate are below the available calcium sufficiency. They are Cataingan sandy loam; Ubay clay; Ubay sandy loam; and Ubay clay, steep phase. These soil types require liming, especially for such "high-lime" crops as sugar cane, alfalfa, and other legumes.

Calcium is rather immobile in the plant sap. Therefore, its deficiency symptoms appear first in the terminal buds, plant tops and root tips and then to the older portions of the plants. Distortion of new leaves, stunted growth of the growing points, yellowing and drying of leaf margins and between veins are some deficiency symptoms for calcium.

Magnesium.—Magnesium is an essential nutrient element. It is a constituent of chlorophyll molecule; the green pigmentation of plants. Its absence or deficiency in plant leaves adversely affects photosynthesis, a natural process by which plants manufacture starch and sugar.

Soil types analyzing 600 to 1,700 p.p.m. of available magnesium are rated high in crop productivity. However, for

[1] Smith, G. F. and A. B. Hester. Calcium content of soils and fertilizers in relation to composition and nutritive value of plants. *Soil Science* 75, 117-128 (1948).

[2] Madamba, A. L. and C. C. Hernandez. The effect of ammophos and lime on the yield of upland rice grown on Buenavista silt loam. *Jour. Soil Sci. Soc. Philippines*. (1948).

TABLE 18.—*Lime and fertilizer requirements of the different soil types of Masbate Province.*

Soil type	Agricultural lime Ton/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Super-phosphate (20% P_2O_5) Kg./Ha	Muriate of potash (60% K_2O) Kg./Ha.
	For lowland rice			
Panganiran clay	-----	200	50	
Mandawe loam	-----	200	250	
Cataingan clay	-----	200	150	
Cataingan sandy loam	4.25	200	300	
Ubay clay	1.00	200	-----	50
Sevilla clay	-----	-----	300	
Ubay sandy loam	2.50	200	300	50
Batuan clay	-----	200	250	50
Macabare clay loam	-----	200	150	50
Himayangan sandy clay loam	-----	100	50	
Sorsogon clay loam	-----	200	200	50
	For upland rice			
Panganiran clay	-----	200	50	
Mandawe loam	-----	200	250	
Cataingan clay	-----	200	150	
Cataingan sandy loam	8.50	200	300	
Ubay clay	2.00	200	-----	50
Sevilla clay	-----	-----	300	
Ubay sandy loam	5.00	200	300	50
Batuan clay	-----	200	250	50
Macabare clay loam	-----	200	150	50
Bolinao clay	-----	-----	50	
Himayangan sandy clay loam	-----	100	50	
Sorsogon clay loam	-----	200	200	
	For coconut			
Panganiran clay	-----	300	50	
Mandawe loam	-----	300	250	
Cataingan clay	-----	300	150	
Cataingan sandy loam	4.25	300	300	
Ubay clay	1.00	300	-----	50
Sevilla clay	-----	100	300	
Ubay sandy loam	2.50	300	300	50
Batuan clay	-----	300	250	50
Macabare clay loam	-----	300	150	50
Bolinao clay	-----	-----	50	
Himayangan sandy clay loam	-----	150	50	
Beach sand	-----	300	150	
Sorsogon clay loam	-----	300	200	50
Ubay clay, steep phase	1.75	300	300	
	For corn			
Panganiran clay	-----	300	50	
Mandawe loam	-----	300	250	
Cataingan clay	-----	300	150	
Cataingan sandy loam	8.50	300	300	
Ubay clay	2.00	300		
Sevilla clay	-----	100	300	100
Ubay sandy loam	5.00	300	300	
Batuan clay	-----	300	250	50
Macabare clay loam	-----	300	150	100
Bolinao clay	-----	-----	50	50
Himayangan sandy clay loam	-----	150	50	
Sorsogon clay loam	-----	300	200	

certain species of citrus (Pummelo or *Citrus maxima* Brun. Merr.) deficiency had been observed in soils that contained even as much as 950 p.p.m. of available magnesium. Camp *et al.*[1]

[1] Camp, A. F., F. D. Chapmen, G. H. Bahrt, and E. R. Parker, Symptoms of citrus malnutrition. Chap. IX, Hunger Signs in Crops. Published by the Amer. Soc. Agron. and National Fertilizer Asso., Washington D. C. 321-326 (1941).

at the Citrus Experiment Station in Florida, U. S. A., found out that magnesium shortage resulted in reduction of crop yield, size of fruits and in the sugar and vitamin C content of the juice. Table 16 shows that the range of available magnesium content of the different soil types of Masbate is from trace, that of Cataingan sandy loam; to 2,500 p.p.m., that of Batuan clay. Cataingan clay; Ubay clay; Sevilla clay; Ubay sandy loam; Batuan clay; Himayangan sandy clay loam; Beach sand; and Ubay clay, steep phase fall within the available magnesium sufficiency. The rest of the soil types are deficient in available magnesium. Application of magnesium carbonate, magnesium sulfate or dolomitic limestone corrects the magnesium deficiency.

Yellowing or reddening of the tips and margins of leaves spreading to areas between the leaf veins, especially to lower or older leaves, premature defoliation of the plant, purplish-red with green veins of cotton leaves, chlorosis of tobacco known as "sand drown" and stripped leaves of corn with green veins and yellow areas between veins are symptoms of magnesium shortage. In legume crops, chlorotic leaves are apparent indications of low supply of available magnesium in soils.

Manganese.—Manganese is generally present in very small amounts in agricultural soils—less than 0.1 per cent or 1,000 p.p.m. Nevertheless, the plant requirements for this nutrient are so minute that they are usually satisfied. Alkaline soils, especially those soils which are heavily limed or calcareous soils, are deficient in manganese. The manganese contents of the following crops as reported in literature 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.

Dwarfness of plants, chlorotic and spotted leaves, especially in tomato, bean and tobacco, are manganese deficiency symptoms. Checkered with yellow dead spots or light green color between the veins of leaves may be caused by manganese deficiency.

Philippine soil types which were rated high or at least medium in crop productivity contain available manganese, varying from 15 to 25 p.p.m. The results of the analysis of the different soil types of Masbate for available manganese are indicated in table 16, ranging from 9 p.p.m., that of beach sand; to 98 p.p.m. that of Sorsogon clay loam. Beach sand is deficient in available manganese.

Iron.—The plant requirement for iron is relatively small ranging from 2 to 30 p.p.m. of available iron. It is mostly available in acid soils as it is soluble in this soil reaction. On the other hand, its availability decreases in neutral and alkaline soils as it is precipitated as hydroxide of iron. In the presence of phosphorus, it may be precipitated as iron phosphate both in acid and alkaline soils. Under this condition, both the iron and phosphorus are rendered unavailable. Availability of iron is greater in anaerobic than in an aerobic condition due to the reduction of the ferric to ferrous salt. The second form is more soluble than the former.

Iron deficiency causes loss of green color (*chlorosis*) of the leaves, especially the young leaves. However, areas along the principal veins remain green. Application of ferrous sulfate corrects iron shortage in soils. Cataingan sandy loam; Ubay sandy loam; Himayangan sandy clay loam; Sorsogon clay loam; and Ubay clay, steep phase contain available iron within the range of sufficiency. The rest of the soil types fall below the iron range of adequacy.

LIME AND FERTILIZER REQUIREMENTS

What is lime? And what is a fertilizer? From the standpoint of agriculture, agricultural lime is calcium carbonate or limestone pulverized to 20-mesh and about 50 per cent to pass 100 mesh. It is the most common liming material, although its neutralizing power is lower than its oxides and hydroxides forms. Pure calcium oxide and magnesium oxide neutralize 1.78 and 2.5, respectively, as much as the same weight of pure calcium carbonate. Calcium hydroxide, magnesium hydroxide, dolomite, and magnesium carbonate have also higher neutralizing power than calcium carbonate. However, agricultural lime is still preferable than the other liming materials mentioned above. The reasons are: (*a*) cheapest and most available among the liming materials, (*b*) less drastic change in soil reaction, hence no deleterious effects to plant growth, (*c*) the ease with which it can be evenly spread and uniformly incorporated in the soil, and (*d*) absence of adverse caustic action on human skin and also on plant leaves.

Fertilizer, on the other hand, is any material which when added to the soil, supplement its insufficient available nutrient content. Commercial fertilizers and organic manures constitute not only the source of plant nutrients. They supplement nature's reserves. Organic manures are as important as fertilizers for soil fertility depends not only on the total amount of available nutrients in the soil. Each functions differently in crop production so that one cannot replace the other. Organic manure is a source of micro-organisms; major and trace elements. It serves also as a soil conditioner and moisture and temperature stabilizer.

Arable soils are generally deficient in the essential nutrient elements necessary for increased production. They are also acidic in reaction. Crop removal, erosion, leaching and volatilization, especially in the case of nitrogen, are contributory factors. The lost nutrients, therefore, must be replenished to maintain maximum production by the application of lime, commercial fertilizers, composts and farm manures. Green manuring supplies not only organic matter but also plant nutrients when mineralized.

The amount of lime and fertilizers to be applied in the soil depends on the balanced nutrient requirements of the crops. All the nutrients, whether they are needed in large or small amounts are very essential to plant growth. If anyone of these elements is inadequately present or absent, stunted growth is remarkably noticeable. The normal growth of plants is always restricted by the element which is unavailable or inadequate in amount in relation to the total requirements of the plants. This condition is referred to as "The Law of the Minimum." Soil types, climate, organic matter, crops, and time and mode of placement determine also the quantity of lime and fertilizers to be applied. Lime requirement of soils is the amount of lime to be added into the soil to bring the pH value to about 6.5, a soil reaction most favorable for most economic crops. Soil types of the same pH value may vary in their lime requirements because of their varying buffering capacity, a distinct resistance to a change in the pH value, either acidity or alkalinity in the soil. Clayey soils with a high content of organic matter have a higher buffering capacity than light soils with a low organic matter content. A drastic change of pH in the soils is injurious to plants. The lime requirement of soils is not only based from their pH value but also from their available calcium content.

Frequent liming and lesser amount of lime in each application are more preferable for sandy soils than for clayey soils. Frequent and heavier application of lime are necessary in regions

subjected to a higher intensity of rainfall. This is also true in soils where intensive farming and heavy application of nitrogenous fertilizers as ammonium sulfate are practiced. The residual effect of excessive application of nitrogenous fertilizers is acidity of the soil. For lime maintenance in the soil, liming is necessary for every five years.

The different soil types of Masbate have been analyzed for their chemical properties. The results obtained are tabulated in table 16 from which the lime and fertilizer requirements for lowland rice, upland rice, coconut, and corn are based. Cataingan sandy loam, Ubay clay, Ubay sandy loam and Ubay clay, steep phase analyze low in available calcium and in their pH values which are below the specific soil reaction requirement or pH preference for most economic crops. These soils having low available calcium and low pH values, need lime application ranging from 1 to 4.25 tons per hectare for lowland rice and coconuts, and from 2 to 8.5 tons for upland rice and corn. The rest of the soil types have sufficient available calcium and thus, their lime requirements are satisfied.

The nitrogen, phosphorus, and potassium requirements per hectare of lowland and upland rice for each soil type deficient in these nutrient elements are the same ranging from 100 to 200 kg. ammonium sulfate (20% N), 50 to 300 kg. superphosphate (20% P_2O_5), and 50 kg. muriate of potash (60% K_2O). The same amounts of superphosphate and muriate of potash are needed for corn and coconuts except for Ubay clay and Macabare clay loam. Both require 100 kg. of muriate of potash. With the exception of Bolinao clay, all the soil types need equal amounts of ammonium sulfate for corn and coconuts ranging from 100 to 300 kg. per hectare.

One of the factors for efficient use of fertilizers is time and mode of application. Broadcasting and localized placement are the two general methods of applications of fertilizers. A combination of broadcasting and localized placement may be used.

Broadcasting method is simply the spreading of the fertilizer material over the soil area to be fertilized. This is accomplished either by the use of machines or by hand. Hand broadcasting method is the most commonly employed in the Philippines in upland and lowland rice fertilization, whereas machine spreaders are resorted to by farmers abroad. The use of machine saves time and labor and bigger area can be fertilized at a given time. However, the broadcast fertilizer may be leached or washed away by surface waters or blown away by the wind. The other portion may be placed out of the feeding areas of the plants rootlets and some may be fixed by the soil particles.

Localized placement method, on the other hand, is the application of fertilizer material in bands along the row or around the areas close to the seeds or plants. Drilling, ring or trench, perforation and foliar methods are also examples of localized placement method. Localized placement method is used extensively by the Filipino farmers in the fertilization of sugar cane. Favorable results were also obtained for other row crops like corn by the localized placement method. It enhances greater utilization of the fertilizer nutrients by the plants mainly because they are placed within the feeding zone and they are less subjected to fixation by the soil particles. In orchard fertilization, one-half of the required fertilizers should be applied at plow depth and the other half within the subsoil due to the deeper penetration of their roots. In fruit trees, like citrus and coconuts, the fertilizer and lime area is along the newly developed roots indicated by the imaginary drip-line of the crown of the trees.

The time of application is as important as the other factors for proper and efficient use of fertilizers. The application may be done before planting, at planting time, and after planting, depending upon the solubility of the fertilizers and the crops to be fertilized.

Lime may be applied in the same way fertilizers are applied under the same favorable conditions. It is usually applied at least one month before planting. When the recommended amount of lime is relatively high, split applications rather than one heavy application are preferable. Overliming of certain spots of the area may be prevented. A change of more than one unit of pH in one application is injurious to plants and bacteria as well. Clayey soils with a high content of organic matter can tolerate heavier lime application more than light soils with low organic matter content because the former has a higher buffering capacity than the latter.

SOIL TEXTURE AND MECHANICAL ANALYSIS OF MASBATE SOILS

Mechanical analysis has for its purpose the determination of the composition of the different soil separates, sand, silt,

and clay, that composed the soil. Soil is made up of weathered rock materials which range in size from 2.00 mm., the largest diameter, to the very minute size that can be seen by the naked eye. Particles larger than 2.00 mm. are referred to as coarse skeletons and depending upon their sizes are classed as gravels, pebbles, cobblestones, and boulders while the finest of clays which can exist in suspension for a long time is called colloids.

Depending upon the amount of sand, silt, and clay formation which make up the soil, the class names can be determined. The mineral particles less than 2.00 mm. in diameter are as follows:

Sands.—Soil material that contains 85 per cent or more of sand; percentage of silt plus 1½ times the percentage of clay, shall not exceed 15.

Coarse sand: 25 per cent or more very coarse and coarse sand, and less than 50 per cent any other one grade of sand.

Sand: 25 per cent or more very coarse, coarse, and medium sand, and less than 50 per cent fine or very fine sand.

Fine sand: 50 per cent or more fine sand or less than 25 per cent very coarse, coarse, and medium sand and less than 50 per cent very fine sand.

Very fine sand: 50 per cent or more very fine sand.

Loamy sands.—Soil material that contains at the upper limit 85 to 90 per cent sand, and the percentage of silt plus 1½ times the percentage of clay is not less than 15; at the lower limit, it contains not less than 70 to 85 per cent sand, and the percentage of silt plus twice the percentage of clay does not exceed 30.

Loamy coarse sand: 25 per cent or more very coarse and coarse sand, and less than 50 per cent any other one grade of sand.

Loamy sand: 25 per cent or more very coarse, coarse, and medium sand, and less than 50 per cent fine or very fine sand.

Loamy fine sand: 50 per cent or more fine sand or less than 25 per cent very coarse, coarse, and medium sand and less than 50 per cent very fine sand.

Loamy very fine sand: 50 per cent or more very fine sand.

Sandy loams.—Soil material that contains either 20 per cent clay or less, and the percentage of silt plus twice the percentage

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of clay exceeds 30 and 52 per cent or more sand; or less than 7 per cent clay, less than 50 per cent silt, and between 43 per cent and 52 per cent sand.

Coarse sandy loam: 25 per cent or more very coarse and coarse sand and less than 50 per cent any other one grade of sand.

Sandy loam: 30 per cent or more very coarse, coarse, and medium sand, but less than 25 per cent very coarse sand, and less than 30 per cent very fine or fine sand.

Fine sandy loam: 30 per cent or more fine sand and less than 30 per cent very fine sand or between 15 and 30 per cent very coarse, coarse, and medium sand.

Very fine sandy loam: 30 per cent or more very fine sand or more than 40 per cent fine and very fine sand, at least half of which is very fine sand and less than 15 per cent very coarse, coarse, and medium sand.

Loam.—Soil material that contains 7 to 27 per cent clay, 20 to 50 per cent silt and less than 52 per cent sand.

Silt loam.—Soil material that contains 50 per cent or more silt and 12 to 27 per cent clay or 50 to 80 per cent silt and less than 12 per cent clay.

Silt.—Soil material that contains 80 per cent or more silt and less than 12 per cent clay.

Sandy clay loam.—Soil material that contains 20 to 35 per cent clay, less than 28 per cent silt and 45 per cent or more sand.

Clay loam.—Soil material that contains 27 to 40 per cent clay and 20 to 45 per cent sand.

Silty clay loam.—Soil material that contains 27 to 40 per cent clay and less than 20 per cent sand.

Sandy clay.—Soil material that contains 35 per cent or more clay and 45 per cent or more sand.

Silty clay.—Soil material that contains 40 per cent or more clay and 40 per cent or more silt.

Clay.—Soil material that contains 40 per cent or more clay, less than 45 per cent sand, and less than 40 per cent silt.

The sizes of the different soil particles called separates are as follows:

Separates	Diameter in millimeter
Very coarse sand	2.00—1.00
Coarse sand	1.00—0.50
Medium sand	0.50—0.25

Fine sand	0.25—0.10
Very fine sand	0.10—0.05
Silt	0.05—0.002
Clay	below 0.002

TABLE 19.—*Mechanical analysis of Masbate soils* [1]

Soil type No.	Soil type	Sand	Silt	Clay	Total colloids
118	Beach sand	88.8	5.2	6.0	92.0
173	Ubay clay	30.4	23.2	46.4	57.6
174	Sevilla clay	25.6	26.4	48.0	60.4
615	Himayangan sandy clay loam	47.6	26.4	26.0	24.4
465	Panganiran clay	23.6	30.4	46.0	62.4
214	Batuan clay	23.6	32.4	44.0	54.0
612	Mandawe loam	42.0	40.0	18.0	26.0
357	Cataingan clay	29.6	28.0	42.4	52.0
358	Cataingan sandy loam	63.6	21.8	14.6	20.4
614	Macabare clay loam	43.6	27.8	28.6	36.4
613	Sorsogon clay loam	31.6	38.8	30.6	36.4
153	Bolinao clay	36.8	15.6	47.6	61.2

[1] Analyzed by Miss Dolores Dimalanta of the Soil Research Laboratory, Bureau of Soils.

FIELD DETERMINATION OF SOIL TEXTURAL CLASS

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

The following are the definitions of the basic soil textural classes in terms of field experience and feel:

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

Sandy loam: A sandy loam is a soil containing much sand with enough silt and clay to make it somewhat coherent. The individual sand grains can be readily seen and felt. Squeezed when dry, it will form a cast which readily falls apart, but if squeezed when moist, a cast can be formed that will bear careful handling without breaking.

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

Silt loam: A silt loam is a soil having a moderate amount of the particles being of the size called "silt." When dry, it may appear cloddy but the lumps can be readily broken, and when pulverized, it feels soft and floury. When wet, the soil readily runs together and puddles. Either dry or moist, it will form casts that can be freely handled without breaking, but when moistened and squeezed between the fingers, it will not "ribbon" but will give a broken appearance.

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

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

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

LAND CAPABILITY CLASSIFICATION AND CONSERVATION GUIDES FOR MASBATE SOILS

Lands are of various kinds but each one is good for one thing or another. It is when we utilize a piece of land that is not suited for a certain use that its destruction follows. We must, therefore, use this land according to what it is good for and treat it according to its requirements.

The different soil types or mapping units on your farm were grouped into classes according to their capabilities to show the necessary treatments for each class. In general, the different land capability classes recognized are as follows:

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

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

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

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

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

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

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

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

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

The basic factors used in the determination of the land capability classes of the different soils in the province are the (a) soil type, (b) slope of the land, and (c) the extent of soil erosion taking place in the land.

The soil type embraces all the factors such as drainage, permeability, presence of organic matter and fertility of the land. The dominant slope of the soil type may be level which is supposed to be class A under normal condition, but because of low fertility or poor drainage, the capability is lowered down, depending upon the severity of the problem which may either be water, soil, or erosion.

In Masbate, the Mandawe loam and the Panganiran clay are both alluvial soils with almost flat to level topography. Ordinarily they should have been classed under capability A had it not been for their poor drainage condition. Hence, the problem for the Mandawe loam and Panganiran clay is water indicated by a small letter *w* after each capability class. Because of these drainage problems, the capability class of each soil type is lowered down to class B in spite of its flat to level topography.

The upland soils, such as the Ubay clay, Ubay sandy loam, Cataingan clay, and the Bolinao clay vary from undulating to rolling topography which are suited only either for pasture or forest. Some of them could have been classed under capability C, judging from their slopes. But because most of them have already suffered from slight to severe erosion due to improper soil management, they have been classed under lower capability class with erosion as the main problem. The same condition follows with the other soil types.

The two miscellaneous land types are the beach sand and the hydrosol. Both of them fall under a specific capability class.

In order to facilitate classification, the possible slope-erosion classes are listed in the following table with their corresponding capability classes.

TABLE 20.—*Land capability classification of the different soil types in Masbate*

Soil type number	Soil type	Possible soil unit [1] (slope-erosion)	Land capability class
612	Mandawe loam		
465	Panganiran clay	a-0	Bw
614	Macabare clay loam		
613	Sorsogon clay loam	b-1	Ce
214	Batuan clay	b-2	
174	Sevilla clay	c-2	
173	Ubay clay	c-2	
224	Ubay sandy loam	c-1	De
357	Cataingan clay	c-2	
358	Cataingan sandy loam	d-2	
153	Bolinao clay	d-2	
615	Himayangan sandy clay loam	e-2	M
132	Faraon clay		
354	Ubay clay, steep phase	e-3	N
1	Hydrosol	----------	X
118	Beach sand	----------	Ds

[1] The slope-erosion units are the possible conditions that may exist in each soil type. Any other unit with an erosion class more than the one specified above will be used under the next capability class. Thus, Ubay clay with C-2 classification will be classed as De.

The following land capability classes of the different soil types in the province have been presented here to serve as a guide in the proper utilization of the land.

CLASS Bw

Soil types: Panganiran clay
Mandawe loam

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

Class Bw is good land but because of poor drainage conditions some efforts to drain the excess water are needed. Included in this class are wet lands that can be easily drained. They usually occur on low bottoms near large streams. The soils are deep but the subsoils are heavy or the water table is very shallow and restrict water movement. Small ditches are needed to drain off surplus water. Diversion ditches should be constructed to prevent damage of run-off from adjoining uplands. Protection from occasional overflow may be needed.

When properly drained, corn, sugarcane, legumes, and many other row crops common in the area may be grown. Lowland rice is especially adapted.

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

CLASS Ce

Soil types: Sorsogon clay loam
Batuan clay
Moderately good upland that can be cultivated safely if a carefully planned combination of conservation practices is applied.

Class Ce is moderately good land suitable for cultivation but needs the most careful use of the best soil conservation practices to prevent erosion. Soils are good, deep to moderately deep, with slopes that would range from 8 to 15 per cent. It has moderate to severe erosion or is subject to moderate to severe erosion, if unprotected.

To farm this land safely a system of terraces must be installed supported by contour farming and strip cropping to protect the land against erosion damage. Terraces should empty into well grassed waterways or natural drainage.

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

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

CLASS De

Soil types: Sevilla clay
Ubay clay
Ubay sandy loam
Cataingan clay
Cataingan sandy loam

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

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

To farm the land, a system of terraces has to be installed with properly laid out terrace outlets in the absence of natural outlets if erosion damage or gullying has made the natural drainageways impracticable. Terrace outlets must be covered at all times with a thick vegetative growth, preferably grass. Reseed and fertilize if the grass is not well established.

Plowing as well as other operations must be done on the contours. Crop rotation on this land should be a long one. Planting to row crops is not advisable. Close growing crops like grains or legumes are preferable. When the land is used for orchards, trees should be planted on the contour and a good stand of leguminous cover crop should be maintained.

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

CLASS M

Soil types: Himayangan sandy clay loam
Faraon clay
Bolinao clay

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

Class M land are usually on steep slopes up to 40 per cent. The soil is generally shallow or highly eroded making it unfit for seasonal cultivation. Stones or gravels may be present or so numerous that they interfere with tillage operations. The

land may be used for pasture or trees but needs to be carefully handled. In order to grow good legume or grass for pasture the land should be well prepared, using lime and fertilizers as recommended in order to give the young plants a good start. Diversion terraces should be made around the heads of active gullies if any are present on the farm. Gullies that start to develop should be smoothened and sodded. Newly developed pastures should not be grazed severely. On well established pastures, grazing should be well controlled and rotated. Wherever possible, stock ponds should be constructed to supply water to the animals.

Where climatic conditions permit, this land can be devoted to orchards, such as citrus, coffee, mango or other similar crops but in all cases, the trees should be planted along the contours and good cover crop to protect the soil from washing should be provided.

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

CLASS N

Soil types: Ubay clay, steep phase

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

This kind of land is not suitable for any tillage except that which is needed to establish permanent vegetations such as for permanent pasture land or woodland. This class consists of lands that are with slopes up to more than 40 per cent. The land is rugged broken only by many large gullies. The soil is badly eroded or very shallow. Stones may also be very abundant making it very impracticable to cultivate.

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

Gullied lands are best used for trees and only trees growing well in the locality should be used. *Ipil-ipil* is especially recommended. Where trees are already growing, they should be left and protected from fire or "kaingin."

CLASS X

Miscellaneous land type: Hydrosol

Land suited only for wildlife or recreation.

Land in this class is usually level or is slightly depressed wherein water, either sea or fresh, stays most of the time.

making it impossible to utilize the land, either for crops or pasture and trees. This land type is termed as hydrosol.

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

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

CLASS Ds

Miscellaneous land type: Beach sand

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

Class Ds land is nearly level to sloping with deep soil but thin topsoil and light, very rapidly permeable subsoil with a low available moisture. Included in this class are level or nearly level lands with deep soils but because of climatic conditions not enough moisture is available for good crop growth. In such cases, lands under this class need artificial irrigation.

This class of land is also subject to some degree of soil erosion during those sporadic periods of heavy rainfall or after excess application of irrigation water.

This land can be made productive if planted to vegetables or truck farming. Root crops will do well if planted at such time of the year when rainfall is abundant.

It is recommended that in order to increase the water-holding capacity of the soil in this land class its organic matter content must be increased. This can be done by the application of animal manure.

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

II. SOIL EROSION SURVEY OF MASBATE

Our farming practices in the past and even at present have failed to consider the effect of losing the vigor-giving elements needed by the plants through accelerated soil erosion. Unmistakable evidences are piling up to the effect that the cultivated lands of the nation are subject to the damage done by erosion in varying degrees. This condition must be corrected before it is too late. To help correct this, soil erosion surveys are being conducted to determine the varying degrees and extent of soil losses and in order to have a guide in planning out a system of land-use that will protect the land, build up its soil and improve the productivity, hence, insuring the permanency of agriculture and stability of the farmers. It is, therefore, the purpose of this report to bring to the attention of the farmers of the province the factors that have contributed to soil losses by erosion; present the seriousness of soil erosion occurring in the province; and suggest possible means of checking soil erosion effectively.

Incidentally, the erosion survey of the province may be timely for most of the pasture lands are still uncultivated and are being subdivided into small farm lots, thus soil conservation way of farming may be introduced right at the start.

SOIL EROSION DEFINED

Soil erosion is the wearing away of the land surface by running water, wind, or other geological agents. This may be subdivided into normal or geologic erosion and accelerated soil erosion.

Normal or geologic erosion.—This is the washing away of the soil under natural condition wherein the erosion taking place is counter-balanced by soil formation. Under this condition the soil is being washed down at the rate it is being formed from the parent material. This occurs under forest covered with thick vegetation.

Accelerated erosion.—This is the wearing away of the soil brought about by man's interference on the natural cover of the soil. Consequently, the rate of soil removal is very much faster than its formation from the parent materials beneath.

The valuable topsoil containing all the essentials for a productive soil is lost and the capacity of that soil to produce is lessened. The land is practically ruined when both the topsoil and subsoil are lost exposing the bedrocks.

Accelerated erosion in Masbate is principally caused by overgrazing of pasture lands; the annual burning of cogonal areas; the plowing up and down the slope of the farm and the "kaingin" system of farming. These conditions expose the surface soil to the beating effect of heavy torrential rain most of the time. Accelerated soil erosion is further subdivided into four classes; namely, sheet erosion, rill erosion, gully erosion, and stream bank erosion.

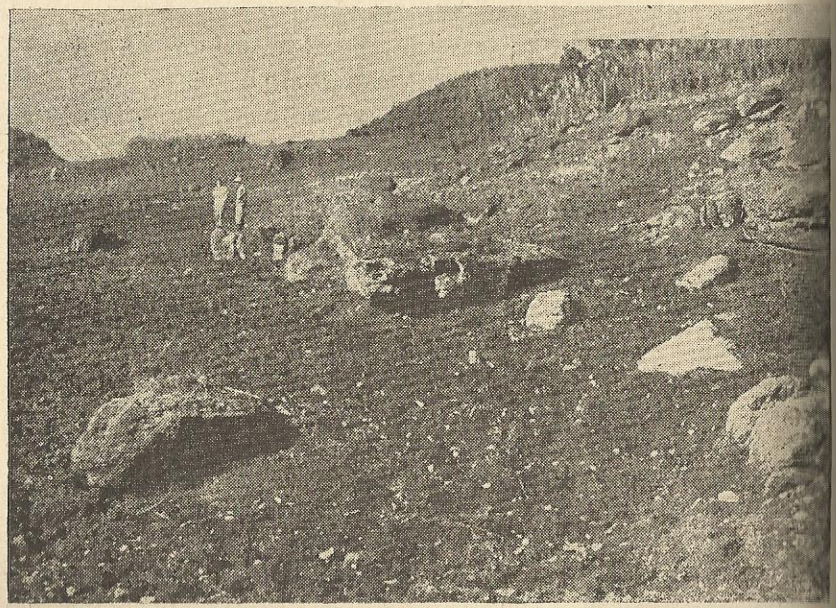

Figure 18. These rock outcrops hinder tillage operation. This land is better suited for pasture than cropland. Erosion class 4.

Sheet erosion.—This is the removal of the surface soil in a more or less uniform depth without the development of conspicious water channels. This kind of erosion is more difficult to recognize than gully erosion. The effect of sheet erosion in some instances are greatly noticed due to a resultant change in color of the surface soil brought about by the removal of

the thin layer of topsoil. Reduced crop yields may also serve as an indicator for the extent of soil erosion that has taken place.

Rill erosion.—This is another type of accelerated erosion known as the finger or rill erosion which often takes place on hilly places. As the surface water flows over the unprotected topsoil, it cuts small paths or rivulets which appear like fingers. If these tiny rivulets are allowed to grow and expand after every rainfall it would ultimately develop into deep gullies which render the farm untillable by any farming implement.

Gully erosion.—This erosion is produced by the formation of deep channels on the surface of the land by running water too deep to be removed by ordinary cultivation as plowing and harrowing. Gullies are developed in exposed natural drainage-ways, in depressed irregularities, in plowed furrows, animal trails, and rows of crops that run up and down the slopes. It is the most conspicous kind of soil erosion caused by water run-off. And anyone can identify it even from a distance.

Stream bank erosion.—This is the kind of erosion that occurs along the banks of streams and rivers. It is very destructive particularly on such lands where the substratum is of coarse or medium-textured soils. The water cuts the lower bank causing the upper portion to collapse.

METHODS USED IN MAKING SOIL EROSION SURVEY

The determination of the extent of both sheet erosion and gullying on the various soils of the province is the primary object of the reconnaissance erosion survey. The degree of soil erosion of a given soil type or soils is determined by comparing their profile to that of a normal or virgin soil of the same type of soil and relief on which no erosion has taken place yet. Each soil type has a standard soil profile set purposely as a basis in the appraisement of soil losses through erosion. A normal range of thickness of the horizon or layer in the solum of a particular soil type under natural condition has been determined accurately for use as guide to evaluate erosion losses.

A virgin land and a cultivated land of the same soil type have different depths of solum. In cases where the virgin topsoil is shallower than six inches or average plow depth, the position and depth of the lower part of the subsoil is used for estimating the degree of erosion. Plant succession, erosion

Figure 19. Cogon grass prevents further erosion damage, foreground. Note the effect of erosion on sparsely covered land, background. Erosion class 2.

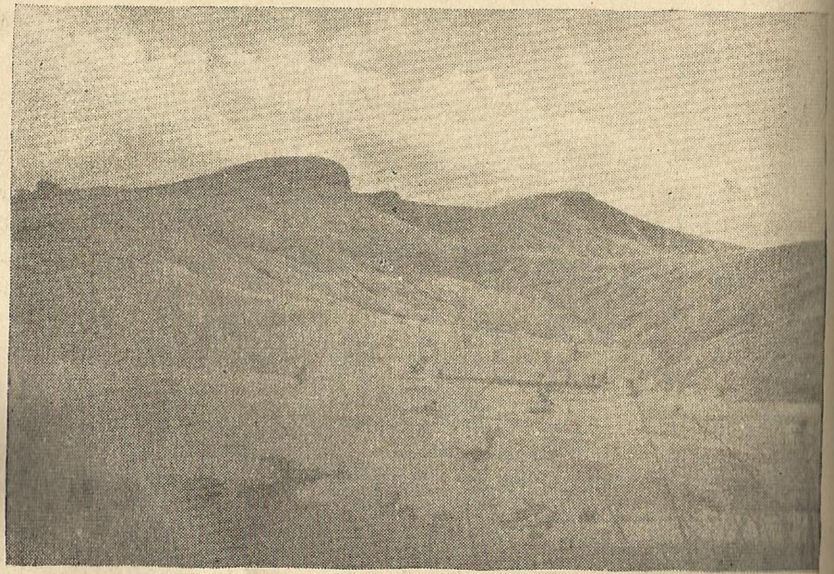

Figure 20. Over-grazing has resulted in gullying even on undulating areas. Erosion class 38.

PLATE 9

history, and other visible evidences of active erosion may serve as indicator of the degree of erosion in the absence of virgin soil profile.

The length and depth of gullies in addition to the frequency of their occurrences are the basis for estimating the extent of gullying. The various groups and classes of erosion recognized and the symbols used to designate them are as follows:

SHEET EROSION

Class 1—Less than 25 per cent of the original topsoil removed. Class 1 is mapped if the effects of erosion can be identified and the average removal is less than 25 per cent of the original topsoil. No gullying.

Class 2—From 25 per cent to less than 75 per cent of the surface soil is eroded.

Class 3—More than 75 per cent of the surface soil to about 25 per cent of the subsoil is eroded.

Class 4—All of the surface soil to 75 per cent of the subsoil is removed.

Class 5—All of the surface soil and subsoil to part of C horizon is eroded.

Class 6—Catstep, steps of cattle along sides of hills falling down.

GULLY EROSION

27—From 25 per cent to less than 75 per cent of the surface soil is removed in addition to shallow gullies.

38—More than 75 per cent of the surface soil is removed in addition to frequent gullies.

7—Gullies more than 100 feet apart (occasional gullies).

8—Gullies less than 100 feet apart (frequent gullies).

9—Very frequent or large gullies. This symbol will be used to designate an intricate network of gullies or an individual gully large enough to be outlined on any mappable area of which more than 75 per cent is gullied.

"Symbols 7 and 8 should be shown in conjunction with sheet-erosion symbols; that is, they should never be used alone. Symbol 9 should be used without a sheet erosion symbol. On land affected by erosion of class 9 some difficulties may be experienced in identifying the soil type and slope. In such cases the slope of the original land surface should be shown, and a soil separation such as rough gullied land may be mapped if approved by the inspector." [1]

O—Inclose in circle either 7 or 8 if gullies cannot be crossed by farm machinery.

MISCELLANEOUS CLASSES

O—No apparent erosion. Mapped from level to nearly level cultivated areas, and on land that is well protected by vegetation and shows no evidence of soil erosion.

W—Normal erosion. Mapped in forest reservation where primary forests are found.

⊖—Erosion undifferentiated.

EXTENT OF SOIL EROSION IN MASBATE

Comprehensive discussion of the severity of erosion and of the various measures would not be possible without first evaluating the main causes of the present condition of soil losses in Masbate. Facts gathered from narrations of different progressive farmers at the time of the survey and actual observations of the relations between the present management of the land and erosion shed light upon several important causes by which erosion has been accelerated in the province. Among them are as follows:

Burning and over grazing of grassland.—It has been a common practice throughout the province to burn the grasslands in order to produce new growth of grass mostly cogon which are succulent feeds and readily consumed by animals. This practice exposes the soil to the climatic forces especially rainfall.

Before the cogon could grow thick to be able to materially aid in intercepting raindrops which would detach the soil, it is already consumed by the animals, hence, the land surface is exposed to the scouring effect of water. Furthermore, burning of vegetation destroys the protective cover of the soil like leaf litters and organic matter which are mainly responsible for the high water holding capacity of the soil and which in turn reduces surface run-off. Overgrazing, which is the greatest problem of the province, is responsible for the accelerated erosion in most parts of Masbate. Too many grazing animals either concentrated in a small area or scattered over a large area reduces the normal stand of grasses and shrubs, thereby

[1] Soil Conservation Survey Handbook by E. A. Norton, U.S.A. Misc. Pub. No. 352.

allowing an unrestricted flow of water on the hillsides. Wide grassy slopes become a network of small gullies going in all directions and meeting in their downward courses to form big gullies that are destroying the power of the soil to produce worthwhile vegetation. In addition, the livestock tramples on the land and make paths all along the slope mostly up and down, thus, making irregular water courses where gullying usually begin.

Planting row crops on steep slopes.—Sloping land planted to row crops are subject to erosion if the rows are made across the contour. The degree of soil erosion on sloping areas increases corresponding with the steepness and length of slope of the land. Water in sloping and open areas does not have much time to sink into the soil whereas water on level area or on sloping area but closely planted to growing crops has the tendency to be absorbed. The planting of corn, tobacco, and upland rice on slopes do not provide enough cover for the soil and it is therefore conducive to erosion. These practices are found in several places in Masbate especially in the thickly populated areas.

Up and down the grade cultivation.—Up and down the grade method of planting is a general practice in the Philippines and it is also common in Masbate. Under this method, the furrows would serve as miniature channels for water and when water concentrates in these depressions the volume and speed are increased and the washing power is also increased, thus, resulting in gully formation. Gullying in the Calumpang–Tagpo area of the western prong and in the upper Guiom on the eastern prong has resulted from this practice.

"Kaingin" method of farming.—This method of farming is very destructive not only to valuable forest trees which are burned or left to decay but also to our soil. "Kaingineros" with or without permit cut down the shrubs and big trees of a virgin forest, usually along the mountain sides. When these shrubs dry up they are burned with the valuable trees. The humus and other organic constituents of the forest soil which have been accumulated for years are also burned, a condition which reduces the water holding capacity of the soil and increases run-off. "Kaingin" farming is very rampant in the province which produces conditions similar to those of cultivating in steep slopes.

The farmers have not fully realized the effect of erosion. Reduced crop yields are generally attributed by the farmers

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to the removal of plant food nutrients from the soil by the plants, which is only very insignificant compared to the amount removed by soil erosion. In the United States, Bennett has estimated that topsoil produces 2 to 10 times greater yields than the subsoil. He also estimated that more than 21 times as much plant nutrients are lost from the soil by erosion as there are removed by crops.

Present condition of soil erosion in Masbate.—The extent of soil erosion in Masbate is shown in the accompanying map and table. The map indicates the extent and distribution of the different erosion classes in the province. Data on the approximate hectarage of the different groups of erosion are shown in the following table.

TABLE 21.—*The character and extent of soil erosion in Masbate Province.*

Types and classes of soil erosion	Average amount of original soil washed	Area in hectares	Per cent
No apparent erosion......0		65,925	16.20
Slight erosion.............1	Less than ¼ of surface soil lost.	18,850	4.60
Moderate erosion.........2	More than ¼ to less than ¾ of surface soil lost.	209,592	51.50
Severe erosion 3	¾ of surface soil to ¼ of subsoil lost.	74,213	18.24
Very severe erosion.......4	All of the surface soil to ¾ of subsoil lost.	38,421	9.46
Total..............	....	407,001	100.00

The total area surveyed as presented in the preceding table is 407,001 hectares. Of this total area, slightly less than 85 per cent has lost more than 25 per cent of its original topsoil. The province is moderately eroded as shown in the table, with 209,592 hectares or 51 per cent of the total land area having lost from 25 to 75 per cent of the original topsoil. It is estimated that 65,925 hectares have lost very little, if any, of their original topsoil as a result of erosion. A little more than 13,550 hectares are badly affected for agricultural purposes because of the hydrosol and deposition of eroded materials from the cultivated uplands.

FACTORS AFFECTING SOIL EROSION IN MASBATE

There are several factors affecting the extent and severity of soil erosion in any given area. Climate, slope, soil, and the vegetative cover of the soil constitute the main causes of soil erosion in Masbate Province. The extent of soil erosion by run-off is affected by the following factors:

Climate.—Soil erosion varies greatly with the season and to a considerable extent the character and amount of rainfall or

precipitation prevalent in a locality. It is expected that under the type of climate prevailing in Masbate, soil erosion is not as serious as in places where heavy rainfall always occur. Drought during summer leaves the soil very hard and dry, thus, creating a condition unfavorable for infiltration and percolation of water. All cultivated lands are also bare during this time of the year. So that heavy rainfalls immediately after the dry season cause excessive run-off on these cultivated lands.

Slope of the land.—The power of water to scour and erode soil depends upon its velocity and volume. And these in turn are dependent upon the slope of the land and the size of the drainage area upon which water collects and passes. Masbate has generally an undulating to rolling topography on account of its good pasture land areas. This type of land configuration creates a favorable condition for soil erosion. Soil erosion is much more intensified in this kind of relief without proper soil management practices being applied to conserve the soil. It has been generally assumed that slope is the most important factor affecting erosion by run-off.

Soil.—Some soils erode more easily than others under the same intensity of rainfall, vegetative cover, and degree of slopes. The amount of run-off is determined to a large extent by the water holding capacity and permeability of the soil. As the texture and structure of the soil appear coarser in nature, the permeability of that soil is high. The higher the permeability of the soil, the more water is absorbed and hence, little erosion occurs. In like manner, the more the organic matter content of the soil, the more water it can hold, and thus little run-off will take place on the land.

Run-off in sloping areas is further aggravated by improper tillage operations, especially in places devoted to clean-cultured crops and where cultivation is done up and down the slopes. The application of contour farming and strip cropping will help reduce accelerated erosion in these areas to the minimum. Erosion is primarily caused by overgrazing in pasture areas. Limiting the number of herd per unit area and more frequent rotation of grazing lands will help minimize catsteps and gullying.

Vegetative cover.—The nature of the vegetative cover differs greatly in their capacity to hold run-off. In undisturbed primary forests, the rain falling on the ground is absorbed and

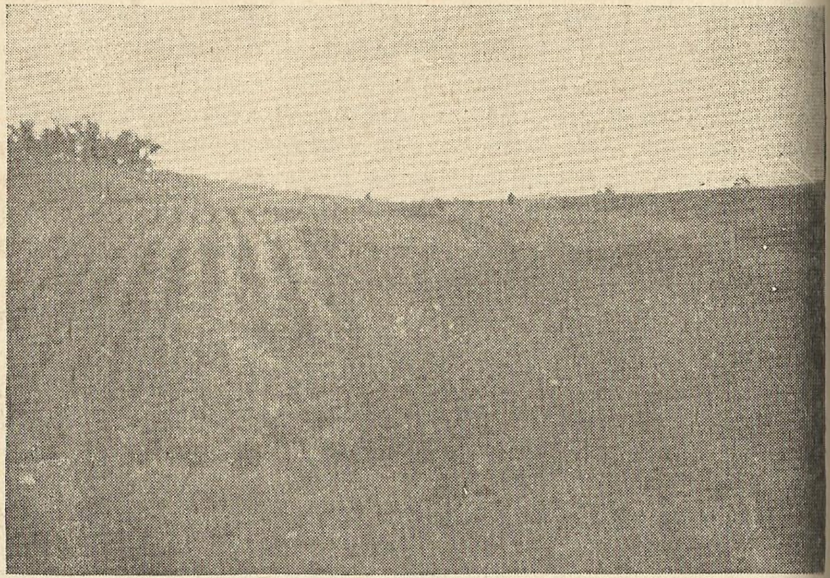

Figure 21. Plowing up and down cultivation of farm lands is a common practice in the province. Erosion class 3.

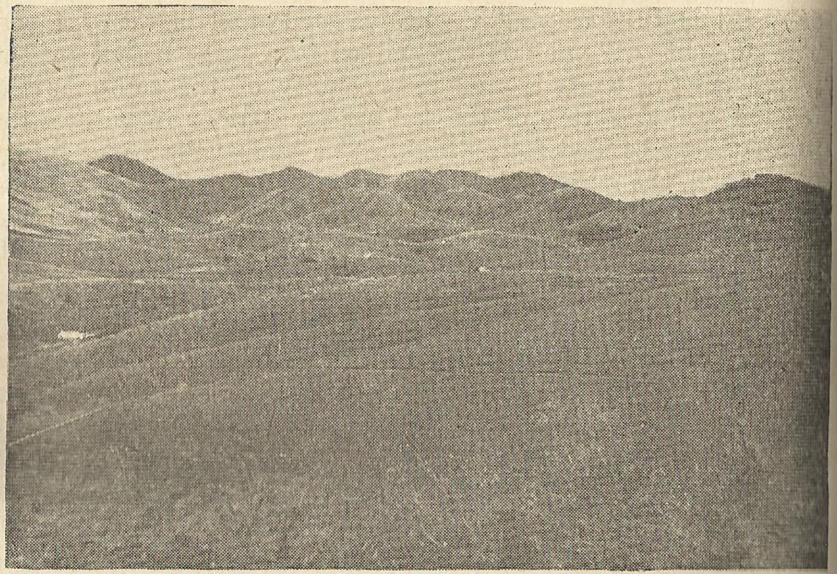

Figure 22. Undulating and rolling areas are the dominant land forms in Masbate. Note the early stages of gullying at the right foreground. Erosion class 27.

PLATE 10

held in by the leaf litters and the porous soil beneath, hence, less erosion takes place. Pasture grasses are almost as sufficient as the forest cover in preventing and checking erosion. Thick growth of grasses tends to reduce the speed of water allowing more time for it to percolate into the soil. The roots also bind the soil tight allowing little loss of soil materials. A great deal of erosion occurs in cultivated areas before the crops are big enough to reduce the impact of rainfall. A recent experiment by W. D. Ellison showed that the amount of soil lost from the vegetated plot was just one-fortieth of the amount of soil lost from the bare plot. He attributed this to the interception of rainfall by plants.

Farming practices.—The century old system of farming still exists in the province. Forest destruction caused by the "kaingin" method of farming is a common sight along the mountain sides. Hillside farming is also rampant. Most of the grazing lands before the war are now cultivated to upland rice and other clean-cultured crops. These are usually rolling to hilly areas which are very susceptible to run-off with the cultivation of row crops and the usual practice of plowing up and down the slopes. This antiquated method of farming in the province has contributed greatly in the decline of crop yields and soil destruction in some pasture lands.

Farmers all over the province should be thoroughly informed on how to use these lands properly. Cover cropping, crop rotation, strip cropping, contour plowing and other conservation measures necessary for these kind of lands should be practiced.

SOIL EROSION IN DIFFERENT AREAS

A thorough discussion of erosion in the province necessitates the grouping of the different soils into classes having similar topographic conditions. For this purpose, the soils are classified as follows:

I. Soils of the Lowlands
  1. Alluvial soils
    a. Poorly drained soils—hydrosols
    b. Well drained soils—beach sand
    c. Imperfectly drained soils
      (1) Mandawe soils
      (2) Macabare soils
      (3) Batuan soils
      (4) Sorsogon soils

2. Residual soils of the flat lands
    a. Imperfectly drained soils
        (1) Panganiran soils

II. Soils of the Uplands, Hills, and Mountains
1. Secondary soils developed from limestone and calcareous gravelly sandstone
    a. Cataingan soils
2. Residual soils developed from coralline limestone
    a. Bolinao soils
    b. Faraon soils
3. Residual soils developed from calcareous shale, limestone, and sandstone
    a. Sevilla soils
4. Residual soils developed from non-calcareous shale
    a. Himayangan soils
5. Residual soils developed from shale, sandstone, and conglomerates
    a. Ubay soils

Erosion in Lowland Soils

Lowland soils with level or nearly level topography are found mostly fringing the coastal regions. They vary from a few meters to more than a kilometer in width. These soils have practically very little erosion. There are insignificant areas that cannot be delineated in the map with the scale used. These are usually in lowland places receiving depositions of soil materials from the nearby cultivated uplands. The depositions are usually rich topsoil. There are instance, however, where debris, subsoils, and even gravels are deposited.

Poorly drained soils.—Poorly drained soils, like mangrove swamps and marshes are called hydrosols. They are found mostly on the mouths of big rivers. These hydrosols vary from a few square meters to several hectares as found in the mouths of Guiom and Nainday Rivers. The province has an aggregate area of 16,928 hectares of hydrosols. These are free from the effects of erosion and sometimes accumulate depositions. These mangrove swamps and marshes, however, have no agricultural value. At present, they are being granted to concessionaires by the Bureau of Forestry for fishpond purposes and as sources of nipa thatches and firewood which are the main industries of the people living near these areas. Tan bark extracts are important products of the mangrove swamps. They are used to give color and flavor to "tuba" or native wine extracted

from the inflorescence of coconuts and nipa. Hydrosols in some places of the province, like San Jacinto, are now being converted into fishponds.

Well drained soils.—The areas classified as beach sand are well drained varying in width from a few meters to about half a kilometer, and an aggregate area of about 5,704 hectares. Erosion is negligible which is mainly due to the action of waves. Coconuts on this land type are vigorous and productive. These soils cover Placer, Dimasalang, Milagros, Baleno, Balud, and other places.

Imperfectly drained soils.—The imperfectly drained soils of Masbate are Mandawe, Macabare, Sorsogon, and the Batuan soils which are generally formed from depositions of soil materials from the adjoining uplands. To these group of soils, the Panganiran is included because of its topographic locations although it is a residual soil from limestone and shale.

EROSION IN MANDAWE SOILS

The Mandawe soils are found extensively in Dimasalang, Baleno, and Syndicate Junction in Aroroy. As shown in the map, no apparent soil erosion occurs on account of its level to nearly level topography. These soils are good agricultural lands. The cultivation of a great percentage of Mandawe soils in Syndicate Junction is being mechanized. Corn, tobacco, peanut, bananas, cassava and other root crops thrive well in these soils. Extensive lowland ricefields are also found in Baleno. The Mandawe soils are occasionally receiving depositions from adjacent uplands which help maintain its fertility. Coconut trees grown in Dimasalang are as luxuriant as those found in the beach. Sometimes, subsoils, gravels, and other debris are deposited in these areas when the rivers inundate. This condition is, however, detrimental to the standing crops and to the land in general. In Syndicate Junction where stream bank erosion was observed, the land has depositions of gravels washed down from the adjoining mining areas.

EROSION IN MACABARE SOILS

The Macabare soils in the province are not extensive. The soils are of alluvial formation from washed down materials of the rolling and hilly sandy areas of highly weathered tuff, sandstones, and conglomerates. They are characterized by a brownish gray to reddish brown clay loam topsoil with an average depth of 30 centimeters; free from coarse skeletons, mellow, friable, and porous. The root systems penetrate readily and water percolates fast enough that erosion is checked to the minimum. Erosion is very little with the exception of some negligible gullying along small streams. Rice and coconuts are commonly grown in the Macabare soils.

EROSION IN BATUAN SOILS

The Batuan soils are mapped northwest of Dayhagan River in San Agustin, Aroroy and between Casabangan, Cataingan; and Masbaranon, Placer, and in the lowlands of Nainday–Daraga–Catmon areas. Batuan soils are derived from alluvial materials washed down from the surrounding uplands and to a certain extent from the weathering of the underlying calcareous sandstones, shales, and limestones. The topography is flat to slightly undulating with characteristic "haycock" hills on the area. The topsoil ranges from dark brown to black which are usually granular clay with brown mottlings and black to brown buckshot concretions. The depth of the topsoil varies with the surface relief. In the undulating areas near Dayhagan River and Masbaranon, the topsoil does not average more than 15 centimeters deep. In the lowlands of Nainday–Daraga–Catmon area, the surface soil usually averages 20 centimeters deep. A fairly good amount of organic matter is found in this horizon which allows good root penetration and water percolation, thus, limiting the extent of soil erosion. The thick growth of cogon grasses helps prevent erosion. The cultivated areas are planted to rice, corn, coconuts, and vegetables.

EROSION IN SORSOGON SOILS

The Sorsogon soils are of alluvial formation with level to nearly level and gently undulating topography. The area covers 632 hectares mostly along the Mayngaran River indenting the coastal area of Masbate harbor. The soils are generally planted to coconuts and permanent trees, hence, soil erosion is not a serious problem. The topsoil is brown clay loam, coarse to fine granular to columnar in structure and slightly plastic when wet and friable when dry. Water percolation is slow and is conducive to run-off in areas bare of vegetative cover.

Residual Soils of the Flat Lands

EROSION IN PANGANIRAN SOILS

The Panganiran soils are residual in origin and developed from shale and limestone with flat to almost level topography, covering an area of 2,796 hectares. The surface soil is black to brownish gray in addition to its characteristics coarse granular structure. They are strongly plastic and sticky when wet and slightly hard when dry. There are no coarse skeletons. The average depth of the surface soil is 25 centimeters. The subsoil, which is strongly plastic is dark brown, heavy clay, of good coarse granular structure. Drainage is imperfect on the more level areas. These conditions present serious problem if these areas are not utilized for lowland rice. Soil erosion could have been more serious in the Panganiran soils had it not been for its flat topography. They are mapped in various places from a few to several hectares. Coconuts, lowland rice, corn, and shrubs cover the area.

Soils of the Uplands, Hills, and Mountains

The upland soils of Masbate include Cataingan, Bolinao, Faraon, Sevilla, Himayangan, and the Ubay series which have similar topographic conditions varying only in extent and degree of soil erosion. The variations are mainly due to the present land use being practiced by the farmers; be it under forest area, pasture land or cropland, and to the inherent physical characteristics of the soil. Soil management and practices are also variable even among the cultivated croplands.

EROSION IN CATAINGAN SOILS

Cataingan soil is one of the most important upland soils in the province from the agricultural standpoint of view. It has an area of 68,308 hectares mostly mapped in southeastern Masbate. The relief varies from undulating to moderately rolling with many anthills scattered over the area. Cataingan clay and Cataingan sandy loam were identified in this series. These soils are formed from old alluvium, with water-laid white and non-calcareous stones underlain by sedimentary rocks such as limestones and gravelly sandstones at various stages of weathering. The surface soil is black to reddish brown; sandy loam to clay; slightly plastic when wet and friable when dry. It contains a fair amount of organic matter. Most of the areas were former pasture lands covered with cogon grasses. Cultivated areas are presently utilized for corn and upland rice. Erosion is not a serious problem except in the cultivated areas where 25 to 75 per cent of the topsoil have been lost through erosion. The cultivation of short season and row crops should be limited to the less steeper slopes to minimize soil erosion. The number of animals in the grazing area should be limited to such a proportion that the land could support the herd and at the same time avoid over grazing of the area.

EROSION IN BOLINAO SOILS

This is a residual soil derived from coralline limestones. It has a strongly sloping to rolling and hilly topography with good surface drainage and fair internal drainage. The vegetation is cogon with scanty second growth trees. Bolinao series is mapped in the eastern mainland of Masbate and in Ticao Island with an area of 6,366 hectares. The surface soil is reddish brown to almost red clay loam to clay; usually friable; fine and granular to a depth of 20 to 35 centimeters underlain by brownish gray to light reddish brown clay loam. The granular structure of the subsoil permits rapid water percolation. Bolinao soils are generally devoted to grazing lands. Erosion is moderate on the slightly rolling areas.

EROSION IN FARAON SOILS

The soil was mapped in the southeastern prong of the Masbate mainland occupying the hilly and mountainous areas of Alegria–Masbaranon and Casabangan to Mintoc with an area of 8,800 hectares. It is a primary soil derived from the weathering of coralline limestones; characterized by a black, granular, soft, and plastic clay topsoil in addition to its fairly high organic matter contents. In less eroded areas with 10 to 15 per cent slopes, the surface soil is usually 5 centimeters deep and on the steeper slopes with 50 per cent grade or more, the topsoil is gone and the limestone boulders are already exposed to the surface. Erosion in Faraon soils is very marked in the cultivated areas due to its sloping topography and the impervious character of the soil which accelerates soil erosion. The degree of erosion increases with the slope of the land. The present soil cover cannot afford to hold accelerated erosion in sloping areas, hence, these soils are better under permanent crops, like bananas, fruit trees, forest trees or legumes, and

other cover crops that will provide protection against run-off and gullying. Intensive cropping should be well regulated and those areas with more than 30 per cent slopes should not be utilized for croplands but instead devoted to permanent crops or grazing lands.

EROSION IN SEVILLA SOILS

The soils of the Sevilla series are mapped in the island of Burias and in the Uson–Dimasalang area in the mainland with a total area of 57,416 hectares. The topography is gently rolling to hilly and mountainous. Sevilla soils are derived from calcareous materials of shale, sandstones, and limestones. The surface soil is dark brown to black clay with an average depth of 30 to 50 centimeters. The organic matter content is high and has good root penetration. Water percolates rapidly, hence, erosion is less serious as when infiltration is slow and surface run-off is great. The cultivated areas planted to corn, upland rice, camote, cassava, and other food crops are suffering from moderate erosion. The Sevilla soils are considered agriculturally important because of their fertile topsoil. These soils are devoted mainly to pasture lands in Burias Islands. Erosion is confined to heavily grazed areas along the water routes and steep slopes where run-off is great. Soil erosion could be reduced to the minimum by rotating the pasture areas and improving the water ponds or sources of water.

EROSION IN HIMAYANGAN SOILS

The Himayangan soils occupy the rolling and hilly to mountainous coastal regions in the north and northeastern part of the Masbate mainland with an area of 31,176 hectares. They are non-agricultural soils covered with forest, second growth trees, and the "parang" type of vegetation. The surface soil is brown to yellowish gray, coarse granular sandy clay loam that is moderately friable when wet and compact when dry. It is poor in organic matter content. The depth of the surface soil varies with the relief. In steep slopes, the surface soil is about 4 centimeters or less while in moderately sloping areas it is around 8 centimeters and below. Even in the normal soil profile the surface soil is shallow varying only from 15 to 20 centimeters deep. The subsoil is slightly compact underlain by a massive sandy shale. Erosion is not a problem because it is under vegetative cover except in areas where it is cultivated to row crops.

EROSION IN UBAY SOILS

This soil occupies 176,009 hectares or a little less than half of the area of the province as shown in the accompanying map. Severe to excessive soil erosion occur in these soils. The three soil types are Ubay clay; Ubay clay, steep phase; and the Ubay sandy loam. These are residual soils that have developed from the weathering of shales, sandstones, and conglomerates. The topsoil is generally shallow ranging from 10 to 15 centimeters in depth; grayish brown to light reddish brown; and sometimes dark brown to black sandy loam. It is low in organic matter content. It has also a poor water holding capacity. The soils are undulating to rolling and hilly dissected by narrow valleys, creeks, and a few ravines. Quite a number of hills or mounds are found in the area.

Ubay clay.—The soil type covers the undulating to gently rolling slopes in the western prong and portion of the eastern prong or the larger arm of the province. This soil is less eroded than the Ubay clay, steep phase; having lost from 50 to 75 per cent of the topsoil. In the narrow valleys and lower elevations, however, the surface soil is much thicker due to the accumulation of soil deposits from the adjoining highlands. These small lowland areas are devoted to lowland rice during the rainy season. The creeks cannot be used for irrigation purposes because they dry up during the summer months of the year. Areas like these are found in several places, principally in Gabitan and Tagpo.

Ubay clay, steep phase.—The soil phase dominates the roughly rolling to hilly and mountainous areas of the western prong of the province. The predominant slope varies widely from 20 to more than 100 per cent covering an extensive area on both sides of the Milagros–Aroroy road. The soil phase occupies also the ranges of hills from Monato, Milagros to Mallin, Dimasalang. Some portions are under primary forests. The solum is characteristically shallow ranging from 20 to 40 centimeters deep.

The surface soil is porous but the substratum is compact, thus, preventing the rapid percolation of water. Most of the sloping areas are cultivated to crops, like corn, tobacco, and rice. The settlers have been forced to farm these areas due to unemployment as a result of the non-operation of gold mines and the loss of cattle industry during the occupation period. Soil erosion is due to over grazing and constant burning of the grass cover in pasture lands and plowing up and down the slopes in cultivated areas.

Ubay sandy loam.—This type of soil embraces the undulating and rolling areas between Mananca River and Cabuluan River which includes the barrios of Cabuluan, Buri, Looc, Ayat, and Canomoy in the western prong and areas between Guiom and Malbug Rivers, including the barrios of Cabayugan, Malbug, Taberna, Dupi, and Madbod. The soil is characterized by a structureless, porous, and highly friable sandy loam. The average depth of the surface soil is 30 centimeters. It is deeper in the lowland areas. The organic matter content is fair allowing rapid moisture percolation and easy penetration of roots. Soil erosion is active in the cultivated areas due to improper soil management. The crops planted are peanuts, upland rice, corn, and cassava. There is very little erosion taking place in this soil as influenced by cattle grazing, because of its slightly undulating relief and the limited number of animals in the area. Pasture lands are generally covered with "parang" type of vegetation, mostly cogon and *binayoyo* trees.

EFFECTS OF SOIL EROSION

Physical effects.—The soil erosion that has taken place in the province is due to the unwise use and improper management of the land. Soil erosion is the removal of the soil in place and with it goes all the mineral soil particles, biological population, and organic matter that support plant life. It is estimated by soil scientists that it takes thousands of years to form an inch of soil.

Soil destruction in pasture areas throughout the province is due mainly to gullying. Heavily stocked pasture lands suffered greatly from sheet erosion. Where sheet erosion had not been checked properly by proper ranch management it resulted to gully formations. Only cogon grass prevents further gullying in these areas. Gullied areas without any protective cover had become too deep to prevent both animals and farm implements to cross.

Experiments in the United States show that as a result of soil erosion, soils lacking in organic matter are unable to absorb and hold water effectively unlike soil which contains a good amount of this material. The loss of topsoil greatly affects the water holding capacity of the soil. Percolation, or the sinking of water into the soil, is very much retarded in the

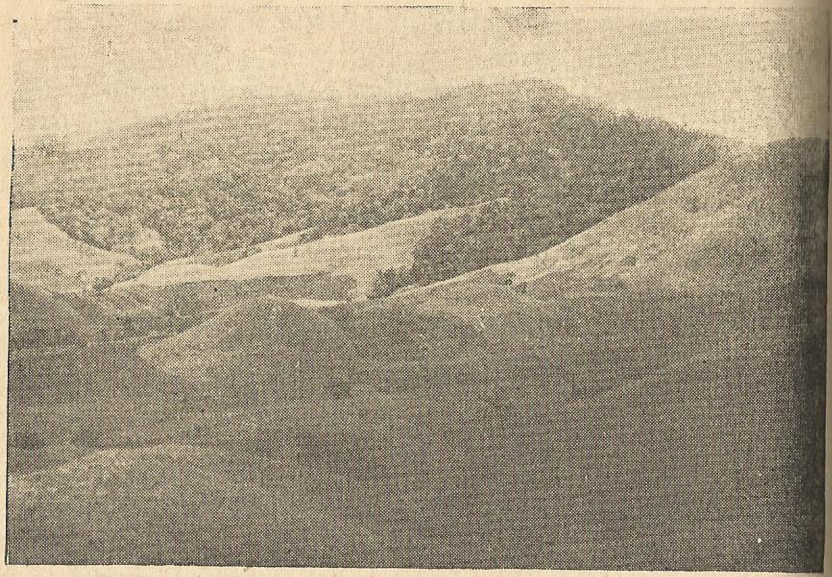

Figure 23. Ubay soils are typical grazing land in Masbate. Erosion class 2.

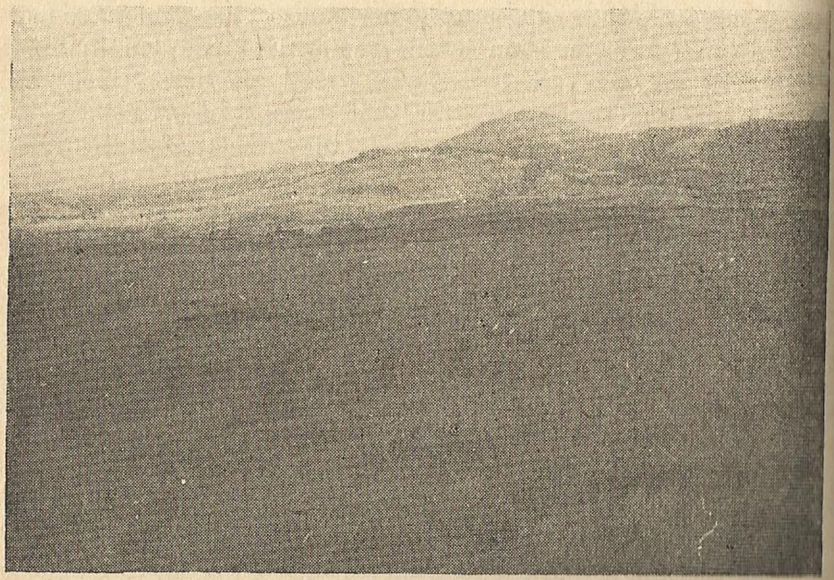

Figure 24. An extensive and typical grazing land. Erosion class 2.

PLATE 11

subsoil due to the closing of pore spaces by small particles of soil. With reduced downward movement of water surface run-off is increased.

During excessive rainfall most of the water escapes in the form of run-off which forms into streamlets and in turn empties into the rivers. During such time, these rivers swell and overflow their banks, flooding croplands and causing damage to crops, properties, and lives. Excessive run-off causes a great amount of water to escape in a short period of time. This water, if given time to percolate into the soil, would greatly add to the reserve water in the soil. This water could be used in several ways not only by plants but also by men. In excessively eroded areas plants suffer from lack of moisture during the dry months of February to May and water supply is also limited due to the drying up of springs and wells.

Soils lost from the croplands eventually find their way to the rivers, streams, and finally to the sea. Deposition of debris and gravels along the water course have caused waterways to become shallow. Masbate harbor is now the only principal port in the province where larger types of commercial vessels can dock to load and unload products. Aroroy and Cataingan harbors are too shallow and non-navigable for commercial ships. Prevention of watershed areas from further destruction by soil erosion should be maintained to safeguard harbors from siltation. Dredging of harbors to deepen the water cost tremendous sum of money.

Economic effects.—The loss of topsoil in many localities especially in the Milagros–Aroroy area is very noticeable to cause a change in the productiveness of the soil. The once fertile farms were transformed into gullied areas and the unproductive farms constitute a menace to the farmers of the downstream areas. Poor crop yields have affected the farmers economic and social life. They have caused the farmers to migrate to other places for want of better living standards. The eroded soils have affected the cattle ranchers. Because of the poor growth of pasture grasses in greatly affected areas, it has become a necessity to move further to new grazing areas.

Mining was once a flourishing industry in Aroroy before the war. Depositions of soils and gravels in the croplands of Aroroy were also observed. The eroded soils washed down from the mined areas covered the fertile lands when rivers overflowed their banks.

Cultural effects.—Even in the absence of reliable statistics, low standards of living are intimately and directly related to poor soils. When the coffer of the government is empty, it cannot support schools, hospitals, and dispensaries for the people. Public conveyances, such as roads, bridges, transportation facilities, and other utilities are also indispensable.

Lack of educational facilities is also caused by insufficient income of the government.

CONTROL OF SOIL EROSION

The success or failure of agriculture in Masbate Province in the years to come will depend in a considerable extent upon the cooperation of the farming population to conserve the soil against erosion.

In order to protect slightly affected lands and to build up seriously eroded areas, a well-planned system of land use, which will invariably involve a variety of control practices from the simplest to the most complex measure, should be applied.

For purposes of general information, the following measures will materially help control soil erosion in the province:

1. *Dissemination of conservation ideas to the farmers.*—One of the most effective ways of preventing and controlling soil erosion is to educate the farmers on how to adopt the soil conservation methods of farming. It is generally difficult to convince the farmers to change their old system of cultivation to the new conservation way of farming unless they see for themselves that this method gives better results than the old one. Actual field experiments and demonstrations are very effective ways of educating them. It clearly shows the favorable results between the old system and the conservation method of farming. The change will bring about encouraging results if a more extensive experimentation and demonstration program throughout the province will be conducted by the different agencies of the Department of Agriculture and Natural Resources.

2. *The need for land use.*—Different kinds of land have different land capability classes. Each piece of land should be properly used for which it is best suited for to get the maximum return and at the same time conserve the soil fertility and productiveness. There are extensive areas in the Ubay clay, steep phase planted to short season crops or utilized to pasture lands, that are badly eroded or too steep for cultivation and grazing. The need for wider grazing areas and land to cultivate has brought about these conditions. These areas should be under permanent trees or reforested to prevent further destruction of the soil and where reforestation is not possible they should be left idle for vegetation to grow. However, there are small areas in the Ubay series that could be used for pastures under good ranch management. Good ranch management includes proper rotation of pasture lands to permit the grass to recover, planting of desirable forage grasses such as Napier grass (*Pennisetum purporium*), Para grass (*Panicum purpurascens*), Tropical kudzu (*Pueraria javanica*), Centrosema (*Centrosema pubescens*), Alabang X (*Dichanthium aristatum*) (Poir) C. E. Hubb. var. *heteropogonoides* (Hack) Jansen, and fertilizing and liming of pasture areas to produce better forage.

3. *Stop "kaingin" method of farming.*—For lack of lands to cultivate, the farmers usually resort to the "kaingin" system of cultivation. The practice has resulted in the deforestation of wide areas of forest lands and the constant exposure of the soil to the beating action of rainfall causing excessive soil erosion.

After the war, the government has taken steps to solve the "kaingin" problem by subdividing public lands suited for their continuous or limited crop production. Most of these lands were leased pasture areas which have not been cultivated. These steps will encourage the farmers to abandon the *kaingin* farming and cultivated lands suited for crop production.

4. *Adopt efficient soil management practices.*—A soil after a long and continuous cultivation is depleted of its natural fertility. This gives rise to the general decline of crop production. What the plants have taken from the soil should be replaced back to the soil in one form or another. One of the most effective ways of correcting soil deficiency in the shortest time possible is the application of commercial fertilizers. Other practices that are recommended to increase production and at the same time conserve soil fertility are: the use of animal manures and composts; plowing under leguminous crops at blooming stage; crop rotation; proper tillage; cover cropping; and irrigation management.

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KEY TO THE SOILS OF MASBATE PROVINCE

TABLE 22.—*Key to the soils of Masbate Province.*

Soil type No.	Soil type	Source of parent material	Dominant relief	Drainage: External	Drainage: Internal	Conservation practices	Remarks
	SOILS OF THE PLAINS AND VALLEYS						
1	Hydrosol	Alluvium from different sources.	Flat	Poor	Poor	Flood control	Good for fishpond
118	Beach sand	Alluvium	Level	Poor	Poor	None	For coconut
612	Mandawe loam	Alluvial soils of recent deposits.	Level	Fair	Fair	Bench terracing on rice lands; irrigation and drainage control, fertilizer application and crop rotation.	Good rice lands and other crops.
613	Sorsogon clay loam	Alluvial soils of recent deposits.	Level to slightly undulating.	Poor to fair.	Poor to fair.	Cover cropping and soil management	Good for coconuts and other fruit trees.
214	Butuan clay	Residual soils from sandstone and shale.	Level to undulating	Poor to fair.	Fair	Introduction to pasture grasses and good herd management.	Good grazing land.
614	Macabare clay loam	Older alluvial deposits.	Flat coastal areas	Fair	Poor	Irrigation of rice fields and fertilization to reduce salinity of soils.	For rice and other crops.
465	Panganiran clay	Alluvial soils from limestone areas.	Flat to level	Fair	Poor	Fertilizer application, soil management and crop rotation.	For rice and other crops.
	SOILS OF THE HILLS AND MOUNTAINS						
178	Ubay clay	Shale and sandstone	Undulating to hilly	Excessive	Fair	Good herd management; introduction of pasture grasses.	Good pasture lands.
224	Ubay sandy loam	Shale and sandstone	Undulating to gently rolling.	Excessive	Fair	Good herd management; introduction of pasture grasses.	For pasture lands.
364	Ubay clay, steep phase	Shale and sandstone	Roughly rolling to hilly and mountainous.	Excessive	Fair	Good herd management; introduction of pasture grasses.	For pasture lands.
357	Cataingan clay	Residual soils from limestone.	Undulating to moderately rolling.	Good	Fair	Fertilizer application; crop rotation and introduction of pasture grasses.	Good for pasture and other crops.
358	Cataingan sandy loam	Residual soils from limestone.	Undulating to moderately rolling.	Good	Fair	Fertilizer application, cover cropping and introduction of pasture grasses.	Good for many crops and pasture.
615	Himayangan sandy clay loam.	Residual soils of non-calcareous shale.	Rolling to hilly and mountainous.	Excessive	Fair	Cover cropping; crop rotation and introduction of pasture grasses.	Good for pasture and other crops.
174	Sevilla clay	Residual soils of calcareous limestone.	Strongly rolling to hilly and mountainous.	Excessive	Fair	Cover cropping; crop rotation; and introduction of pasture grasses.	Good for pasture and other crops.
158	Bolinao clay	Hard coralline limestone	Gently rolling to hilly.	Excessive	Fair	Cover cropping and planting permanent trees.	Good for fruit trees and pasture lands.
182	Faraon clay	Soft coralline limestone.	Strongly rolling to hilly.	Fair	Fair	Cover cropping and planting permanent trees.	For limited crop only like fruit tree.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN MASBATE PROVINCE

Common name	*Scientific name*	*Family name*
Abaca	*Musa textilis* Nee.	Musaceae
Achuete	*Bixa orellana* Linn.	Bixaceae
Agingai	*Rottboellia exaltata* Linn.	Gramineae
Alibangbang	*Bauhinia malabarica* Roxb.	Leguminosae
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceae
Anahau	*Livistona rotundifolia* (Lam.).	Palmae
Anonas	*Anona reticulata* Linn.	Anonaceae
Api-api	*Avicennia officinalis* Linn.	Verbenaceae
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceae
Arrow root	*Maranta arundinacea* Linn.	Marantaceae
Atis	*Anona squamosa* Linn.	Anonaceae
Avocado	*Persea americana* Mill.	Lauraceae
Bakauan-babae	*Rhizophora mucronata* Lam.	Rhizophoraceae
Bakauan-lalake	*Rhizophora candelaria* DC.	Rhizophoraceae
Balangot	*Typha capensis* Rohrb.	Typhaceae
Bamboo	*Bambusa spinosa* Roxb.	Gramineae
Banana	*Musa sapientum* Linn.	Musaceae
Bangkal	*Nauclea orientalis* Linn.	Rubiaceae
Batao	*Dolichos lablab* Linn.	Leguminosae
Batino	*Alstonia macrophylla* Wall.	Apocynaceae
Bermuda grass	*Cynodon dactylon* (Linn.) Pers.	Gramineae
Binayuyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceae
Breadfruit	*Artocarpus communis* Forst.	Moraceae
Buri	*Corypha elata* Roxb.	Palmae
Cabbage	*Brassica oleracea* Linn.	Cruciferae
Cacao	*Theobroma cacao* Linn.	Sterculiaceae
Cadios	*Cajanus cajan* (Linn.) Millsp.	Leguminosae
Caimito	*Chrysophyllum cainito* Linn.	Sapotaceae
Cantaloupe or melon	*Cucumis melo* Linn.	Cucurbitaceae
Cashew	*Anacardium occidentale* Linn.	Anacardiaceae
Cassava	*Manihot esculenta* Crantz.	Euphorbiaceae
Castor oil plant	*Ricinus communis* Linn.	Euphorbiaceae
Cauliflower	*Brassica oleracea* Linn.	Cruciferae
Chico	*Achras zapota* Linn.	Sapotaceae
Coconut	*Cocos nucifera* Linn.	Palmae
Coffee	*Coffea sp.* Linn.	Rubiaceae
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineae
Corn	*Zea mays* Linn.	Gramineae
Cowpea	*Vigna sinensis* (Linn.) Savi.	Leguminosae
Cucumber	*Cucumis sativus* Linn.	Cucurbitaceae
Dapdap	*Erythrina variegata* Linn.	Leguminosae

Common name	Scientific name	Family name
Dayap	*Citrus aurantifolia* (Christm.) Swingle	Rutaceae
Duhat	*Eugenia cumini* (Linn.) Druce.	Myrtaceae
Dungon-late	*Heritiera littoralis* Dryand.	Sterculiaceae
Dao	*Dracontomelum dao* (Blanco) Merr. and Rolfe.	Anacardiaceae
Derris	*Derris eliptica* (Roxb.) Benth.	Leguminosae
Eggplant	*Solanum melongena* Linn.	Solanaceae
Gabi	*Colocasia esculenta* (Linn.) Schott, and Endl.	Araceae
Garlic	*Allium sativum* Linn.	Liliaceae
Ginger	*Zingiber officinale* Rosc.	Zingiberaceae
Guava	*Psidium guajava* Linn.	Myrtaceae
Guayabano	*Anona muricata* Linn.	Anonaceae
Ipil	*Intsia bijuga* (Colebr.)	Leguminosae
Ipil-ipil	*Leucaena glauca* (Linn.) Benth.	Leguminosac
Kalumpit	*Terminalia edulis* Blanco.	Combretaceae
Kamachile	*Pithecolobium dulce* (Roxb.) Benth.	Leguminosae
Kapok	*Ceiba pentandra* (Linn.) Gaertn.	Bombacaceae
Kondol	*Benincasa hispida* (Thunb.) Cogn.	Cucurbitaceae
Katmon	*Dillenia philippinensis* Rolfe.	Dilleniaceae
Langarai	*Bruguiera parviflora* (Roxb.)	Rhizophoraceae
Lanzones	*Lansium domesticum* Correa.	Meliaceae
Lauan (white)	*Pentacme contorta* (Vidal) Merr. and Rolfe.	Dipterocarpaceae
Lemon	*Citrus limon* Burm. f.	Rutaceae
Lettuce	*Lactuca sativa* Linn.	Compositae
Mandarin	*Citrus nobilis* Lour.	Rutaceae
Madre de cacao	*Gliricidia sepium* (Jacq.) Steud.	Leguminosae
Makopa	*Syzygium samarangense* (Blume) Merr. and Perry.	Myrtaceae
Malungay	*Moringa oleifera* Lam.	Moringaceae
Mango	*Mangifera indica* Linn.	Anacardiaceae
Molave	*Vitex parviflora* Juss.	Verbenaceae
Mungo	*Phaseolus aureus* Roxb.	Leguminosae
Mustard	*Brassica integrifolia* (West) Schulz.	Cruciferae
Nangka	*Artocarpus heterophyllus* Lam.	Moraceae
Narra	*Pterocarpus indicus* Wild.	Leguminosae
Nipa	*Nypa fruticans* Wurmb.	Palmae
Onion	*Allium cepa* Linn.	Liliaceae
Orange	*Citrus aurantium* Linn.	Rutaceae
Palosapis	*Anisoptera thurifera* (Blanco) Blume.	Dipterocarpaceae
Pandan	*Pandanus tectorius* Solander	Pandanaceae
Papaya	*Carica papaya* Linn.	Caricaceae
Patolang-bilog	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceae
Patola	*Luffa acutangula* Linn. Roxb.	Cucurbitaceae
Patani	*Phaseolus lunatus* Linn.	Leguminosae

Common name	Scientific name	Family name
Peanut	*Arachis hypogaea* Linn.	Leguminosae
Pechay	*Brassica chinensis* Linn.	Cruciferae
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceae
Pepper	*Capsicum annuum* Linn.	Solanaceae
Pili nut	*Canarium ovatum* Engl.	Burseraceae
Pummelo	*Citrus maxima* (Burn.) Merr.	Rutaceae
Pumpkin (summer squash)	*Cucurbita pepo* Linn.	Cucurbitaceae
Radish	*Raphanus sativus* Linn.	Cruciferae
Ramie	*Boehmeria nivea* (Linn.) Gaudich.	Urticaceae
Rattan	*Calamus sp.* Linn.	Palmae
Red top	*Tricholaena rosea* Nees.	Gramineae
Red lauan	*Shorea negrosenensis* Foxw.	Dipterocarpaceae
Rice or palay	*Oryza sativa* Linn.	Gramineae
Santol	*Sandoricum koetjape* (Burm. F.) Merr.	Meliaceae
Sincamas	*Pachyrrhizus erosus* (Linn.) Urb.	Leguminosae
Sineguelas	*Spondias purpurea* Linn.	Anacardiaceae
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae
Soybean	*Glycine max* (Linn.) Merr.	Leguminosae
Squash	*Cucurbita maxima* Duchesne.	Cucurbitaceae
Sugar cane	*Saccharum officinarum* Linn.	Gramineae
Sweet potato	*Ipomoea batatas* (Linn.)	Convolvulaceae
Tabigi	*Xylocarpus granatum* Koenig	Meliaceae
Talahib	*Saccharum spontaneum* Linn.	Gramineae
Tangile	*Shorea polysperma* (Blanco) Merr.	Dipterocarpaceae
Tobacco	*Nicotiana tabacum* Linn.	Solanaceae
Tomato	*Lycopersicum esculentum* Mill.	Solanaceae
Tugui	*Dioscorea esculenta* (Lour.)	Dioscoreaceae
Ubi	*Dioscorea alata* Linn.	Dioscoreaceae
Upo	*Lagenaria leucantha* (Duch.) Rusby.	Cucurbitaceae
Vetiver grass	*Andropogon zizanoides* (Linn.) Urban.	Gramineae
Watermelon	*Citrullus vulgaris* Schrad.	Cucurbitaceae

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