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SOIL SURVEY OF SORSOGON PROVINCE PHILIPPINES

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INTRODUCTION

The soil directly or indirectly influences our daily lives, and, for that matter, we are duty bound to protect, safeguard, conserve, and preserve the soil for posterity.

One of the means to accomplish this purpose is to take the inventory of the soil resources through soil survey, the result of which would give a systematic information as to the capacity of the soil, its needs, requirements, and treatments necessary. There should be available a working knowledge for the different soils under various conditions for their best use to get the maximum return of investment per unit area.

Charles E. Kellogg of the U.S.D.A. mentioned that the ultimate purpose of soil survey is "to provide accurate map necessary for the classification, interpretation, and extension of data regarding agricultural production, the classification of rural lands, and for factual basis in the development of sound programs of rural land use, whether planned by public or private agencies, or by individuals."

To attain this end, a soil survey work of Sorsogon Province was conducted from July 8 to November 19, 1948, inclusive, by the Bureau of Soil Conservation (now the Bureau of Soils) under the directorship of Dr. Marcos M. Alicante and during the incumbency of Hon. Mariano Garchitorena as Secretary of Agriculture and Natural Resources. Discussion on land capability classes of the different soils in Sorsogon Province was added in this manuscript. This report was updated, edited, and proofread by Mr. Juan N. Rodenas, Soil Technologist, Bureau of Soils.

SUMMARY

Sorsogon Province occupies the southernmost tip of the Bicol Peninsula. It has a total area of 2,054.5 square kilometers, or 205,450 hectares. Sorsogon is its capital, which is 270 nautical miles from Manila.

The relief ranges from narrow coastal plains and valleys to undulating, gently rolling, steep slopes, rugged hills, and mountains. Mount Bulusan with 1,560 meters elevation, Sharp Peak having 1,215 meters elevation, and Rock Dome having 1,099 meters elevation are the three conspicuous mountains of the province.

The coastline is very irregular with several indentures; Sorsogon Bay is the largest. Wave-cut cliffs are characteristics on the south and southwest coastline of the province.

Early and middle tertiary volcanic and intrusive rocks are mostly found in the southern part of the province, while Tertiary and Quarternary volcanic rocks predominate the eastern and northwestern sections. Along the Sorsogon Bay are quarternary alluvium of terraces, flood plains, deltaic, and littoral deposits. Tuffaceous rocks and coralline limestone are also found.

The province has a radial pattern of natural drainage. All the rivers draining the province have their headwaters located in the hills and mountains. Among the big rivers of the province are Donsol, Putiao, Hipanao, Dalagnan, Casiguran, Cadacan, Banuangdaan, Fabrica, Irosin, Ogod, and Buhang Rivers.

Potable water supply is adequate in the province. Most of the water is obtained from wells and springs either through gravity, pumping or other mechanical devices.

Commercial and noncommercial forests occupy 23.19 per cent of the total area of the province, while the grassland and cultivated land comprise 74.90 per cent. The swamps and mangroves constitute the smallest area being only 1.91 per cent of the total area of the province.

The province was first explored by Spanish Capt. Luis Enriquez de Guzman in 1569, and then followed by Juan de Salcedo in 1573. After these exploration, the Spaniards estab-

lished a mission in Casiguran, a port in Sorsogon Bay. This mission was later spread to Bacon and Sorsogon, Sorsogon, the present capital of the province.

The work of the missionaries was never challenged until the year 1649 when the people rose in rebellion and tried to drive away the Spanish Friars. This first outbreak of hostilities, however, was never successful. Nevertheless, it netted some reforms in the government.

The years that followed the aborted uprising were devoted to the advancement of agriculture and commerce which brought progress to the province. The first hemp-stripping machine was invented in the province and galleons were built in Pilar and in Bagatao Island. These galleons were used by the Spaniards in the Manila–Acapulco trade.

Like the other provinces of the country, Sorsogon Province came under the revolutionary government during the later part of the 19th century and participated in the general revolution that defeated the Spanish government in all provinces of the country.

Civil government was established in Sorsogon Province, which included Masbate, on April 30, 1901. But in 1921, Masbate became a separate province. At present the province has 16 municipalities.

The population of Sorsogon Province in 1918 was 178,443; in 1938 was 245,400; and in 1948 was 291,140.

Transportation facilities in the province, both land and sea, are adequate. There is a total of 332.45 kilometers of first, second, and third class roads besides the Juban–Magallanes and Matnog–Sta. Magdalena roads which were inaugurated after the soil survey of the province. A national highway connects the province with Albay Province.

Sorsogon, Magallanes, Bulan, and Gubat are the commercial ports of the province where foreign and interisland vessels call to load and unload articles of trade and commerce. Launches, motor bancas, and "batel" are used by farmers in transporting their products from one town to another among the towns along the shore.

Public and private schools are available in the province. In the year 1947–1948, there were a total of 340 elementary schools and 10 secondary schools, including 1 trade school.

The health of the populace is adequately taken cared of by the government and private institutions. There is one public hospital located in Sorsogon, Sorsogon, and 17 dispensaries in different towns, besides 4 puericulture centers looking after the health of the people.

The province falls under the second type of rainfall of the Philippines, except the narrow western extremity which is under the fourth type of rainfall. The second type of rainfall has no dry season with a very pronounced maximum rain period from November to January. The months of March to June have less rainfall. The fourth type of rainfall has no very pronounced rain period and no dry season. The annual rainfall for the second type of climate in the province ranges from 2,474.2 millimeters in Castilla to 4,723.2 millimeters in Juban.

Agriculture is the main industry of the people of the province. Manufacturing, fishing, lumbering, trade and commerce are the other industries.

A total farm area of 72,066 hectares was cultivated to various crops in the province in 1948. The value of the crops produced for the same year amounted to ₱13,171,543, while the fruits and nuts were valued at ₱12,174,264 or a combined value of ₱25,345,807. The ten important crops grown are coconut, rice, abaca, camote, cassava, corn, gabi, sugar cane, maguey, and eggplant. Coconut and abaca are export crops. The six important fruit trees are banana, pili nut, jackfruit, chico, papaya, and pummelo.

The age-long agricultural method of farming in the country is followed by majority of the farmers in the province. The carabao and cattle remain the main source of power and the plow and harrow are the principal implements of tillage. The use of farm machinery and fertilizer on the farm has been increasing and gaining a place in the agriculture of the province.

The total number of livestock and poultry in the province as recorded in the 1948 census was 283,974 valued at ₱4,957,165. The total farm investment amounted to ₱22,424,310.32, including land, buildings, equipment, and work animals.

The 1948 census shows that there were 23,403 farms in the province comprising 97,283.22 hectares. Of these farms, 56.95 per cent were operated by owners; 5.45 per cent by part owners; 22.80 per cent by share tenants; 0.44 per cent by share-cash tenants; 0.32 per cent by cash tenants; 13.52 per cent by other tenants; and 0.52 per cent by farm managers. The average size of farm was 4.16 hectares. Agriculture in the province is diversified, having 11 types of farms.

The soils of Sorsogon Province were mapped into three general groups, namely, (1) soils of the plains and valleys, (2) soils of the flat upland, undulating, rolling, hills, and mountains, and (3) the miscellaneous land types.

The soils of the plains and valleys are agricultural lands. They comprise a total area of 24,920 hectares or 12.16 per cent of the total area of the province. These soils include the Bascaran, Sorsogon, Macabare, Donsol, Silay, Irosin, and Pañganiran series. They are alluvial soils well adapted to all crops grown in the locality. They are presently devoted to lowland rice, coconut, abaca, corn, and root crops. They have no erosion problem but some of them need artificial drainage for optimum yields of the crops.

The soils of the flat upland, undulating, rolling, and hilly areas are primary soils having an aggregate area of 175,120 hectares or 85.25 per cent of the total area of the province. These soils include eight soil series and one soil complex, namely, Castilla, Bolinao, Ubay, Annam, Luisiana, Casiguran, Bulusan, and Sevilla series; and Castilla–Bolinao complex. Of these soil series Castilla with 38,520 hectares, Casiguran with 38,120, and Bulusan with 30,540 hectares are the most extensive. They are devoted principally to coconut, abaca, upland rice, corn, and root crops. They are susceptible to severe erosion and many sections of the area have become submarginal to all crops as a result of continuous erosion. These soils need extensive soil conservation measures for optimum yields of the crops.

The miscellaneous land types comprise the hydrosol and beach sand with an aggregate area of 5,440 hectares or 2.59 per cent of the total area of the province. These land types are not important for agricultural purposes. The hydrosol may be good for fishponds and for wildlife while part of the beach sand may be planted to coconut and some fruit trees.

The secondary soils of the province have been developed from recent and older alluvial deposits while the primary soils have been formed from the weathered products of different country rocks mostly basalt, andesite, shale, sandstone, limestone, tuff, conglomerate, and agglomerate. On the basis of topography, mode of formation, and kind of profile, they are placed into profile groups I, II, III, IV, VII, and VIII. The first four profile groups are alluvial soils and the last 2 profile groups are primary soils.

The soils of the province were classified into land-capability classes A, B, C, D, M, and X. Classes A, B, and C are croplands and have a total area of 86,730 hectares; class D is a pasture land with a total area of 6,050 hectares; class M is a forest land with a total area of 108,620 hectares; and class X with a total area of 4,050 hectares is good for fishpond, recreation, and wildlife purposes.

The productivity ratings of the various soils of Sorsogon Province are shown in table 15. From this table it can be seen that the soils of the province vary in their production of the major crops. They are generally less productive than the soils with the standard index, except for coconut.

The control of runoff and erosion is a major problem in the province. About 175,090 hectares, or 85.15 per cent of the total area of the province, have slopes ranging from 3 to 60 per cent or more and are subject to all stages of erosion. Only about 30,360 hectares, or 14.85 per cent, have no apparent erosion. The control of runoff and the conservation of water in the province can be achieved through proper soil management practices by using vegetative and mechanical methods, fertilization, addition of organic matter, and good tillage suited to the need of the various kinds of the soils of the province.

SOIL SURVEY OF SORSOGON PROVINCE PHILIPPINES

DESCRIPTION OF THE AREA

Location and extent.—Sorsogon is one of the four provinces of the Bicol Peninsula, occupying its southernmost tip (fig. 1). North of it is the province of Albay and its eastern boundary is the Pacific Ocean. The San Bernardino Strait and the Ticao Pass delimit it on the south, while on the west are the Ticao Pass and the Burias Pass. The town of Sorsogon along the Sorsogon Bay is the capital of the province. It is 279 nautical miles or 380.8 kilometers from Manila. The province has a total area of 2,054.5 square kilometers, or 205,450 hectares.

Relief and drainage.—The province consists of various plains and valleys, ridges, escarpments, gently to rolling and steep slopes to hills and mountains (fig. 2). The level coastal plains and valleys rise abruptly to rolling uplands and blunt-topped hills into rugged mountains. The three most conspicuous of the mountains are the Rock Dome (1,099 meters elevation) located on the northern part of the province; Mount Bulusan (1,560 meters elevation) and Sharp Peak (1,215 meters elevation) which are located in the south-central part of the province. South of Rock Dome and Mt. Bulusan is a broad valley, traversed by the Irosin River. There are less prominent peaks scattered in the northern and central parts of the province.

The coastline is very irregular with several indentures, the largest of which is the Sorsogon Bay. This bay has a deep and landlocked body of water, a condition characteristic of a good harbor. The predominance of wave-cut cliffs are characteristics of the south and southwest coastlines of the province.

The province has a radial pattern of natural drainage (fig. 3). The rivers that drain the province have their headwaters located in the hills and mountains. Among the longest and biggest of these are Donsol, Putiao, Hipanao, Dalagnan, Casiguran, Cadacan, Banuang-daan, Fabrica, Irosin, and Buhang Rivers. The rivers and their tributaries draining the northwestern part of the province have their headwaters originating from the highlands of the northern provincial boundary and empty into the Burias and Ticao Passes. On the other hand,

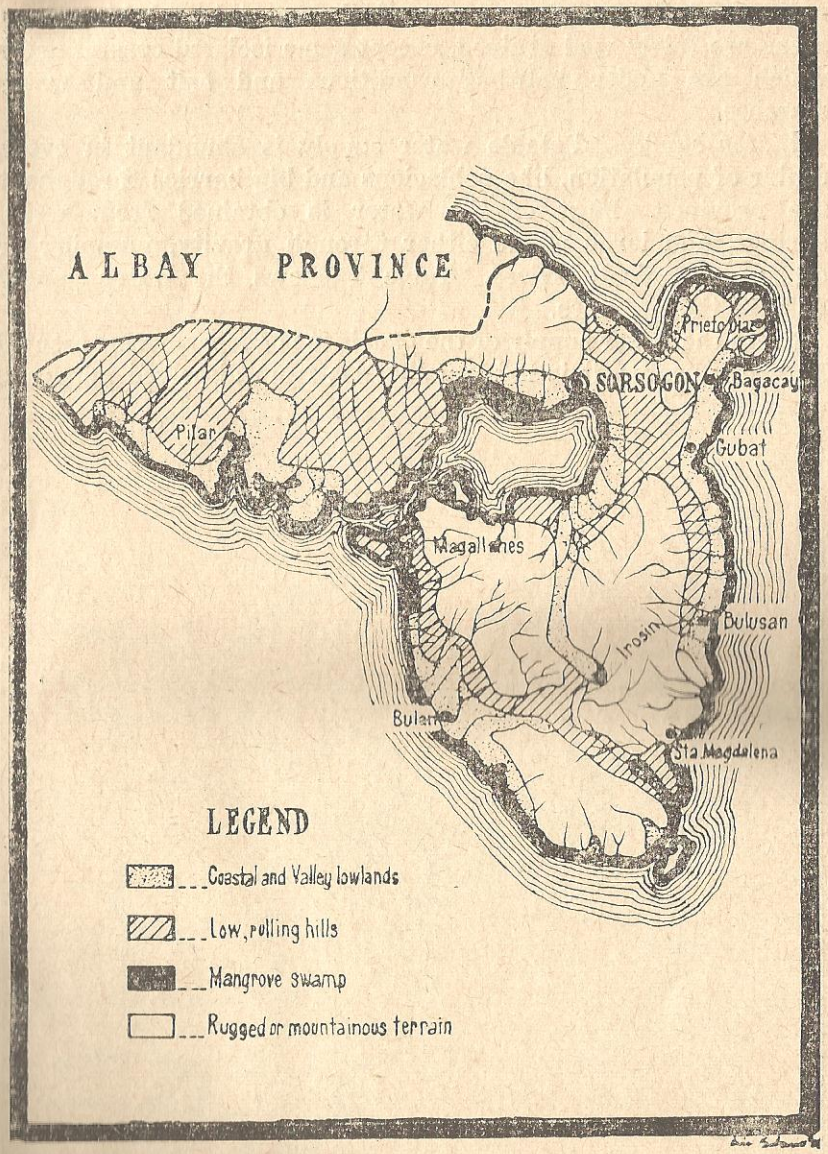

Figure 2. Map of Sorsogon Province showing the general physiography.

the rivers that drain the central and southern parts of the province have their sources from Sharp Peak and Mount Bulusan and empty into the Sorsogon Bay, Ticao Pass, and San Bernardino Strait.

In general, the province is well dissected with rivers, streams, and creeks which empty into the sea. Because of this drainage

pattern of the province, most of the coastal and hinterland areas are fairly well drained, except some isolated coastal areas which are under half-bog conditions and salt and water marshes.

Water supply.—Potable water supply is abundant in every center of population, like poblacions and big barrios throughout the province. Most of the water is obtained from wells, springs, and large rivers either through gravity, pumping or other mechanical devices. Table 1 shows the water supply data in the province.

Since the water supply of the province is generally represented by groundwater, it is not usually free from dissolved minerals.

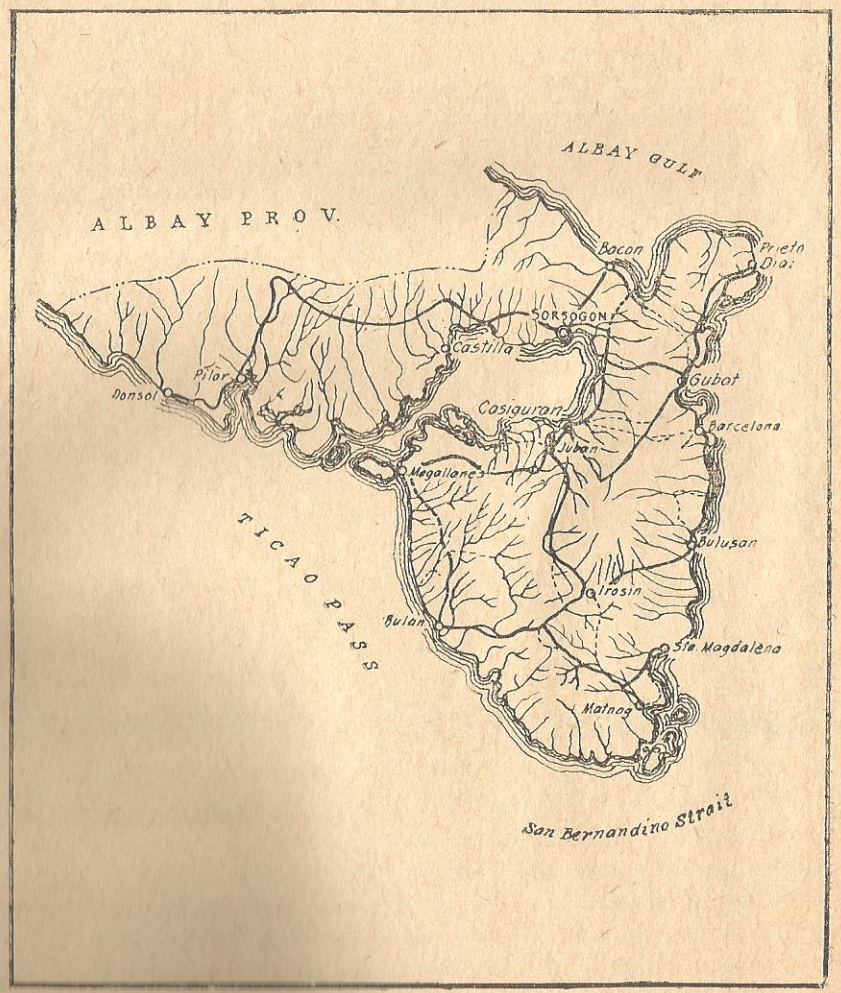

Figure 3. Map of Sorsogon Province showing drainage pattern.

However, the nature and quantity of the chemical salts carried in solution differ widely from region to region. Table 2 shows the chemical analysis of the different samples of water taken from representative sections of the province.

TABLE 1.—*The different water supply of the province of Sorsogon, including the municipality, population served, type, depth, and capacity.*[1]

Municipality	Population served	Type	Depth (ft.)	Capacity in gallons per day
Bacon	3,200	Gravity	530	79,200
Bulan and extension to army cadre	1,150	do	395	136,800
Bulusan	3,500	do		64,800
Casiguran-Juban	12,000	do	520	259,200
Juban		Pumping	485	17,280
Castilla	1,500	Gravity		28,800
Donsol	4,000	do		
Gubat	7,000	do	313	288,800
Gubat—Barrio Bulacao	6,000	Pumping	410	129,000
Irosin	4,000	Gravity	510	144,000
Magallanes	8,500	Gravity & pump	400	115,200
Sorsogon and extension to army cadre	6,400	Gravity & pump	305	242,000

[1] Northern Luzon, Phil. Islands. Terrain Intelligence. Special Report No. 135. Strategic Engineering Study, Geologic Survey, U. S. Dept. of Interior.

TABLE 2.—*Analysis of water supply in Sorsogon Province in parts per million*

Municipality	Total solids	SiO_2	Fe	Ca	Mg	Cl	SO_4	CO_3	HCO_3
Bacon	1,052	62	0.5	25	9.2	382	18		
Bulan and extension to army cadre	1,295	75	T	57	36.0	380	82		310
Casiguran—Juban	300	36	T	43	6.5	43	23		
Juban	380	120	5.7	14	1.2	8.9			
Donsol			0.2			44	17		440
Gubat	700	77	0.3	110	17.0	130	12		320
Gubat—Barrio Bulacao	840	80	0.3	130	25.0	210	22		350
Irosin	515	100	0.7	48	49.0	27	31		350
Magallanes	1,300	10	1.7	50	32.0	518	52		
Sorsogon and extension to army cadre	243	88	4.6	19	10.0	6.4	79		

There are mineral springs and medicinal hot springs found around the foot of Mount Bulusan. Some of these springs are in Monhon, Bujan and in Mapaso. Others are found in the barrios of San Roque, San Benon, and Masacrot, municipality of Irosin.

Geology.—Geologically, the southern part of the province consists of early and middle Tertiary volcanic and intrusive rocks, such as andesite lavas, volcanic conglomerate and breccia and tuff, locally hydrothermally altered. On the eastern and northwestern parts are late Tertiary and Quarternary volcanic rocks, some of which are basaltic and andesitic lavas, and water-laid tuffs in surrounding areas. Along the Sor-

sogon Bay are Quarternary alluvium of terraces, flood plains, deltaic, and littoral deposits. Tuffaceous clastic rocks and coralline limestones are also found.

Vegetation.—Sorsogon Province has three major types of natural vegetation; namely, forest, grass and cultivated crops, and marsh vegetation consisting of fresh and salt water marshes. The extent of these vegetal covers is shown in table 3.

TABLE 3.—*Area and extent of the actual soil cover of Sorsogon Province*[1]

Kind of soil cover	Area in hectares	Percentage
Commercial forest	25,300	12.32
Non-commercial forest	22,342	10.87
Open-cultivated land	151,728	74.90
Swamps	6,080	1.91
Total	205,450	100.00

[1] Census Office of the Philippine Islands, 1947. Yearbook of Philippine Statistics, 1946. Bureau of Printing, Manila.

The forest vegetation of the province consists of the commercial and the non-commercial forest. Most of the mountains of the province are covered with commercial or primary forest where excellent timbers from first to fourth class are cut for export. A few representatives of these commercial timbers are as follows:

Narra
Molave
Apitong
Guijo
Yakal
Dao
Lauan (red)
Lauan (white)
Tangile
Ipil
Akle

The commercial forest is located mostly in the northeastern section of Albay-Sorsogon border, around Mt. Bulusan, and in the mountain ranges of the towns of Matnog and Sta. Magdalena. The non-commercial forest is mostly the second growth and communal forest of the province. It is found in areas contiguous to the commercial forest. Its trees are generally utilized for less durable housing materials and for firewood.

The open and cultivated lands embrace those areas under cover of *parang* type, meadows, and areas cultivated to annual and perennial crops. The *parang* type of vegetation is predominated by cogon, admixed with *talahib*, vetiver grass and *amorsecos*. Scanty growth of trees like *binayoyo*, guavas and

other smaller trees are found. The cultivated crops are rice, corn, root crops, vegetables, fruit trees, abaca, coconuts, and bananas.

The salt water marshes are extensive in the eastern coast of the province. Several species of halophytic plants are growing in these areas, some of which are nipa palms, *api-api*, *bakauan*, *dapdap*, *dungon-late*, and ferns locally called *tinglog*.

Organization and population.—The early organization of the province started from every center of population which later grew into towns. Historical accounts about the province reveal that the early Spanish exploration was undertaken by Capt. Luis Enriquez de Guzman in 1569, who made extensive travels over the province. He was followed by Juan de Salcedo in 1573. At that time the province was made a part of Albay Province.

The earliest step taken by the Spaniards to secure a permanent hold on the province was the establishment of a mission in Casiguran, a port in the Sorsogon Bay. In the following years the Spanish activities spread to Bacon and Sorsogon, Sorsogon. It appears that Sorsogon, the present provincial capital, was only an outgrowth of Bacon in the beginning.

Influenced by the rebellion of Sumoroy in Samar, the people of Sorsogon Province rose in rebellion, and drove away the Spanish friars of the town of Sorsogon. The first serious disturbance took place in 1649. However, it was not successful. Nevertheless, the cause and its effect netted some reforms in the government. During the peaceful recession, several endeavors were created along agriculture and commerce. Significant among them were the invention of the hemp-stripping machine by a priest named Espellargas and the building of many galleons in Pilar and in the island of Bagatao at the entrance of Sorsogon Bay. These galleons were used by the Spanish Government in the Manila–Acapulco trade. Agriculture and commerce have flourished and brought progress to Sorsogon and its inhabitants, despite the fact that Sorsogon remained a part of Albay Province.

Interruption of the progress of Sorsogon in agriculture and commerce came in the nineteenth century, when the Filipinos started uprising against the Spanish domination. At the outbreak of this uprising, Sorsogon, like Albay Province, remained peaceful for sometime. Later, it came under the revolutionary government and participated in the general revolution which

defeated the Spanish Government in all provinces of the country. The most prominent military leader of the province at that time was Vito Bellarmino.

Civil government was established in Sorsogon Province on April 30, 1901. Included in her jurisdiction was Masbate. But in 1921, Masbate became a separate province. For that matter, Sorsogon Province, with her reduced area, consisted 16 municipalities; namely, Sorsogon, Bacon, Pilar, Prieto Diaz, Gubat, Barcelona, Bulusan, Sta. Magdalena, Matnog, Irosin, Bulan, Donsol, Castilla, Casiguran, Juban, and Magallanes. There are 279 barrios in the province.

Sorsogon Province had a population of 178,443 in 1918; 245,400 in 1938; and 291,140 in 1948.

Transportation and market.—The province has good land and sea transportation facilities. All towns and big barrios are connected to the provincial capital by either a second class or first class road. The "Facts and Figures of 1946–1947" shows the extent of roads in the province as follows:

1. First class road	175.60 kilometers
2. Second class road	129.73 kilometers
3. Third class road	27.10 kilometers
Total	332.43 kilometers

In addition to this total length of road, the Juban–Magallanes road was inaugurated in 1949, and the Matnog–Sta. Magdalena road was completed that same year. Due to this network of roads, every town and big barrios are accessible by land transportation. The cart and the carabao, however, remain the principal vehicle of the farmer in transporting farm products. A national highway connects the province with Albay Province.

Big land transportation companies maintain lines in the province besides small cars, jeeps, and bus owners. Some of the big transportation companies are the Bitranco, which has a route extending to Naga, Camarines Sur; the Alatco, which maintains the same route; and the Manila Bus Line, which maintains train connections to Sorsogon from Naga and Legaspi, Camarines Sur and Albay Provinces, respectively.

The ports of call in Sorsogon, Magallanes, Bulan, and Gubat are open to commercial ships and interisland vessels to load export products, like copra and abaca, and to unload articles of commerce and trade. Weekly trips of ships from Manila

calls at either ports of Bulan and Sorsogon or both. Daily trips of interisland vessels from Masbate and other islands call at Bulan. Sailboats and banca, however, are the principal sea transportations used generally by the people along the coastal towns and barrios in their daily commerce and in transporting their farm products. The port of Bulan is the busiest in the province.

The Philippine Air Lines, Inc., has no regular schedule in province. Usually it calls at Bulan airport Thursday and Saturday only.

Telegraph and radio communications are available in the province. Sorsogon, Bulan, Gubat, Irosin, Bacon, and Donsol are provided with either a telegraph or radio office to transmit messages from one municipality to another in the province as well as to other provinces in the country.

The Post Office takes care of the mail in the province. Every municipality has a post office for the convenience of the public.

Markets in the province are the centers of business transactions of commerce and trade. Farmers bring their farm products and manufactured articles to these places. The transactions may be either in cash or barter. Almost every big barrio and town has its own market day, except Sorsogon poblacion, where every day is a market day.

Cultural development and improvement.—Public and private schools are available in the province. According to statistics, the growth of schools in the province has been comparatively fast. In 1918, the province had a total of 92 schools classified into 85 primary schools, 5 intermediate schools, 1 high school and 1 vocational school, all of which had a total enrollment of 11,832 students. This total enrollment was increased to 31,094 with a corresponding increase in the number of schools in several barrios and towns in 1939–1940. In 1945–1946 the total number of schools in Sorsogon Province increased to 225, of which 222 were elementary and 3 were secondary schools with a total enrollment of 45,558 students. In 1948 there were 340 elementary schools and 10 secondary schools including one trade school with a total enrollment of 63,672 or more students. The above data show the progress made in Sorsogon Province in the education of the masses.

The landmarks of the Spanish influence in the cultural development of early times are the churches which are located in the heart of every town. Several of the churches were

destroyed during World War II. Some are in the process of rehabilitation. Chapels for other religions are also strategically located. Weekly congregation are mostly noted in these places. The influence of religion on the moral culture of the people cannot be overlooked.

The health of the population has become the concern of the government. There is one public hospital in Sorsogon and 17 dispensaries in different towns, besides 4 puericulture centers which look after the health of the people. Traveling health officers and dispensaries, from time to time, make investigations on the health conditions of the people in remote places and make treatment of cases right on the spot. School dentists and doctors are included in this group.

Industries.—Agriculture is the major industry of the people in the province. The other industries are fishing, manufacturing, lumbering, commerce, rope making, and other household industries.

In 1918 the province was credited with 781 establishments for house industries and 68 manufacturing establishments which gave an annual income of ₱245,810.10 and ₱2,848,223.79, respectively, to the province. But in 1938 the number of operators engaged in the manufacture of varied articles was 6,729 employing 13,412 men and the total value of the manufactured articles was ₱485,481. There was a relative increase in the number of operators but there was a great decrease in the value of manufactured articles.

The furniture manufacturing is making a name for the province. First class lumbers like narra and molave, especially the former, are used. Beds, chairs, tables, dressers, and other household furnishing are manufactured and sold cheaply in Sorsogon. There are more establishments for furniture in Sorsogon Province than any other industries. Most of these establishments are found in Sorsogon town, Prieto Diaz, outskirt of Irosin, and other places which are near the sources of lumber.

Fishing is one of the leading minor industries of the province. In 1938 the quantity of fisheries of all kinds recorded for the province was 782,407 kilos valued at ₱203,865. The fishing regions of Sorsogon are Donsol, Pilar, Castilla, Magallanes, Bulan, Matnog, and Sta. Magdalena.

Lumbering is another lucrative industry during the post war period. In 1946 Sorsogon had 61 lumber establishments

that employed 466 men and the gross sales reached as high as ₱124,998. Some of these lumbers are exported to other places or provinces. The town of Matnog is noted for its lumber output.

Commerce is another important industry of the province. Interisland and foreign ships call at the ports of Sorsogon Province to unload and load commercial articles.

The household industries consist of the manufacture of abaca slippers, shoes and other woven abaca products. Making of abaca slippers is the most important. The town of Gubat is highly noted for its abaca products, but there is no commercial establishment for such household industry.

CLIMATE

Climate may be defined as a composite or generalization of the variety of day to day weather conditions expressed by a combination of several atmospheric elements; namely, temperature, precipitation, humidity, cloudiness, winds, and air pressure. Climate plays an active part in the formation of soils, besides affecting the physiological functions of economic plants, the pattern and characteristics of drainage, and to a degree the nature of land forms. It is also a determinant factor of the degree of diversification and adjustment of farm operations or practices.

Sorsogon Province falls practically under the second type of rainfall of the Philippines, except the narrow western extremity, which is under the fourth type of rainfall (fig. 4).

The second type of rainfall has no dry season with a very pronounced maximum rain period from November to January. Under this type, much of the cyclonic rain occurs during July to February with a maximum precipitation from November to January. The months of March to June have the least rainfall. There is not a single dry month in the region under this type.

The fourth type of rainfall, occurring in the western narrow section of the province, has no very pronounced rain period and no dry season. Both the cyclonic and the northeast monsoon as well as the thunderstorm rains are experienced in this region without a single dry month during the year. The minimum rainfall occurs generally during the months of March to May.

Rainfall.—Table 4 shows the annual rainfall among the weather station in the province. It ranges from 2,475.2 millimeters in Castilla to 4,723.2 millimeters in Juban. The months

easterly directions is 15. The percentage of calm is 20 for the whole year, 29 for the period of June to October, and only 14 for the period of November to May. During the northeast monsoon, Sorsogon and southeastern provinces are usually visited by typhoons of varying intensities and destructiveness to lives and properties, especially standing crops. Perhaps, the strongest typhoon or wind of highest velocity which passed over the province was the typhoon "Jean" in December 1947.

TABLE 5.—*The means of the monthly and annual extreme temperatures of Gubat Station, Sorsogon* [a]

Months	Temperature from 1908 to 1918		
	Maximum	Optimum	Minimum
	° C.	° C.	° C.
January	31.0	25.8	20.0
February	31.0	25.9	19.6
March	31.4	26.6	20.7
April	33.0	27.7	20.6
May	34.8	28.4	21.7
June	34.7	28.4	22.4
July	34.5	28.0	22.1
August	34.8	28.4	22.4
September	34.6	28.1	21.9
October	34.1	27.4	20.9
November	32.6	26.9	20.6
December	31.6	26.3	20.8
Annual average	35.7	27.3	18.8

[a] Census of the Phil. Islands, 1918. Temperature.

Relative humidity.—Generally the relative humidity in the Philippines is high. This is due to (1) the extraordinary evaporation from the seas that surround the country, (2) the richness of the vegetation, (3) the different prevailing winds occurring in different seasons of the year, and (4) the abundant rains so proper of a tropical country. The first two may be considered the general causes of the great humidity which is observed generally in all the islands throughout the year, while the last two may influence in different degree the humidity of the different months of the year and of the different regions of the archipelago.

In Sorsogon Province where the second type of rainfall occurs practically throughout, the region has a relative humidity gradually increasing from September to December. Its annual range is from 78 per cent during April to 83 per cent for December. The annual mean is 81.5 per cent. Figure 5 shows the graph of the climatic element for the second type of rainfall of the Philippines as compared with that of Gubat, Sorsogon Province.

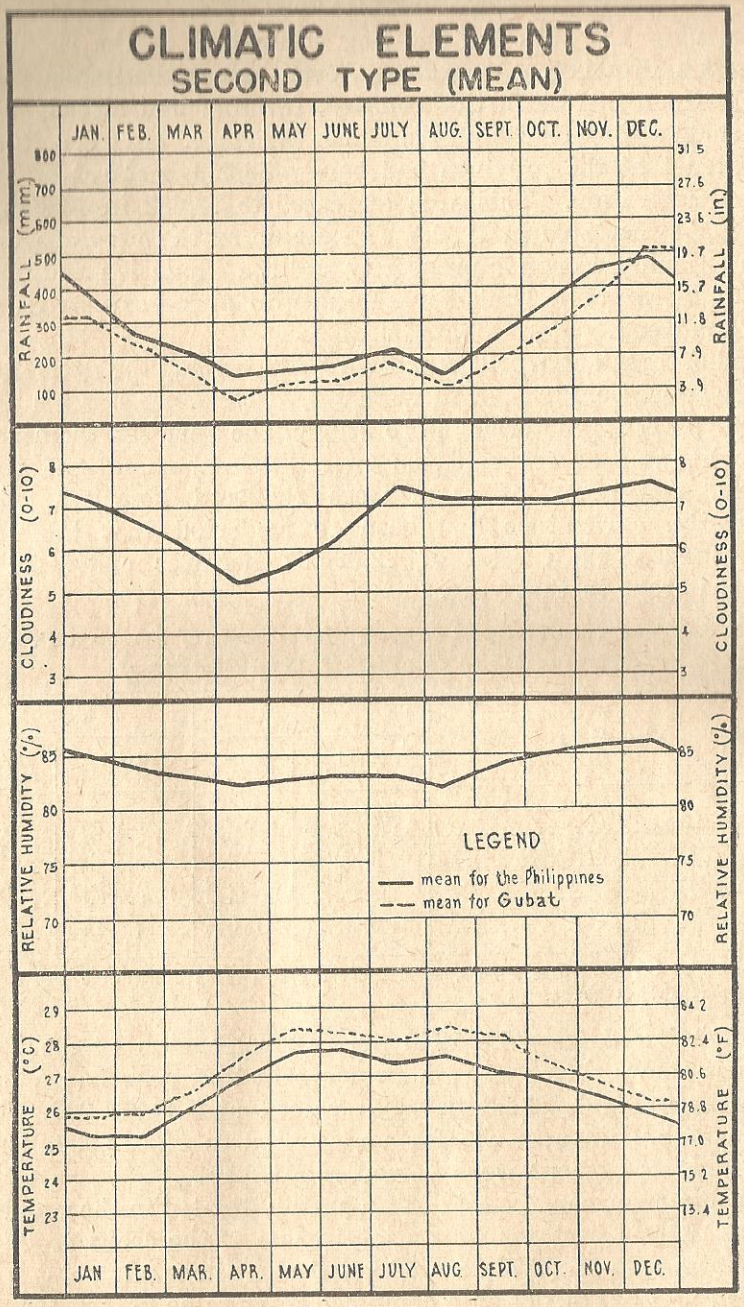

Figure 5. Graph of the climatic element for the second type of rainfall of the Philippines as compared with that of Gubat, Sorsogon Province.

AGRICULTURE

Farming has been the age-long occupation of the people in Sorsogon Province. Accordingly, even before the implantation of the Spanish rule in this country, farming had already been the chief calling of the people of the province. In 1903 it was reported that the province had barely 54,688 hectares of land under cultivation. This area increased to 78,452 in 1918, and to 110,595 hectares in 1939. The people of the province were then enjoying economic prosperity and the expansion and opening of more public lands for agricultural purposes was on the upward trend.

The outbreak of World War II in 1942 changed the agriculture of the province. The crops were destroyed, work animals were killed, planting materials were scarce, the farmers themselves were haunted or suspected as guerrillas and abandoned their farms, and many of them were rendered homeless. Consequently, agriculture had been so neglected that the 1948 census recorded a total of 72,066.57 hectares cultivated to various crops in that year.

TABLE 6.—*Total area and percentage of farm lands of Sorsogon Province according to use as per 1938 and 1948 census.*[a]

Kind of land	1938		1948	
	Total area	Percentage	Total area	Percentage
	Hectare		*Hectare*	
Cultivated land	110,595.50	73.54	72,066.57	74.08
Idle land	22,817.91	15.17	11,185.74	11.50
Pasture land	3,866.94	2.57	3,993.15	4.00
Forest land	9,180.35	6.10	7,246.87	7.45
Other lands	3,914.71	2.62	2,790.89	2.97
Total	150,375.41	100.00	97,283.22	100.00

[a] Census of the Philippine Islands, 1948. Summary Report on Agriculture Under ECA Counterpart Project No. 5.

Statistical data.—The 1948 agricultural census of the Philippines shows that Sorsogon Province in that year had a total farm area of 97,283.22 hectares valued at ₱28,851,203. The value of buildings in the farm amounted to ₱2,012,934, while the farm equipment were valued at ₱378,150.

In the same year, the total farm area cultivated in the province was 72,066.57 hectares with a total value of the crops produced amounting to ₱13,171,543 while the fruits and nuts were valued at ₱12,174,264 or a combined total value of ₱25,345,807. The coconut products, however, such as copra, oil, and *tuba* were valued at ₱11,172,950 and that of sugar cane, like *basi* had a value of ₱32,285. Hence, the grand total value of the agricultural products of Sorsogon Province in 1948 was ₱36,551,024.

CROPS

There are various crops raised and cultivated in the province; among the leading ones are coconut, rice, abaca, camote, cassava, corn, gabi, sugar cane, maguey, and eggplant. Table 7 shows their total area, production, and value of the produce. Besides these crops, there are also various kinds of fruit trees planted.

Coconut.—This is the leading crop of the province with respect to the area cultivated and the value of the produce. A total of 33,550.67 hectares was planted to this crop in 1948 and a total value of the produce including nuts, copra, oil, and *tuba* was ₱21,794,098. At the present time, however, this crop, once lucrative, is fast loosing its hold as the leading crop of the province. This is due to the damage done by storm and the "cadang-cadang" disease which practically destroyed more than 50 per cent of the standing coconut trees of the province.

TABLE 7.—*The ten leading crops, area planted and value of the produce of Sorsogon Province* [a]

Crops	Area planted	Total production	Total value
	Hectare		
Coconut	33,550.67	128,577,455 n	₱21,794,098.00
Palay	21,706.71	529,052 c	5,439,757.00
Abaca	13,228.63	6,461,177 k	3,984,813.00
Camote	7,233.88	12,634,876 k	1,957,938.00
Cassava	3,332.36	7,161,859 k	1,024,738.00
Corn	2,419.61	32,060 c	360,481.00
Gabi	476.51	740,979 k	157,104.00
Sugar cane	152.97	5,323 t	102,395.00
Maguey	106.33	45,709 k	22,855.00
Eggplant	71.77	43,798 k	10,398.00
Total	82,279.44		₱34,854,577.00

[a] Agricultural Census of the Philippines, 1948. Vol. 2 Part III, pp. 1667–1690.
n–nuts, c–cavans, k–kilos, t–tons.

Prior to 1947 when typhoon "Jean" occurred and the outbreak of the "cadang-cadang" disease, the average nut production in the province per tree per year was about 50 to 60 nuts. At present, hardly could a tree produce 15 to 20 nuts a year on the average. As a result, many coconut plantations have been cleared of coconut trees and cultivated to lowland rice and other crops. Some coconut plantations, however, are rejuvented by planting "cadang-cadang" resistant coconut varieties.

Rice.—This crop is second to coconut in the area planted and the value of the produce. In 1948 the area planted to it was 21,706.71 hectares which produced a total of 529,052 cavans of palay valued at ₱5,439,757. It is raised both in the lowlands and in the uplands.

Where the area has irrigation water available throughout the year two crops are raised, otherwise there is only one crop. In 1948 there was a total area of 5,507 hectares planted to the second crop which gave a production of 147,215 cavans of palay valued at ₱1,519,658. The rice varieties grown in the lowland are *Baranoy, Mulao, Baginbaloy, Tongkin, Senador,* and *Kinawayan.* The last two varieties, because of their high yielding quality, are considered the most important. The upland rice varieties commonly grown are *Cabodit, Kampina, Bondoc, Saigon,* and *Dinorado.* The leading towns in the province producing rice are Gubat, Irosin, Sorsogon, Casiguran, and Bacon for the lowland rice, and Donsol and Pilar for the upland rice.

Abaca.—Before World War II, abaca was the premier crop of the province with regards to area planted. After the war, however, it became third with coconut and rice, the first and second, respectively. In 1938 the area planted to this crop was 44,929.98 hectares which produced 12,675,439 kilos, while in 1948, ten years later, the area planted to it was 13,228.63 hectares which gave a production of 6,461,177 kilos valued at ₱3,984,813.

In general, the abaca plantations in the province, especially those in the rolling areas, have been neglected if not entirely abandoned. Few are fairly well kept which also give better quality of fiber. On the average, the abaca plantations in the province are 50 years old or more. Hence they need a sort of rejuvenation and better upkeep in order that this crop can gain its pre-war place in the agriculture of the province.

The leading abaca-producing towns of the province are Irosin, Juban, Sorsogon, Casiguran, and Magallanes. About 52 per cent of the total fiber produced in the province comes from the above-mentioned towns.

Corn.—This crop is second to rice in importance as a food crop of the people. It is grown in level areas as well as in the undulating and rolling sections from small patches to regular-sized fields. It is planted twice a year. The yield ranges from 8 to 15 cavans of shelled corn to the hectare. The common varieties grown are the White Flint and Yellow Flint. A white glutinuos variety is also grown but in small scale.

In 1948 the total area planted to corn was 2,419 hectares which gave a production of 32,060 cavans of shelled corn worth ₱360,481. Bulan, Pilar, Castilla, and Matnog are the important corn-producing towns of the province.

Sugarcane.—This is one of the ten leading crops raised in the province. It is not, however, grown in commercial scale, but rather raised for chewing and for the manufacture of *basi* and *panocha* for local consumption. Hence, the areas planted to this crop are small and scattered.

In 1948 there was a total area of 152.97 hectares planted to this crop. It gave a production of 5,323.7 tons of canes which was valued at ₱70,110. The *basi* produced out of 1,420 tons of canes was 136,948 liters valued at ₱32,285. Hence, for the year 1948, the total income realized from sugar cane was ₱102,395.

Maguey.—This crop is the 9th leading crop of the province. Like abaca, maguey is planted for its fiber. There were 106.33 hectares planted to it in 1948 with a production of 45,709 kilos which was valued at ₱22,855. It can be grown in all the soils of the province. Bulan, Casiguran, and Bulusan, arranged in their order of importance, are the leading towns in the province planted to this crop.

Root crops.—The important root crops grown in the province are camote, cassava, and gabi. These crops are important substitute for rice and corn as food of the people. They are planted to them in 1948 which gave a production of 20,537,714 towns of the province. A total area of 11,042.75 hectares was planted to them in 1948 which gave a production of 20,537,714 kilos valued at ₱3,138,780.

Camote (sweet potato) is the leading root crop. Of the 11,042 hectares planted to root crop in 1948, camote occupied 7,233.88 hectares which gave a value of the produce amounting to ₱1,957,938. Cassava is second in importance and gabi comes next. These crops can be planted in all the soils in the province, but grow best on the coarse-textured soils. Castilla, Matnog, Bulan, and Bulusan are the leading towns growing camote in the province, while Castilla, Barcelona, and Matnog are important for cassava.

Vegetable crops.—Of the vegetable crops, eggplant is the most important having a total area of 71.77 hectares in 1948

which produced 43,798 kilos valued at ₱10,398. Other vegetables planted are tomato, kondol, patola, squash, upo, and various beans with a total production valued at ₱42,016 in 1948. These are planted mostly in home gardens, in backyards, or in small open areas. The supply of leafy and fruit vegetables of the province is adequate.

Miscellaneous crops.—There are various miscellaneous crops in the province planted on the farm and in backyards. Some of these miscellaneous crops are arrowroot, black pepper, *sinkamas, tugue, yautía,* watermelon, seguidilla, cucumber, pineapple, cotton, carrot, etc. In 1948 the total value of the produce of the miscellaneous crops amounted to ₱114,206.

Fruit trees.—Fruit trees comprise one of the principal crops of the province. The well distributed rainfall throughout the year in the province makes possible the growing of a variety of fruit trees. The only hazzard is the seasonal occurrence of typhoon. Table 8 gives the ten leading fruit trees in the province.

Banana ranks first in importance among the fruit trees in the province. It grows well in all the soils and is planted in backyards, in open lands and on slopes of the hills. In 1948 the value of fruits harvested from banana was ₱613,400. *Saba* and *Latundan* varieties are commonly planted. Castilla, Bulan, and Matnog lead other towns in banana production.

Pili was second to banana in the value of fruit produced in 1948. Jackfruit was third and chico was fourth with ₱122,867 and ₱82,826, respectively. Gubat, Bulan, Sorsogon, and Bulusan lead in the production of pili nuts while Bulan, Bulusan, and Magallanes for jackfruit. Prieto Diaz leads in the production of chico in the province.

TABLE 8.—*Ten leading fruit trees, production, and value of produce in Sorsogon Province* [a]

Fruit trees	Number of trees or hills	Total production	Total value in pesos
Banana	1,200,315	763,818 bunches	₱613,400
Pili	32,019	1,120,115 kilos	344,699
Jackfruit	78,388	453,106 fruits	122,867
Chico	1,280	3,011,500 fruits	82,826
Papaya	69,469	978,853 fruits	65,420
Cacao	6,256	20,536 kilos	61,074
Pummelo	9,874	553,663 fruits	37,720
Santol	19,350	4,581,119 fruits	36,033
Betelnut	69,664	6,454,257 nuts	21,536
Kalamansi	6,095	4,098,361 fruits	21,038
Total value			₱1,385,965

[a] Census of the Philippines, 1948. Agriculture, Vol. 2 Part III pp. 1682–1690.

AGRICULTURAL PRACTICES

The age-long agricultural methods of farming in the country are followed by the majority of farmers in Sorsogon Province. The carabao and cattle remain the primary source of power in the farm and the plow and harrow as the main implements of tillage. Lately, farm mechanization has been started by few progressive farmers.

Plowing up and down the slopes in the undulating and rolling sections is still common. There is no program of soil conservation, thus soil wastage due to erosion is very extensive. Few farmers practice contour cultivation and terracing as a means of preventing soil losses from erosion.

Farmers have become interested in the use of fertilizers on their farms. If such interest continues and is properly implemented, agriculture in the province may be improved. Seed selection and clean culture are practiced, but thorough preparation of the land is still wanting in the majority of cases.

There are few farmers who practice crop rotation. Majority of them plant various crops without considering their proper succession. As a result, the soils get easily exhausted of plant nutrients. Proper crop rotation should always have a legume crop in rotation with the main crop to maintain the fertility of the soil.

Green manuring and composting to increase organic matter are not practiced. Organic matter and green manure aid in the retention of moisture and supply plant nutrients to the soil. Strip cropping, contour plowing and cover cropping of the rolling areas are not done. But *kaiñgin* system of agriculture is still practiced along the slopes of hills and some mountainsides. This practice should be stopped. It is destructive and enhances soil erosion.

LIVESTOCK AND LIVESTOCK PRODUCTS

There is no organized commercial livestock farm in the province aside from the one maintained and operated by the Bureau of Animal Industry in Sorsogon, Sorsogon. Farmers own one to two or ten heads of farm animals like carabaos and cattle, besides some pigs and chickens, and sales of which supplement their income from other crops. Table 9 shows the number of livestock and poultry in the province.

Livestock and poultry products barely meet the demand of the people of the province. As of 1948, the total milk produced

from carabao, goat, and cattle was 12,089 liters valued at ₱5,628. For the same year the total number of eggs produced from chicken and ducks was 1,027,755 eggs which gave a total value of ₱99,303.

TABLE 9.—*Number and value of livestock and poultry in Sorsogon Province* [a]

Kind	Number	Value
		Pesos
Carabao	31,207	2,898,510
Cattle	2,529	275,282
Horse	205	18,010
Hog	53,977	1,566,831
Goat	1,423	10,859
Buffalo	14	1,663
Sheep	73	908
Chicken	191,470	188,119
Duck	2,966	4,822
Geese	20	67
Turkey	13	65
Pigeon	77	29
Total	283,974	4,957,165

[a] Census of the Philippines, 1948. Agriculture, Vol. 2, Part III pp. 1669–1674.

LAND USE CHANGES

Land use changes in the province were merely from pasture, idle, and forest lands into crop lands or other lands and vice versa. There is no available record to show the extent of land use changes in the province, nevertheless, it is believed that more of the pasture and idle lands have been turned into crop lands.

Since the occurrence of the coconut disease known as "cadang-cadang" in the Bicol Region, many of the coconut plantations have been so badly infected resulting in the cutting of the coconut trees. These plantations were converted into rice lands, orchards, and miscellaneous crops. Rice lands are also used as pasture after the harvest and pasture lands are tilled for crops. Some of the swampy areas are made into salt beds where salt is manufactured, or are developed into fishponds. Some of the slopes of hills and mountains are cleared of vegetation and planted to crops, but later are abandoned to become again a second growth forest.

In the 1948 census of the Philippines, Sorsogon Province had a total farm area of 97,283.22 hectares classified into the following: (1) cultivated land, 72,066.57 hectares; (2) idle land, 11,185.74 hectares; (3) pasture land, 3,993.15 hectares; (4) forest land, 7,246.87 hectares; and (5) other lands, 2,790.89 hectares. Cultivated land includes those lands cultivated for various crops, fruit trees and nuts in 1948. Idle land is suitable for the cultivation of crops, fruit trees, and nuts but which was not cultivated in that year, and used for pasture either. Pasture land was exclusively used for grazing in that year, and forest land was that part of the farm land which was occupied by forest. Other lands are those lands occupied by buildings, establishments, and waste lands.

FARM TENURE

Farm operators in Sorsogon Province are classified into owners, part owners, tenants, and managers. Owners are those farm operators who own all the land they till, while part owners are farm operators who own part and rent or lease the other part of the land they work. Managers are farm operators who supervise the work in the farm for land owners, receiving wages or a certain per cent of the produce, or both for their services.

The tenants are of three kinds as follows: (1) farm operators who rent the land they work and pay as rent a share of the crop or crops grown are called share tenants, (2) farm operators who rent the land they work and pay as rent a specified amount of money or a definite quantity of the crop or crops grown are called cash tenants, and (3) farm operators who rent all the lands they work and pay as rent a share of the crops in addition to a specified amount of money are called share-cash tenants.

The number and percentage distribution of farm areas according to farm tenure for 1948 are as follows:

Types of farm operators	Area in Hectare	Per cent
Owners	54,263.04	56.95
Part owners	6,943.26	5.45
Share tenants	19,897.65	22.80
Share-cash tenants	704.74	.44
Cash tenants	232.58	.32
Other tenants	10,115.55	13.52
Farm managers	5,126.40	.52
Total	97,283.22	100.00

The farm lands of the province are fairly distributed. The average size of farm was 4.16 hectares. While there are tenants in the province, comprising about 37 per cent of the farm operators, cases of agrarian problems between the landlords and the tenants have not been heard of, a healthy sign of the good relationship existing between them.

FARM INVESTMENT

The value of farm land alone constitute the greatest single farm investment in the province of Sorsogon. It comprises 88.35 per cent of the total investment. The 1948 census of the Philippines shows that the value of a hectare of farm land in the province was ₱276 or a total of ₱19,890,373.32 for the total farm area cultivated. Building comes next with a total value of ₱2,012,934 or 9.08 per cent of the total investment. There is considerable range in the value of buildings on different farms.

Farm equipment constitutes 1.79 per cent or ₱378,150. It includes harrows, plows, sleds, carts, and stripping machines. There was only one tractor in 1948 in the province. Work animal is also evaluated as part of farm investment, and this is about 0.78 per cent or ₱142,853. It includes carabao and buffalo.

TYPES OF FARMS

The census of the Philippines in 1948 gives 11 types of farm in the province indicating that the province is diversified. Table 10 shows the number of farms by type in the province and their description are as follows:

1. Palay farms—area planted to lowland and/or upland palay was equal to 50 per cent or more of the area cultivated.
2. Corn farms—the area planted to corn was equal to 50 per cent or more of the area cultivated.
3. Abaca farms—50 per cent or more of the cultivated land was planted to abaca.
4. Sugar cane farms—the area planted to sugar cane was equal to 50 per cent or more of the area cultivated.
5. Coconut farms—50 per cent or more of the cultivated land was planted to coconut.
6. Fruit farms—the calculated area planted to fruit trees was equal to 50 per cent or more of the area cultivated.
7. Tobacco farms—the area planted to tobacco was equal to 50 per cent or more of the area cultivated.
8. Vegetable farms—the area planted to camote, mongo, soybeans, tomatoes, sitao, cowpeas, patani, beans, cadios, onions, radishes, eggplants, cabbages, gabi, and potatoes was equal to 50 per cent or more of the area cultivated.
9. Root crops farms—the area planted to camote, gabi, cassava, tugue, and ubi was equal to 50 per cent or more of the area cultivated.
10. Livestock farms—having (1) an area of 10 hectares or more or (2) more than 10 heads of cattle, horses, goats, and sheep; or (3) less than 20 per cent of the total farm area was used for the production of crops, fruits or nuts.

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

Coconut, palay, root crops, and abaca, arranged in their order, have the greatest number of farms, while sugar cane, tobacco, vegetables, and livestock have less number of farms.

TABLE 10.—*Number of farms by type in Sorsogon Province*[a]

Type of farm	Number of farm	Per cent
Palay	4,995	21.38
Corn	149	0.63
Abaca	1,891	8.05
Sugar cane	49	0.20
Coconut	8,549	36.54
Fruit	307	1.31
Tobacco	8	0.03
Vegetable	3	0.01
Root crops	2,882	12.31
Livestock	3	0.01
Others	4,571	19.53
Total	23,407	100.00

[a] Summary Report on the 1948 Census of the Philippines. Agriculture.

SOIL SURVEY METHODS AND DEFINITIONS

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

Soils, their landscapes and underlying formation, are examined in as many sites as possible. Borings with the soil auger are made, test pits are dug, and exposures such as road and railroad cuts are studied. An excavation or road cut exposes a series of layers called collectively the soil profile. These horizons of the profile as well as the parent material beneath are studied in detail and the color, structure, porosity, consistency, texture, and content of organic matter, roots, gravel and stones are noted. The reaction of the soil and its content of lime and salts are determined either in the field or in the laboratory. The drainage, both external and internal, and other features such as the relief of the land, climate, 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 three principal ones are (1) soil series, (2) soil type, and (3)

soil phase. When two or more of these mapping units are in such intimate or mixed pattern that they cannot be clearly shown on a small-scale map, they are mapped or grouped into a (4) complex. Areas of land that have no true soil, such as 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 similar parent material. It comprises soils which have essentially the same general color, structure, consistency, range of relief, natural drainage condition and other important internal and external characteristics. In the establishment of a series, a geographic name is selected, taken usually from the locality where the soil was first identified. For example, the Sorsogon series was first found and classified in the municipality of Sorsogon, Sorsogon Province.

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

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

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

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

The soil survey party, composed of two or three technical men, maps the area and delineates the various soil types, phases, complexes and miscellaneous land types. All natural and cultural features found in the area are indicated on the soil map, such as trails, railroads, bridges, telephone and telegraph lines; barrios, towns, and cities; rivers and lakes; prominent mountains, and many others.

THE SOILS OF SORSOGON PROVINCE

The soils of Sorsogon Province are more of the medium-textured soils rather than the fine-textured ones. They range from sandy loam, silt loam, clay loam, fine sandy loam to clay. They exhibit various shades of color from light gray, brownish gray, reddish brown, brown, red, and black. The lighter and reddish colors are mostly in upland and rolling to hilly areas, while the browns, grays and blacks are in the coastal regions. Some contain gravels, stones, and even boulders in some places. The consistence of both the surface soils and subsoils varies from loose and friable to moderately compact, sticky and plastic. Consequently, the permeability becomes variable. The surface drainage is influenced by the relief of the land—free to excessive in the undulating, rolling, hilly to mountain areas and poor to adequate in the plains and valleys.

The soils of the province are divided into three general groups; namely (1) soils of the plains and valleys, (2) soils of the flat upland, undulating, rolling, and hilly areas, and (3) the miscellaneous land types. The third is more of the land types than of the soil types. The first two groups are

further subdivided into several soil series based on the genetic and morphological characteristics of the soils and in turn the series are classified into soil types and phases according to the texture of the surface soil.

The key to the soils of Sorsogon Province is shown in table 14. Their descriptions and agricultural importance are discussed in the following pages. The accompanying map shows their distribution and relative extent.

The soils under each group are as follows:

1. Soils of the plains and valleys.

	Soil type Number
(*a*) Bascaran clay	235
(*b*) Bascaran sandy loam	351
(*c*) Bascaran sandy clay	350
(*d*) Irosin silt loam	277
(*e*) Irosin sandy loam	273
(*f*) Sorsogon silty clay loam	250
(*g*) Sorsogon sandy loam	249
(*h*) Macabare sandy loam	247
(*i*) Macabare sandy clay loam	274
(*j*) Donsol sandy clay	245
(*k*) Silay fine sandy loam	252
(*l*) Panganiran clay	465

2. Soils of the flat uplands, undulating, rolling and hilly areas.

(*a*) Castilla clay loam	244
(*b*) Castilla-Bolinao complex	342
(*c*) Bolinao clay	153
(*d*) Ubay clay loam	172
(*e*) Annam clay loam	98
(*f*) Luisiana clay	239
(*g*) Casiguran clay loam	246
(*h*) Sevilla clay	174
(*i*) Bulusan sandy loam	275
(*j*) Bulusan loam	248

3. Miscellaneous land types.

(*a*) Hydrosol	1
(*b*) Beach sand	118

Soils of the Plains and Valleys

The plains and valleys of the province are not very extensive. They occur in random notches fringing the coastal region in the northern, eastern, and southern sections of the province and also bordering the Sorsogon Bay as well as in between hills. The texture ranges from sandy loam to silt loam to fine sandy loam and clay loam to clay. This variability of texture may have been influenced by the surrounding uplands, rolling and hilly areas which have been the sources of the alluvium of the plains and valleys.

The soils of the plains are the best soils for agricultural purposes in the province. A greater part of the plains and valleys is devoted to lowland rice and the rest is cultivated to miscellaneous crops, such as corn, peanut, camote, cassava, gabi, coconut, abaca, banana, vegetables, and fruit trees. A total area of 24,920 hectares or 12.16 per cent of the total area of the province was mapped comprising 12 soil types.

BASCARAN SERIES

The Bascaran series was first studied and mapped in the province of Albay. In Sorsogon, it is found in the coastal alluvial plains between Sorsogon and Casiguran and from Prieto Diaz to Barcelona in the east. It has a poor to fair drainage depending on its distance from the coastlines. In some places, the water table is shallow being only 10 centimeters or even less below the surface. In some cases the area has a half-bogged condition.

The soils of this series are made up of the alluvial and creep sediments from the uplands contiguous to the area. The solum is deep being generally 115 centimeters from the surface. The surface soil is brownish gray, grayish-brown to light reddish brown, and at places with gravels. It is underlain by a grayish brown to dark brown heavy silty clay to clay subsoil with abundant brick red streaks and gray specks. It is principally utilized for the cultivation of lowland rice. The uncultivated area is grazed. Bascaran clay, Bascaran sandy loam, and Bascaran sandy clay were mapped.

Bascaran clay (235).—This is the most extensive soil of the Bascaran series having a total area of 7,280 hectares or 3.54 per cent of the total area of the province. It is level and has a poor drainage. Areas near the hydrosol are waterlogged and need artificial drainage. Areas of this soil are mapped between the barrios of Balogo and Martinez in Casiguran; Barrio Bugod in Bacon; the coastal plain and valley

Figure 6. A landscape of Bascaran clay. Nearly level. It is generally cultivated to lowland rice.

Figure 7. A typical broad rift valley as represented by the Irosin valley. This valley is planted to lowland rice and coconut as main crops.

PLATE 1

between Prieto Diaz and Barcelona; and the plains of Pawa in Matnog and Fabrica in Bulan.

The profile characteristics of the soil type are as follows:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay, brownish-gray to grayish brown and light reddish brown; moderately compact; blocky structure; slightly plastic when wet; fair amount of organic matter. Gravels are present.
40–65	Subsoil, silty clay to clay, grayish brown to dark brown with abundant brick red streaks; plastic when wet and brittle when dry; coarse columnar. Weathered yellowish gravels are present in this layer. Boundary is diffused and smooth to the lower horizon.
65–115	Lower subsoil, clay, brownish gray splotched with red; columnar and contains yellowish orange gravels. Boundary is smooth and diffused.
115–150	Substratum, clay, yellowish brown, grayish brown to brownish gray, massive. Compact.

This is a deep soil and considered one of the most productive soils in the province if properly managed. However, because of poor drainage of some sections of the area, the farmers resort to three types of cultural practices under lowland condition as follows:

1. The use of the plow and harrow in the preparation of the rice fields in fairly drained areas.
2. The use of hoes, bolos, and other hand farm implement in preparing rice paddies on boggy areas.
3. The trampling by herd of carabaos over the paddies in half-bogged areas.

In the first method, the rice fields are fairly well prepared, but in the last two methods the rice fields are poorly prepared resulting in the luxuriant growth of the sedge and other grasses. There is a keen competition between the rice plants and the grasses for plant nutrients. As a consequence, poor yield of the crops result. The yield of lowland rice ranges from 30 to 40 cavans of palay to the hectare without the use of fertilizer and at normal condition. Corn yields from 8 to 12 cavans of shelled corn to the hectare. The liberal application of fertilizer, good tillage, and the practice of artificial drainage in this soil may result in optimum yields of the crop.

Bascaran sandy loam (351).—A total of 440 hectares of this soil type was mapped on two narrow strips contiguous to the Bascaran clay, bordering the Banuang-daan and Bulan Rivers and a tributary of Pawic River at barrio Sisigan, Matnog. This soil type is similar to Bascaran clay both in external and internal characteristics. Their main difference lies only on the texture of the surface layer.

Diversified farming is practiced. Such crops as corn, rice, banana, coconut, fruit trees, abaca, tobacco, camote, cassava, and other food crops are grown. The normal yield of lowland rice without the use of fertilizer ranges from 30 to 35 cavans to the hectare and that of corn is from 8 to 10 cavans of shelled corn. This soil has the same management problems, fertilization and cropping requirements as Bascaran clay.

Bascaran sandy clay (350).—This soil was mapped in a triangular coastal plain bordering the Sorsogon Bay between barrios Trece Martires and Rizal of Casiguran town. It has a nearly level relief with poor to fair drainage. It has a total area of 720 hectares.

This soil type differs from the Bascaran clay in that it has a sandy clay surface soil. It is intensively cultivated to lowland rice, but is suited also to all crops grown in the locality and can be made productive when properly fertilized. The yield of lowland rice is rather low, the average being 20 cavans of palay to the hectare. Corn gives an average production of 8 cavans of shelled corn per hectare. The land improvement practices suggested for Bascaran clay can be adapted to this soil to improve its fertility and increase the yields of the crops.

IROSIN SERIES

Irosin series represents the soils of the broad rift valley of Irosin formed by tectonic and gradational forces, principally by volcanism (fig. 7). The soils had developed from alluvium from the surrounding uplands. The surface soil is dark brown, dark grayish brown to brownish gray, and the subsoil is brownish gray to gray, friable and fine granular loam. The relief is almost flat with elevation of about 180 feet above sea level. The area is traversed by the tributaries of the Cadacan River which serve as drainage channels and sources of irrigation water. They empty into the Sorsogon Bay. The soils of the series are principally devoted to lowland rice.

Isolated well drained areas are planted to coconut, banana, abaca, camote, cassava, and some fruit trees. Irosin silt loam and Irosin sandy loam were mapped.

Irosin silt loam (277).—Irosin silt loam occurs chiefly on valley floor and is one of the most extensive and important agricultural lowland soils of the province. It is a deep soil, easy to till and responsive to good management. It is well suited to all crops grown in the locality and becomes productive when properly managed. It is moderately well drained. The total area mapped is 2,170 hectares and is located in the municipality of Irosin. The profile characteristics of this soil type are as follows:

Depth (Cm.)	Characteristics
0–35	Surface soil, silt loam to fine sandy loam, dark brown to dark grayish brown to brownish gray; friable, structureless to fine granular. It is free from stones and gravels and contains fair amount of organic matter. The lower portion is fine granular loam with reddish brown and orange brown streaks. Boundary to the subsoil is clear and smooth.
35–60	Subsoil, medium to coarse sandy loam, gray to reddish gray and light brown; loose and structureless; free from stones. Boundary to the lower subsoil is clear and smooth.
60–160	Lower subsoil, gravelly sand, grayish brown, grayish black to light brown; structureless; very porous and loose, Boundary to the substratum is abrupt and smooth.
160–below	Substratum, loam to silt loam, light brown to grayish white; friable and massive. Underneath this layer is a grayish black to gray speckled white coarse sand, structureless, loose, and very porous.

Most of the areas of this soil are principally grown to lowland rice, and the presence of irrigation water makes possible the raising of two crops of rice a year. Corn, coconut, banana, root crops, and some fruit trees are mostly grown in the higher and better drained sections of the area. Yield of rice without using fertilizer ranges from 35 to 45 cavans of palay to the hectare; corn gives from 8 to 14 cavans of shelled corn; and coconut, from 35 to 40 nuts per tree per year.

The low yield of rice is attributed to poor tillage. In many instances the rice fields are weedy and the weeds sometimes outgrow the rice plants. Proper soil management through the liberal application of commercial fertilizer and good prepa-

ration of the land will increase the yield of the crops in this soil.

Irosin sandy loam (273).—This soil type constitutes the sandy loam soil of the Irosin valley and adjoins the Irosin silt loam on the north. It contains some gravels on the surface. These gravels and the sandy loam surface soil differentiate it from the Irosin silt loam. They have, however, essentially the same use, management requirements, and crop adaptation. The relief is nearly level to sloping at the adjoining foot hills, and is fairly well drained. A total of 1,030 hectares was mapped.

This soil is diversified. Abaca, coconut, and lowland rice are the principal crops. Corn, cassava, camote, and peanut are the secondary crops. Banana and some fruit trees are also raised. Rice gives a yield from 25 to 35 cavans of palay to the hectare; coconut, 35 to 40 nuts per tree per year; abaca, 15 to 18 piculs of abaca fiber to the hectare; and corn, 10 to 18 cavans of shelled corn to the hectare. The use of cover crops is advantageous for the coconut plantations. Clearing the abaca plantations of weeds and shrubs and rejuvenating the old ones are essential for optimum production of abaca fiber. Proper cultivation and the liberal application of commercial fertilizers are also important for increased crop yields of this soil.

SORSOGON SERIES

The soils of the Sorsogon series are of recent alluvial deposits from the surrounding upland areas. The relief is generally flat to slightly undulating (fig. 9). The elevation ranges from sea level to about 200 meters above sea level. It is dissected by rivers and streams and is subject to flooding. The drainage condition is fair to good.

The surface soil is dark brown to grayish brown, and a grayish brown sandy clay loam subsoil. Lowland rice is the main crop. Corn, sugar cane, cassava, camote, coconut, peanut, and some fruit trees are also planted. Sorsogon silty clay loam and Sorsogon sandy loam are the two soil types mapped under this soil series.

Sorsogon silty clay loam (250).—This soil type has a total area of 5,360 hectares, comprising the lowland coastal areas from barrios Capoy to Gabao of Sorsogon town and from barrios San Roque to San Isidro of the town of Bacon. It is

of recent alluvial deposits and has a fair drainage condition. Figure 8 shows its profile picture which has the following characteristics:

Depth (Cm.)	Characteristics
0–35	Surface soil, silty clay loam, dark brown, grayish brown to brown, mottled reddish orange and yellowish brown; fine granular to columnar; soft when wet and slightly friable and crumbly when dry. At places few gravels are found. Boundary to the subsoil is abrupt and smooth.
35–55	Subsoil, sandy clay loam; grayish brown to brownish gray, mottled brown to orange brown; structureless, compact and slightly plastic. Stones are present. Boundary to the lower layer is abrupt and smooth.
55–85	Lower subsoil, sandy loam to loamy sand, mottled gray and with fine red streaks; structureless; porous and very friable. It is free from stones and gravels.
85–130	Grayish brown to light brown fine sandy loam to silt loam, with brick red streaks. It is coarse granular to columnar. The boundary is clear and smooth to the substratum.
130–below	Substratum, sandy clay, grayish black to black speckled brown; medium to coarse columnar; compact. It is free from coarse skeleton.

This is a good agricultural soil, deep, easily worked to good tilth, and can be made highly productive under proper management. This soil is principally devoted to lowland rice with abundant irrigation water. Abaca and coconut are also planted in sections of the area which are well drained. Corn, peanuts, root crops, and vegetables are also planted.

The yield of lowland rice is rather low being about 35 cavans of palay to the hectare. This is because of poor tillage. Land preparation is not thorough resulting in weedy fields which compete with the rice plants for food nutrients in the soil. Corn yields from 6 to 12 cavans of shelled corn to the hectare, while coconut gives about 30 nuts per tree per year, and abaca yields 15 piculs per hectare. Good tillage, application of fertilizers, addition of organic matter, and green manuring would bring this soil to a higher level of fertility and hence increase yields of the crops.

Sorsogon sandy loam (249).—This soil was mapped in a narrow strip of lowland areas in the barrios of Sto. Domingo, Sta. Cruz, and Poblacion of the municipality of Bacon. This is a recent alluvial deposit and has a fair external and internal drainage conditions. It has a total area of 520 hectares which is not susceptible to erosion.

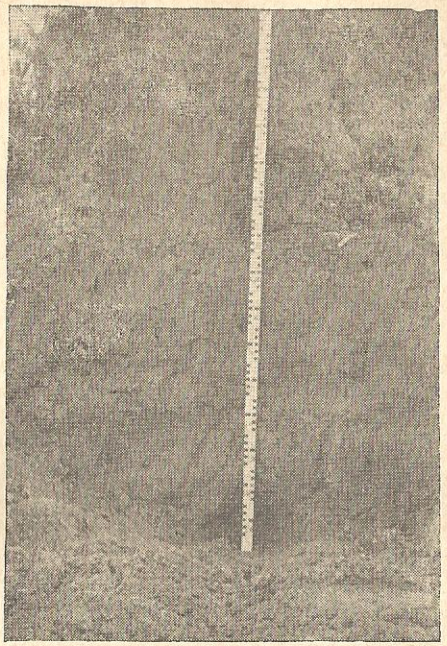

Figure 8. A profile of Sorsogon silty clay loam. Sorsogon series is a recent alluvial deposit.

Figure 9. A landscape of Sorsogon series. It is nearly level to slightly undulating.

PLATE 2

This soil type differs from Sorsogon silty clay loam only in the texture of the surface soil and the presence of gravels in some places. It is very friable and porous but is quite low in organic matter content. It is adapted to diversified farming.

Most of the areas of this soil are principally utilized for lowland rice. Areas along the river banks with fair drainage condition are cultivated to corn, camote, cassava, peanut, and other secondary crops. Yields of rice range from 25 to 30 cavans of palay to the hectare without fertilizer, while corn is from 10 to 14 cavans of shelled corn to the hectare. The soil management suggested for Sorsogon silty clay loam holds true with this soil.

PAÑGANIRAN SERIES

The soil of the Pañganiran series had been developed from alluvial materials from the surrounding hills and upland areas of limestone formation. The areas are narrow and nearly level valleys which are not very extensive. The elevation ranges from 20 to 100 feet above sea level and the drainage condition is poor. The soil of the surface layer is grayish black to black and a grayish brown, fine-textured and sticky clay subsoil. Only one soil type, Pañganiran clay was mapped.

Pañganiran clay (465).—Areas of this soil type are mapped as narrow and nearly level valleys in barrios Abucay, Milabas, Calongay, Lumbang, and Sta. Fe in the municipality of Pilar. It is a recent alluvial deposit washed down from surrounding limestone uplands. The drainage, both external and internal, is poor. It has a total area of 920 hectares. This soil type has the following profile characteristics:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay, grayish black to black; medium blocky to columnar; slightly compact; crumbly and brittle when dry but plastic and sticky when wet. Free from coarse skeleton. Boundary to the subsoil is wavy and diffused.
40–100	Subsoil, heavy clay, grayish brown and speckled gray and orange; medium columnar; very sticky and highly plastic when wet and becomes brittle and hard when dry. Free from coarse skeleton. Boundary to substratum is wavy and diffused.
100–150	Substratum, gravelly clay, grayish black to gray, hard and compact. The gravels are limestone.

This is a fine-textured soil and it cannot be plowed soon after heavy rains without affecting its structure. It should

be plowed when the moisture conditions are ideal because it is sticky when wet and becomes hard when too dry. It is a deep soil and is good for agricultural purposes.

This soil is adapted to all crops grown in the locality. It is presently used for diversified farming, planting such crops as rice, corn, sugar cane, tobacco, camote, cassava, coconut, and some fruit trees. The yield of rice under upland culture ranges from 15 to 20 cavans of palay to the hectare; under lowland culture, from 25 to 35 cavans. Corn yields range from 10 to 12 cavans of shelled corn to the hectare. Crop rotation, green manuring, addition of organic matter, application of fertilizer, and good tillage operation are good farming practices that would bring this soil to a higher state of fertility.

MACABARE SERIES

This series was mapped on the coastal plains of the province, with elevation ranging from 0 to 50 feet above sea level. They are fairly well drained. These soils are developed from recent alluvial deposits brought down by rivers from the surrounding uplands. Having a plain relief, they are not susceptible to erosion. The surface soil is brownish gray to reddish brown and a light brown to brownish gray, friable sandy loam subsoil. Macabare sandy clay loam and Macabare sandy loam are the soil types mapped.

Macabare sandy clay loam (274).—This soil type is mapped as a part of the coastal plain of Pilar. It has a total area of 590 hectares and is poorly drained. It is not, however, subject to erosion. This soil type has the following profile characteristics.

Depth (Cm.)	Characteristics
0–30	Surface soil, sandy clay loam, brownish gray, brown to reddish brown with orange mottlings; coarse granular; soft and slightly plastic when wet and mellow to crumbly when dry. Insect burrows are abundant in this layer. Fair in organic matter content and free from coarse skeleton. Boundary is clear and wavy to the subsoil.
30–80	Subsoil, sandy loam, light brown to brownish gray, mottled brown and black. It is friable and slightly compact. Few gravels are present in this layer. Boundary to substratum is wavy and diffused.
80–150	Substratum, light brown to grayish brown and mottled chocolate and rusty brown, coarse and medium sand with some gravels. It is structureless, loose and very friable. Underneath this is a layer of light gray, coarse and medium sand.

This soil is deep and is generally easily put under good tilth. Due to its drainage condition, however, its use is practically limited to the culture of lowland rice. Most of the area of this soil is cultivated to this crop. Corn and other food crops are planted on areas bordering natural drainage or during months of less precipitation. At normal condition, the yield of rice ranges from 30 to 40 cavans of palay to the hectare and corn gives an average of 10 to 12 cavans of shelled corn to the hectare. The liberal application of fertilizer, addition of organic matter, green manuring, artificial drainage, and good tillage operation would make this soil produce optimum yields of the crops.

Macabare sandy loam (247).—Areas of this soil type are scattered in the province. They are parts of the coastal plains of Donsol, Pilar, Bacon, Prieto Diaz, Gubat, and Barcelona. They occur as narrow and irregular strip along the seashore, and because they have a high water table, the natural internal drainage is rather poor. A total area of 3,440 hectares was mapped.

This soil type differs largely from the Macabare sandy clay loam in that it has a sandy loam surface soil which is very friable and easily cultivated. Sections of the area having a fairly good drainage are planted to coconut, cassava, camote, banana, vegetable, and some fruit trees. The poorly drained areas are cultivated to lowland rice giving a yield from 30 to 35 cavans of palay to the hectare. Corn gives production from 8 to 10 cavans of shelled corn to the hectare, while the yield of coconut is from 22 to 50 nuts per tree per year. The presence of "cadang-cadang" in the area affects the yield of coconut.

Farming practices suggested for Macabare sandy clay loam hold equally true with this soil type.

DONSOL SERIES

Donsol series was first identified and studied in the lowlands of the town of Donsol. This soil has been developed from alluvium washed down from calcareous upland areas by rivers and partly by depositions made by sea. The relief is nearly level (fig. 10) with elevation ranging from 0 to 50 feet above sea level, and is poorly to fairly drained. The surface soil is

reddish brown to dark brown and a black, grayish black to grayish brown massive to columnar sandy clay subsoil. This soil is devoted principally to lowland rice and coconut. Donsol sandy clay was mapped.

Donsol sandy clay (245).—This is the only soil type mapped under the Donsol series and covers most of the lowlands of the town of Donsol with a total area of 2,040 hectares. It is a coastal plain of almost flat relief with the highest elevation of about 50 feet above sea level. The drainage, both internal and external, is poor to fair. This soil type has the following profile characteristics.

Depth (Cm.)	Characteristics
0–25	Surface soil, sandy clay, reddish brown to dark brown; slightly compact and cloddy; moderately sticky and plastic when wet, but becomes brittle when dry. It contains a fair amount of organic matter. It is free from stones and gravels. Boundary to the subsoil is smooth and diffused.
25–40	Subsoil, sandy clay, black, grayish black to grayish brown and speckled brown and orange brown; massive to coarse columnar. Slightly compact and free from coarse skeleton. Boundary to the lower layer is smooth and clear.
40–130	Lower subsoil, sandy clay, orange brown to yellowish brown, splotched with dark brown and black; coarse granular; moderately compact. Boundary to the substratum is clear and smooth.
130–150	Substratum, medium to coarse sand, ash gray to yellowish gray, structureless. No stones.

Areas of this soil type are traversed by streams and narrow creeks which serve as natural drainage and at the same time use for irrigation purposes. The flat relief of the rice area and the presence of high water table, however, make both internal and external drainage rather slow.

This soil is utilized mainly for lowland rice culture and there are usually two crops a year. The areas bordering the streams and creeks, which are fairly well drained, are devoted to coconut, corn, root crops, vegetables, banana, and some fruit trees. The yield of rice is from 30 to 40 cavans of palay to the hectare and that of corn is from 10 to 14 cavans of shelled corn. Coconut gives 40 to 50 nuts per tree per year. These crops are not fertilized. This soil can be developed into good rice land when properly managed and yields of the crops can be considerably increased by liberal use of commercial fertilizer and good tillage.

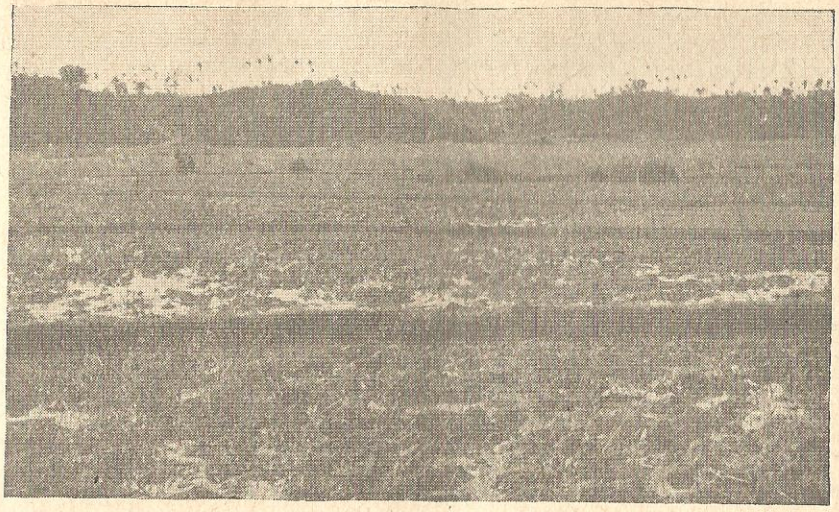

Figure 10. A landscape of Donsol sandy clay. Donsol series is a level coastal plain. Cultivated areas are generally grown to lowland rice.

Figure 11. Lowland ricefield ready for planting.

PLATE 3

SILAY SERIES

This series consists of soil belonging to the older alluvial plains having strongly developed profile. It was first identified and studied in the town of Silay, Negros Occidental. As found in Sorsogon Province, it exists as a narrow strip of land west of Banuang-daan River and in the northern part of Bulan proper. The relief is nearly level with elevation ranging from 20 to 30 feet above sea level. It is poorly drained. The surface soil is black to grayish black to gray and friable. The subsoil is grayish brown to gray, structureless and friable silt loam, but with hard and compact lower subsoil down to the substratum known as "bakias" which corresponds to the "Podas" of Java soils. The compact layer varies in thickness from two to three meters or more. This soil is mostly cogonal with patches cultivated to lowland rice, corn, camote, cassava and peanut. Silay fine sandy loam was mapped.

Silay fine sandy loam (252).—This soil type, being alluvial with almost flat relief can be tilled with a minimum of effort. Under good management and proper fertilization, it will become productive and can be planted to all crops grown in the locality. Although it is poorly drained, it is not susceptible to serious erosion. It has an aggregate area of 410 hectares located west of the Banuang-daan River and in the northern part of the poblacion of Bulan. It is traversed by the Bulan-Magallanes road. The profile characteristics of this soil type are as follows:

Depth (Cm.)	Characteristics
0–15	Surface soil, fine sandy loam, black to grayish black to gray; friable; fine granular; loose and mellow in all moisture, conditions. Fair in organic matter content and no stones. Boundary to the subsoil is clear and smooth.
15–30	Subsoil, silt loam, grayish brown to gray, friable and structureless; hard and compact when dry. No coarse skeleton. Boundary to the lower subsoil is smooth and clear.
30–60	Lower subsoil, silt loam, brown to grayish brown and mottled brown; structureless; very compact in dry and wet conditions. Boundary to substratum is smooth and diffused.
60–150	Substratum, sandy loam, light gray and compact. Below the substratum is a layer of dark gray clay.

This is a good agricultural soil, only it has poor internal drainage because of the well compacted subsoil. It needs subsoiling to improve the internal drainage. A greater area of this soil is cogonal. Cultivated areas are in patches planted to lowland rice, corn, cassava, camote, and peanut.

Normally, rice gives a yield from 25 to 35 cavans of palay to the hectare and corn, 10 to 12 cavans of shelled corn. They are not fertilized. The addition of organic matter, green manuring, application of commercial fertilizer, subsoiling to improve internal drainage, and good cultivation will make this soil liberally productive. It is suited to all crops grown in the locality.

SOILS OF THE FLAT UPLANDS, UNDULATING, ROLLING AND HILLY AREAS

The soils comprising the flat uplands, undulating, rolling and hilly areas are extensive in the province. They include eight soil series and one soil complex, to wit: Castilla, Bolinao, Ubay, Annam, Luisiana, Casiguran, Bulusan, and Sevilla series; and Castilla-Bolinao complex. They have a total area of 175,120 hectares or 85.25 per cent of the total area of the province.

These soils had been developed from the weathered products of various rocks, such as basalt, andesite, limestones, shales, sandstones, clays, tuff, agglomerates, and conglomerates. The Annam and Luisiana series have been formed from the weathered products of basalt and andesite; Bolinao from coralline limestone; Castilla, Casiguran, and Bulusan from tuff, basalt, agglomerates and conglomerates; and Sevilla and Ubay from shale, sandstone, and limestone. Luisiana series is perhaps the oldest among these soil series because its parent material had weathered too deep that the thickness of the resulting soil is 2 meters or more.

These soils, occurring as they do on uplands, rolling and hilly areas, have rather excessive external drainage but the internal drainage is rather slow, thus resulting to severe and serious erosion and truncation of profiles. Gullies are numerous; narrow ravines and canyons are also found in this group of soils, which are evidences of severe erosion that have taken place. A big portion of the area is cultivated to coconut, abaca, fruit trees, upland rice, corn, root crops, vegetables and other crops. The rest is either cogonal, open land, second growth forest, or primary forest.

CASTILLA SERIES

The Castilla series is an extensive upland soil of the province. The soil of this series had developed from the weathered products of loosely consolidated calcareous tuff, clay, basalt, and agglomerate. The relief ranges from slightly undulating, roughly rolling to hilly (fig. 13). It is well to excessively drained. It is subject to different degrees of sheet and gully erosion. The surface soil is dark brown to brick reddish brown underlain by reddish brown, dark brown to brown mottled black plastic clay subsoil. In the undulating area the soil is deep and favorable for mechanized farming.

The native vegetation is of the *parang type*. Cogon is the main grass with few and scattered *binayoyo* trees and bushes. The cultivated areas are planted to upland rice, corn, fruit trees, coconut, camote, cassava, and some annual crops. Castilla clay loam is the only soil type mapped.

Castilla clay loam (244).—This soil was first identified and studied in the town of Castilla, Sorsogon. It is extensive in the province with a relief ranging from undulating, rolling to hilly. Surface drainage is excessive while the internal drainage is poor. This soil is susceptible to erosion and would become severely eroded when used for clean cultivated crops under poor management practices. A total area of 38,520 hectares, or 18.77 per cent, of the total area of the province was mapped. It comprises practically the whole town of Castilla and part of the town of Pilar, Prieto Diaz, Gubat, Bacon, Bulusan, Irosin, and Sta. Magdalena. It has the following profile characteristics:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay loam, dark brown to brick reddish brown; coarse granular to blocky; highly plastic when wet, but becomes brittle upon drying. It has a fair organic matter content and is well penetrated by roots. Boundary to the subsoil is wavy and diffused.
40–110	Subsoil, clay, reddish brown, dark brown to brown; coarse granular to columnar. It is mottled black and gray, highly plastic and sticky when wet and brittle and hard when dry. It is moderately compact. Boulders are present in some places in this layer. It has a diffused and wavy boundary to the lower layer.
110–170	Lower subsoil, clay, dark brown to reddish brown; blocky to columnar. Presence of gray and bluish streaks and concretions. Boundary to the substratum is clear.

170–200	Substratum, clay, dark brown to reddish brown; moderately compact and columnar with plenty of concretions. Underneath is a reddish orange and gray highly weathered parent material.

The cultivated area of this soil type is small in comparison with the uncultivated area. Coconut is the main crop. Upland rice, corn, cassava, camote, vegetables, and some fruit trees are the other crops grown. They are not fertilized. The yield of upland rice varies from 15 to 25 cavans of palay to the hectare; corn, 10 to 12 cavans of shelled corn; and coconut, 24 to 30 nuts per tree per year.

The undulating and gently sloping sections of the area may be used for clean-cultivated crops with proper soil conservation practices such as contour tillage, crop rotation, strip cropping, slight terracing, green manuring, and fertilization. The sections having moderate slopes should be under intensive conservation practices, while the strongly sloping or rolling areas and the hills are best suited for pasture or forestry to minimize further soil erosion.

Castilla-Bolinao complex (342).—This soil complex is an association of the Castilla and Bolinao series. They are so mixed that one cannot be mapped separately from the other with the scale used in the survey. The relief of the complex is slightly undulating to gently rolling and is fairly well drained on the surface but the internal drainage is quite slow. The Castilla series predominates in the complex. A total area of 6,800 hectares was mapped in the southeastern part of Pilar.

The surface soil of the Castilla-Bolinao complex is reddish brown to brick red, coarse granular clay loam to clay. The depth ranges from 15 to 24 centimeters. This layer is underlain by orange brown, yellowish brown and brick reddish brown columnar to blocky clay subsoil, which is sticky and plastic when wet and brittle when dry. Occasional buckshot-like concretions are present at the bottom of this layer. The depth ranges from 25 to 80 centimeters from the surface. Underneath is a layer of buckshot-like concretions resting on coralline limestone and other highly calcareous materials.

The area is mostly cultivated to upland rice, corn, camote, cassava, tobacco, vegetables, and other food crops. The continuous cultivation of this soil to the same crop depletes the soil fertility as evidenced by the decrease of yields. Upland rice yields from 10 to 18 cavans of palay to the hectare while

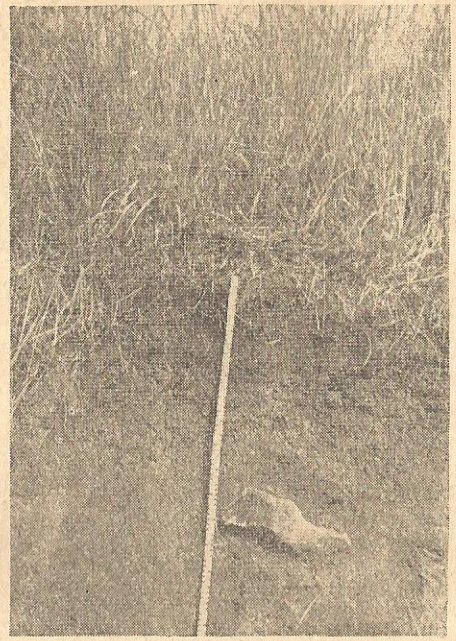

Figure 12. A profile of Castilla clay loam. This is a residual soil from tuff, coral sands, basalts, and clays.

Figure 13. A typical landscape of the Castilla clay loam. It is slightly rolling to undulating upland soil.

PLATE 4

corn is from 5 to 10 cavans of shelled corn. Systematic crop rotation with a legume crop as one of the crops in rotation, application of commercial fertilizer, and good cultivation would build up and increase the fertility of this soil complex, thus increasing the yields of the crops.

ANNAM SERIES

Annam series was first identified and studied in the province of Nueva Ecija. As found in Sorsogon Province, it exists as a continuation of the Annam soil mapped in Albay Province. This is a primary soil developed from the weathered products of volcanic rocks such as andesite and basalt. The surface soil is brown, grayish brown to light reddish brown lying on a strong brown and brownish red coarse granular clay loam to clay subsoil. The relief is rolling to hilly (fig. 15) and is well to excessively drained. Boulders of basalt and andesite abound on the surface as outcrops. It is generally under forest. Annam clay is the soil type mapped.

Annam clay loam (98).—A total of 15,710 hectares of this soil was mapped on a rolling, hilly and mountainous relief north of the poblacion of Sorsogon and small areas in barrios Buenavista and Ponji of the towns of Irosin and Matnog, respectively. It is well drained to excessively drained externally and fairly drained internally. This soil is subject to severe erosion and should not be cultivated under clean-tilled cropping system. However, most of the area is presently forested, though some sections of the area are abandoned *kaiñgin* where cogon and *talahib* are now growing. A profile (fig. 14) of this soil type has the following characteristics:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay loam, brown, grayish brown to light reddish brown; granular, and moderately compact; sticky and slightly plastic when wet but friable under optimum moisture and brittle to hard in the dry state. Orange brown concretions are present. Boulders are also found on the surface. Boundary to subsoil is diffused and smooth.
40–85	Subsoil, clay loam to clay, reddish brown to brownish red; coarse granular and moderately compact. Boulders and concretions are present in this layer. Boundary to the substratum is wavy and abrupt.
85–150	Substratum, gravelly to stony clay, brown to dark brown with reddish brown mottlings; nutty in structure. Concretions, weathered gravels and boulders are present in this layer.

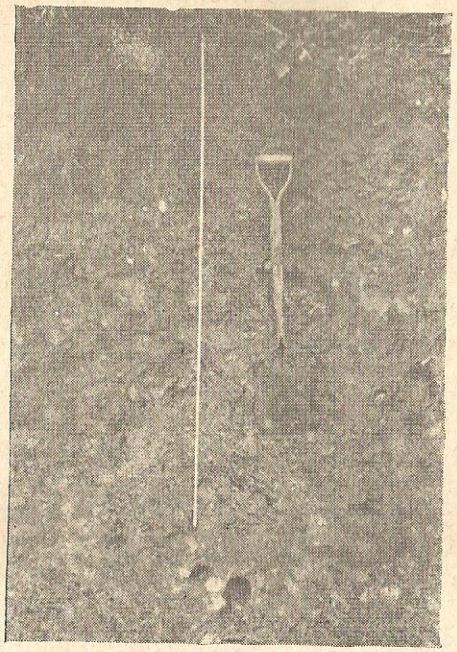

Figure 14. A profile of Annam clay loam. Brown to light reddish brown residual soil from andesite, basalt, and tuff.

Figure 15. A landscape of Annam clay loam. Annam soils are rolling to hilly and mostly grown to coconuts.

PLATE 8

The condition of relief of this soil type does not warrant extensive cultivation of seasonal crops because it is susceptible to erosion. Permanent planting of coconut, abaca, banana, and fruit trees can be done, but they should be well taken care of to prevent the setting in of erosion. It is also adapted to pasture purposes. The strongly rolling areas, hills, and mountains should be kept for forestry purposes.

Small portion, mostly of the lower slopes, is presently planted to upland rice, camote, cassava, and sugar cane without the use of fertilizer. Upland rice gives a yield ranging from 15 to 20 cavans of palay to the hectare and corn, 12 to 15 cavans of shelled corn; camote, 5 to 10 tons; while cassava, 8 to 14 tons to the hectare.

BOLINAO SERIES

The soils of the Bolinao series are grouped under the red soils of the Philippines. They are primary soils developed in place from the weathered products of coralline limestone. The relief is rolling to hilly with good to excessive external drainage. The internal drainage is poor. The surface soil is reddish brown, brown to grayish brown resting on orange brown to yellowish brown or reddish brown cloddy to coarse columnar heavy clay subsoil. Limestone boulders, as outcrops, are present on the surface. The native vegetation is cogon with few trees. Cultivated areas under clean-tilled cropping system are subject to erosion. Such crops as coconut, upland rice, banana, root crops, and fruit trees are planted. Bolinao clay is the only soil type mapped.

Bolinao clay (153).—This soil type was mapped on a rolling and hilly relief on the northeastern tip of Sorsogon Province bordering the Sugod Bay. It is not extensive, with a total area of 3,450 hectares. The external drainage is good to excessive and the internal drainage is poor. It is subject to gully and sheet erosions necessitating the control of runoff by mechanical or vegetative measures, or both. It has the following profile characteristics:

Depth (Cm.)	Characteristics
0–25	Surface soil, clay; reddish brown, brown to almost red; moderately compact; fine granular; highly plastic and sticky when wet and hard when dry. In badly eroded areas are outcrops of limestone boulders.

25–80	Subsoil, gravelly clay; orange brown to light reddish brown; coarse granular; highly plastic and sticky when wet and hard when dry. Boundary to the substratum is smooth and gradual.
80–150	Substratum, reddish orange and orange yellow tinge; massive or laminated partially weathered limestone. Below this layer is the limestone rock.

This soil is generally deep under natural condition in Sorsogon. It has a high water-holding capacity due to its clayey soil, but the aeration is poor. At its optimum moisture condition good tilth is easy to obtain. However, it cannot be plowed just after heavy rains because it is too sticky, neither when it is too dry because it is too hard.

The greater portion of the area of this soil is cogonal with few trees and this condition should be maintained to prevent washing of surface soil through runoff. Portions cultivated are mainly planted to coconut, upland rice, banana, root crops, corn, and some fruit trees. The yield of coconut ranges from 25 to 30 nuts per tree per year: rice, 16 to 20 cavans of palay to the hectare; and corn, 12 cavans to the hectare. These crops are not fertilized.

CASIGURAN SERIES

Casiguran series is one of the extensive soil series of Sorsogon Province. This series is a primary soil developed in place from the weathered products of volcanic massive rocks, mainly agglomerate, tuff, andesite, and basalt. It has a rolling to hilly relief with good to excessive surface drainage and fair internal drainage. It is subject to gully and sheet erosion. The surface layer has a grayish black to reddish brown soil and a reddish brown to strong brown, coarse granular to columnar clay subsoil. It is a deep soil and principally planted to coconut and abaca. Casiguran clay loam is the only soil type mapped in the province under this series.

Casiguran clay loam (246).—This soil type is extensive in the province. It covers a total area of 38,120 hectares, or 18.58 per cent of the total area of the province, comprising the rolling and flat upland and hilly areas of the towns of Casiguran, Juban, Magallanes, Barcelona and Gubat. The surface drainage is good to excessive, but the downward flow of water is slow. It needs intensive soil conservation measures when clean-tilled cropping system is practiced. The

profile (fig. 16) of this soil type has the following characteristics:

Depth (Cm.)	Characteristics
0–60	Surface soil, clay loam; grayish black to reddish brown; coarse granular and moderately compact; slightly sticky and plastic when wet and very crumbly when dry. Contain good amount of organic matter and coarse skeleton is present on areas along rivers. Boundary to the subsoil is clear and wavy.
60–80	Subsoil, clay; reddish brown to strong brown; coarse granular to columnar; moderately compact; very sticky and plastic when wet. In some places stones are present. Boundary to the lower layer is diffused and wavy.
80–120	Lower subsoil, clay; dark brown to reddish brown with bluish black mottlings; coarse columnar. Free from stones. Boundary to the substratum is clear and smooth.
120–below	Substratum, clay; orange brown to reddish brown speckled yellow and black; coarse granular. This layer rests on highly weathered sandstone and tuff.

The relief of this soil type makes it unfavorable for intensive farming. For that matter, only those areas under flat upland and the lower slopes may be considered safe for cultivation with the use of soil conservation measures. The rolling areas are suited only for limited cultivation with intensive soil conservation practices, or they are adapted to permanent crops or pasture. The hilly areas are good for woodland.

Abaca, coconut, and fruit trees are planted mostly in the rolling areas. The flat upland where irrigation water is available is devoted to lowland rice culture giving a yield from 30 to 45 cavans of palay to the hectare. Coconut yields from 30 to 40 nuts per tree per year. Abaca yields from 4 to 14 piculs to the hectare. The low yield of abaca may be attributed to poor management. The plants have become overcrowded. They need rejuvenation and proper care.

SEVILLA SERIES

Sevilla series had been developed from the weathering of calcareous sedimentary rocks such as sandstone, shale, and limestone. This soil, as identified and mapped in Sorsogon, is a continuation of the same soil mapped in Albay Province. It represents the rolling, hilly and mountainous areas in the northwestern part of the province. It has good to excessive external drainage and a fair to poor internal drainage. Some portions

have been already seriously eroded especially the areas which have been under clean-tilled crops. The surface soil is dark brown to black, granular clay underlain by a yellowish brown to light yellowish brown, slightly compact clay subsoil. Limestone gravels and boulders are present in the surface soil especially in the eroded areas. Only one soil type, Sevilla clay, was mapped.

Sevilla clay (174).—This soil type comprises the rolling and hilly to mountainous area on the northwestern part of the province belonging to the municipalities of Donsol and Pilar. It is well drained to excessively drained on the surface, but poorly drained within the soil mass. This soil type has the following profile characteristics (fig. 17).

Depth (Cm.)	Characteristics
0–35	Surface soil, clay; dark brown to almost black; slightly compact and granular. In some places are few limestone gravels and cobblestones. Fairly well penetrated by roots.
35–100	Subsoil, clay; yellowish brown to brown; granular and sticky. Limestone precipitates and gravels are found in this layer. Boundary to the substratum is wavy and diffused.
100–200	Substratum, yellowish brown sticky clay, mixed with a considerable amount of limestone gravels and fragments of weathered calcareous shale and sandstone.

The moderately rolling area of this soil with slopes of 8 to 15 per cent can be cultivated safely to annual crops, such as rice, corn, and root crops with the use of intensive soil conservation measures. Sections of the area with slopes ranging from 15 to 25 per cent are suited to limited cultivation with the use of intensive conservation measures, but they are preferably best for pasture purposes. The roughly rolling, hilly and mountainous sections should be under woodland so as to prevent too much soil loss from erosion.

Cultivated areas of this soil type are principally planted to coconut. Patches are planted to upland rice, corn, and root crops and vegetables. The yield of coconut is from 29 to 51 nuts per tree per year, while corn is 8 to 14 cavans of shelled corn to the hectare and rice is 15 to 20 cavans of palay per hectare. These crops are not fertilized.

BULUSAN SERIES

The soils of the Bulusan series represent the soils of the south and southwest foot slopes of Mount Bulusan. They

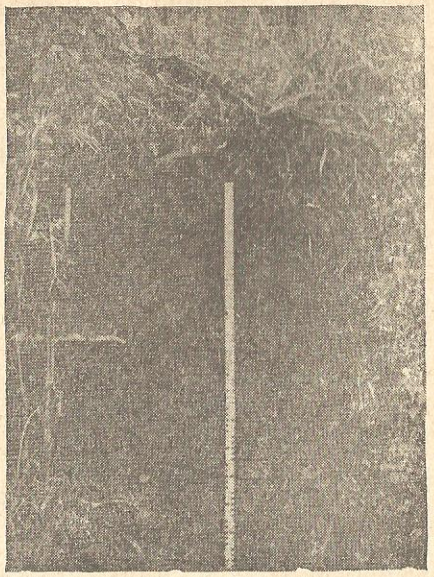

Figure 16. A profile of Casiguran clay loam. Casiguran soils are residual soils from massive lava rocks and tuff.

Figure 17. A profile of Sevilla clay. Sevilla soils are residual soils from calcareous shales and limestones.

PLATE 6

are primary soils developed from the weathering of massive to fragmental volcanic rocks, mostly basalt and andesite. The relief is generally undulating to rolling and mountainous. The elevation ranges from 90 to 4,700 feet above sea level. The natural surface drainage is good to excessive with slow internal drainage. The surface soil is dark brown, brownish black, medium fine granular clay loam. The native vegetation consists of cogon, *talahib*, and forest. The cultivated areas are planted to abaca, coconut, pili, some fruit trees, upland rice, corn, and some root crops and vegetables. Bulusan loam and Bulusan sandy loam were mapped.

Bulusan loam (248).—One of the best abaca soils in the province is the Bulusan loam. A total of 6,770 hectares of this soil was mapped on the southeastern and southern slopes of Mount Bulusan, contiguous to the Annam clay loam and Bulusan sandy loam. It is well drained to excessively drained in the surface. The internal drainage is slow to fair. Some parts of the area of this soil can be planted to clean-tilled crops but necessary conservation measures should be followed. Other sections need intensive conservation measures, whereas the roughly rolling and mountain areas should be under forest to prevent severe soil losses from erosion. The profile (fig. 18) of this soil type has the following characteristics:

Depth (Cm.)	Characteristics
0–50	Surface soil, loam; dark brown, brownish black to black; fine granular, loose and friable. Boulders are found in the surface soil in some places. Organic matter content is fair. Boundary to the subsoil is smooth and abrupt.
50–95	Subsoil, clay loam; light brown, grayish brown to light yellowish brown; medium fine granular; slightly compact. Free from stones. Boundary to the lower layer is smooth and gradual.
95–115	Lower subsoil, loam to silt loam; yellowish brown, grayish brown to light yellowish brown with splotches of gray; fine granular to coarse columnar. It is slightly compact and free from stones. Boundary to the substratum is clear and smooth.
115–below	Substratum, highly weathered sandstone, light orange brown to light brown mottled orange and gray. Pebbles of sandstone and conglomerate are present.

A bigger portion occupied by this soil type is planted to abaca and coconut. The rest of the cultivated area is planted to upland rice, corn, root crops, some fruit trees, and vege-

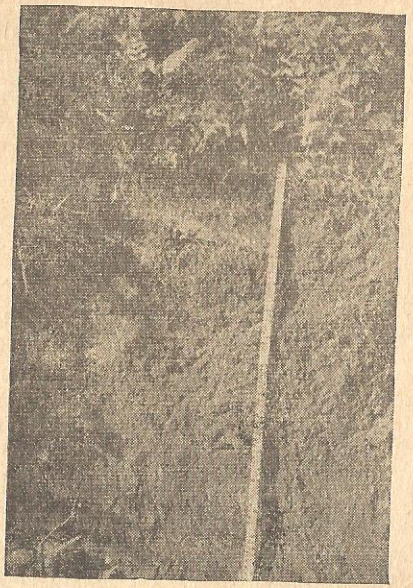

Figure 18. A profile of Bulusan loam. This is a residual soil from sandstones, conglomerates, basalt, and andesite.

Figure 19. Bulusan loam is planted to abaca and coconut principally.

PLATE 7

tables. The yield of abaca is low—11 piculs of abaca fiber to the hectare. This low production is attributed to the fact that the abaca plantations are already old and are not properly taken care of. Coconut yields an average of 30 nuts per tree per year, while upland rice has an average production of 15 cavans of palay to the hectare. Corn gives an average yield of 15 cavans of shelled corn to the hectare. These crops are not fertilized.

Good soil conservation measures, fertilization, and proper tillage and management will increase the yields of the crops in this soil.

Bulusan sandy loam (275).—This soil type has a total area of 30,540 hectares, or 14.86 per cent of the total area of the province. It occurs on the southern and southwestern slopes of Mount Bulusan, contiguous to the Irosin Valley. The major portion covers the ranges between Irosin and Bulan extending to the Matnog coast. It is traversed by creeks radiating from the volcano. It is well drained to excessively drained in the surface. Internal drainage is slow.

This soil type is similar to Bulusan loam except in the texture of the surface soil which is sandy loam. As such they have the same utilization, management problems, fertilization and cropping requirements, and erosion control measures.

Presently, most of the cultivated area of this soil is planted to abaca and coconut. Camote, cassava, corn, upland rice, and some fruit trees are also grown. This soil gives similar production as that of the Bulusan loam in abaca, coconut, rice, corn, and other crops planted. These different crops are not fertilized.

UBAY SERIES

The Ubay series was first studied in the province of Bohol. In Sorsogon Province, it was found occupying the undulating, rolling to hilly coastal areas of Magallanes and Bulan and between Bulan and Matnog. It is a primary soil developed from the weathered products of sedimentary rocks, mainly shales, sandstones, and conglomerates. It has good to excessive external drainage and a poor internal drainage. The soil is light reddish brown to gray in the surface layer, underlain by a brownish red to dark brown, columnar, gravelly clay subsoil. The area is quite extensive, covered dominantly by cogon and other grasses with scanty trees. Ubay clay loam is the only soil type mapped.

Ubay clay loam (*172*).—A total area of 10,120 hectares of this soil was mapped in the province covering the undulating to rolling and hilly coastal areas between Magallanes and Bulan and between Bulan and Matnog. It is subject to severe erosion as the external drainage is good to excessive while the internal drainage is poor. The undulating area is suited to general farming provided soil conservation measures are adopted such as terraces, contour cultivation, strip cropping, and crop rotation. It is, however, adapted for pasture purposes. It has the following profile characteristics:

Depth (Cm.)	Characteristics
0–25	Surface soil, clay loam; light reddish brown, grayish brown and brown; granular; sticky when wet, but becomes hard when dry; slightly compact. Fairly well penetrated by roots and contain fair amount of organic matter. Boundary to the subsoil is abrupt and smooth.
25–55	Subsoil, clay; reddish brown to grayish brown; coarse granular to columnar; moderately compact with admixture of soft, orange brown concretions. Sometimes this horizon is absent. Boundary to the lower layer is wavy and diffused.
55–115	Lower subsoil, gravelly clay; reddish brown, dark grayish brown to brick reddish brown; structureless. Iron concretions and gravels are present in abundance in this horizon. Boundary to the substratum is wavy and abrupt.
115–below	Substratum, gravelly clay; brown, yellowish brown to brick red with concretions and fragments of highly weathered shale and sandstone.

This soil type was devoted to pasture land before World War II. At present most of the areas has a *parang* type of vegetation, predominantly cogon with scattered *binayoyo* trees. Small portion of the area is devoted to the growing of coconut, fruit trees, upland rice, corn, and root crops with few vegetables. The valleys are devoted to lowland rice giving a production from 30 to 35 cavans of palay to the hectare. Upland rice yields from 20 to 26 cavans of palay to the hectare; corn, 14 to 17 cavans of shelled corn to the hectare; and coconut, 36 nuts per tree per year. These crops are not fertilized. When properly managed and fertilized, this soil may give higher yields of the crops planted.

LUISIANA SERIES

Luisiana series is a primary soil developed from the weathered products of basalt and andesite. In some places, these

rocks have weathered to a depth of 3 meters or more—an indication of its advanced development. This soil has a brown to reddish brown surface soil and a yellowish brown to light reddish brown and moderately compact subsoil resting on a yellowish brown to reddish brown clay. It has a rolling to hilly relief which is well drained to excessively drained in the surface. The internal drainage is fair. Luisiana clay is the only soil type mapped.

Luisiana clay (239).—This soil type is an extension of the Luisiana clay mapped in Albay Province. It is located in the northern part of the province contiguous to the Castilla clay loam. This is a deep soil and would be a good agricultural land if it were not for its unfavorable relief which makes cultivation difficult. A total area of 1,210 hectares was mapped. The profile characteristics of this soil type are as follows:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay; brown to reddish brown and brick reddish brown; coarse granular; slightly friable and moderately compact. There are no stones. Boundary to the subsoil is diffused.
40–85	Subsoil, clay; yellowish brown to light reddish brown and brick reddish brown; coarse granular or columnar to blocky; moderately compact; highly plastic and sticky when wet and becomes hard when dry. Boundary to the substratum is diffused and smooth.
85–below	Substratum, clay; reddish brown and brick reddish brown; fine granular. Fresh cut shows splotches of light gray, yellowish brown, orange brown, and orange yellow; usually mixture of highly weathered basalts and andesites. This layer sometimes reaches a depth of 3 meters or more.

The areas of this soil type with gentle slopes which can be easily terraced should be cultivated to annual crops. The strongly rolling and sloping areas should be put under permanent crops or to pasture in order to prevent soil loss from erosion.

Presently, only a small area of this soil is planted to coconut with a production of 29 to 35 nuts per tree per year. Upland rice and corn are planted in patches. Rice yields from 18 to 20 cavans of palay to the hectare while corn, 7 to 12 cavans of shelled corn to the hectare. These crops are not fertilized. The use of proper soil conservation measures and the application of commercial fertilizers will increase the yields of the crops in this soil.

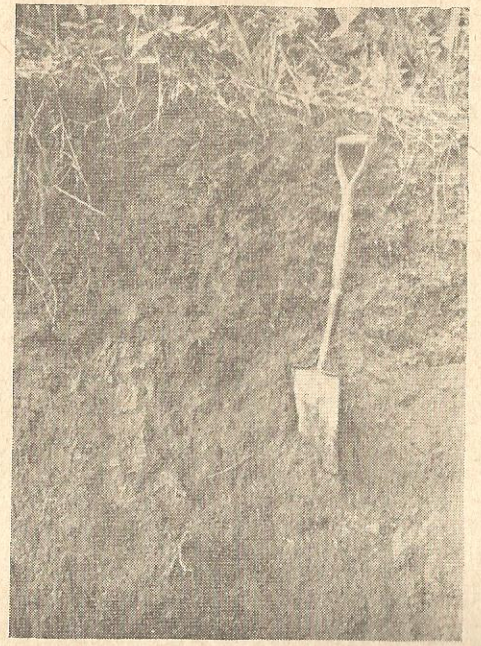

Figure 20. A profile of Luisiana clay. It is a residual soil from igneous rocks.

Figure 21. A landscape of Luisiana series. Open lands are covered with shrubs. Cultivated areas are planted to rice, corn, vegetables, and fruit trees.

PLATE 9

Miscellaneous Land Types

The miscellaneous land types delineated in the province comprise the hydrosol and the beach sand. These land types were classified primarily in terms of land form. The relief is nearly level to level and are less subject to erosion. A total area of 5,440 hectares or 2.59 per cent of the total area of the province was mapped.

Hydrosol (1).—The hydrosol in the province comprises the areas of the swamps and marshes. The areas are under water practically the whole year round, and are extensive along the Prieto Diaz–Gubat coastline and the Sorsogon–Casiguran coast bordering Sorsogon Bay. The total area is approximately 4,050 hectares.

The hydrosol of Sorsogon is generally characterized by a brackish aqueous horizon which is about 100 centimeters deep or more depending upon the rise and fall of the tide. Underneath the aqueous layer is the sub-aqueous horizon equivalent to horizon "A" of the normal soil profile. It is slimy, brownish gray to grayish brown to light gray, fine to coarse sandy clay to silty clay with plenty of plant remains. The depth ranges from 35 to 80 centimeters. The basal horizon, equivalent to the "B" horizon of the normal soil profile, is also slimy, ashy gray sandy clay. The depth ranges from 80 to 150 centimeters or more from the subaqueous surface.

The hydrosol has no agricultural value. It is under mangrove and *nipa* vegetation. The mangroves are good sources of firewood, while the leaves of the *nipa* palms are used for roofing of houses and some establishments.

The hydrosol is also good for fish pond purposes. In other provinces in the Visayan Islands and in Central Luzon, the hydrosol is prized for fish pond purposes, especially for the culture of *bangus*.

Beach sand (118).—The beach sand is not important for agricultural purposes, although some sections of the area are planted to coconut, banana, vegetables, camote, and some fruit trees. It is characterized by a light gray, brown, black and white sand generally mixed with gravels, some coral and shells from the surface to as deep as 150 centimeters or more. Its profile consists of successive layers of sand and gravels without distinct arrangement. In certain sections in Gubat, the white sand predominates so it is called the white beach, an attractive spot for excursionists.

The beach sand in Sorsogon Province was mapped along the coastline. It is found quite extensive in Bacon, Prieto-Diaz, Gubat, Barcelona, Bulusan, Bulan, and Magallanes. It occurs as a narrow strip of sand indenting the coast.

TABLE 11.—*Area, percentage and present use of each soil type of Sorsogon Province*

Soil type No.	Soil types	Area in hectares	Per cent	Present uses
235	Bascaran clay	7,280	3.54	Lowland rice, corn.
351	Bascaran sandy loam	440	0.21	Lowland rice, corn, banana, coconut, fruit trees, abaca, tobacco, root crops.
350	Bascaran sandy clay	720	0.35	Lowland rice, corn.
250	Sorsogon silty clay loam	5,360	2.61	Lowland rice, corn, peanuts, root crops, vegetables.
249	Sorsogon sandy loam	520	0.25	Lowland rice, corn.
247	Macabare sandy loam	3,440	1.72	Coconut, cassava, camote, banana, vegetables, lowland rice, fruit trees.
274	Macabare sandy clay loam	590	0.29	Lowland rice, corn.
245	Donsol sandy clay	2,040	0.99	Lowland rice, coconut.
252	Silay fine sandy loam	410	0.20	Lowland rice, corn, cassava, camote, peanut.
465	Panganiran clay	920	0.45	Lowland rice, corn, sugar cane tobacco, camote, cassava, coconut, fruit trees.
273	Irosin sandy loam	1,030	0.50	Lowland rice, corn, cassava, coconut.
277	Irosin silt loam	2,170	1.05	Lowland rice, corn, coconut, cassava.
244	Castilla clay loam	38,520	18.77	Upland rice, corn, cassava, camote, vegetables, fruit trees.
342	Castilla–Bolinao complex	6,800	3.31	Upland rice, corn, camote, cassava, tobacco, vegetables.
153	Bolinao clay	3,450	1.68	Upland rice, coconut, banana, root crops, fruit trees.
98	Annam clay loam	15,710	7.64	Forest land.
246	Casiguran clay loam	38,120	18.58	Abaca, coconut, fruit trees, upland rice.
275	Bulusan sandy loam	30,540	14.86	Abaca, coconut, upland rice, camote, corn, fruit trees.
248	Bulusan loam	6,770	3.29	Upland rice, abaca, coconut, corn, root crops, vegetables.
174	Sevilla clay	23,850	11.61	Coconut, upland rice, corn, root crops, vegetables.
172	Ubay clay loam	10,120	4.92	Upland rice, corn, coconut, root crops.
239	Luisiana clay	1,210	0.59	Upland rice, corn, coconut.
1	Hydrosol	4,050	1.91	Mangrove, nipa palms.
118	Beach sand	1,390	.68	Coconut.
	Total	205,450	100.00	

MORPHOLOGY AND GENESIS OF SORSOGON SOILS

"Soil is the product of the forces of weathering and soil development acting on the parent material deposited and accumulated by geologic agencies." Soils vary in their characteristics. There are no two soils alike. They have one or more distinct differences. This is so because soil formation is a natural process in which five factors, namely, (1) parent material, (2) climate, (3) relief, (4) vegetation, and (5) time, play an important part. These factors are interdependent and each one affects the effectiveness of the others.

Climate and vegetation are known as the active factors, while parent material, relief, and time are the passive factors. When the active factors are dominant over the passive factors the resulting soil has a well developed profile. On the other hand, the ascendency of the passive factors over the active factors produces immature soil, or soil of less developed profile. Soils having undeveloped profile characteristics indicate that one of the factors has had appreciable effect on the soil—it is still young.

The parent materials of the soils of the province vary in their physical characteristics and chemical composition. The residual soils have been developed mostly from the weathered products of igneous rocks, principally basalt, andesite, and gabbro; metamorphic rocks such as slate, schist, and gneiss; and sedimentary rocks which include limestone, sandstone, tuff, shale, and conglomerates. Some of these rocks have been weathered to a depth of 2 to 3 meters or more as in the case of the Luisiana soil. The secondary soils include alluvial materials, rocks fragments and other organic and inorganic materials washed down from the uplands, hills, and mountain areas and deposited in the valley floors and plains by running water. These alluvial materials are from different sources. Along the seashore is a narrow strip of land consisting of sands, gravels, and stones that have been recently deposited by sea water.

These different rock formations in the province give rise to several soil series. In some cases even similar parent rock materials had developed into one or more soil series. On the basis of topography, mode of formation, and kind of profile, the soils of Sorsogon Province may be placed into six profile groups as follows: Groups I, II, III, IV, VII, and VIII. The first four profile groups consist primarily of secondary soils, while the last two are primary soils.

Profile Group I.—Soils on recent alluvial fans, flood plains and other secondary deposits having undeveloped profiles underlain by unconsolidated materials:

Beach sand

Profile Group II.—Soils of young alluvial fans, flood plains, or other secondary deposits having slightly developed profiles, underlain by unconsolidated material. The presence of the slightly developed profile in these soils shows an appreciable influence of the passive factors in the formation of these soils over that of the active factors. The soils under this group are as follows:

Donsol sandy clay
Macabare sandy loam
Macabare sandy clay loam
Irosin silt loam
Irosin sandy loam

Profile Group III.—Soils on older alluvial fans, alluvial plains or terraces having moderately developed profiles (moderately dense subsoil) underlain by unconsolidated materials. These soils are generally deep and are not underlain by claypan or hardpan but the subsoil is moderately dense. Their moderately developed profiles show that the passive factors of soil formation have a greater effect on these soils over those of the active factors. Under this group are the following:

Sorsogon silty clay loam
Sorsogon sandy loam
Bascaran clay
Bascaran sandy loam
Bascaran sandy clay

Profile Group IV.—Soils on older plains or terraces having strongly developed profiles (dense clay subsoils) underlain by unconsolidated materials:

Silay fine sandy loam
Luisiana clay

Profile Group VII.—Soils on upland areas developed on hard igneous rock and occupy a rolling to steep relief:

Castilla clay loam
Casiguran clay loam
Luisiana clay

Profile Group VIII.—Soils on upland areas developed on consolidated sedimentary rocks such as limestone, sandstone, and shale. The topography is generally rolling to steep. The soils under this profile group are as follows:

Ubay clay loam
Bolinao clay
Bulusan loam
Bulusan sandy loam
Sevilla clay
Annam clay

MECHANICAL ANALYSIS OF SORSOGON SOILS

The aim of mechanical analysis is to determine the different grades or sizes of the soil separates that constitute the soil. These are sand, silt, and clay. Accordingly, the sand includes

the particles having a diameter ranging from 2.0 to 0.05 millimeters; the silt from 0.05 to 0.002 millimeter; and the clay are those particles smaller than 0.002 millimeter. All particles larger than 2 millimeters fall under coarse fragments which include gravels, pebbles, and cobbles. Basing on the relative proportions of the various soil separates in a soil mass, the soil texture is thus determined as sand, sandy loam, loam, silt loam, clay, clay loam, etc.

The textural class names of the soils of Sorsogon Province were first determined in the field by the feel method—bringing the soil at optimum moisture and feeling the texture with the fingers. This method is not very accurate and it requires the skill and experience of an expert soils man. So the textural classifications in the field were checked up in the laboratory by mechanical analysis using the modified Bouyoucos method.

The representative samples of the surface soil of each soil type collected in the field were analyzed. The samples were passed through a 20-mesh sieve and were oven-dried. There was no effort made to remove the organic matter content of the soil. The result of the mechanical analysis is shown in table 12.

In general, the field classification agrees with the mechanical analysis. Where, however, the field classification of the textural grade is doubtful, the result of the mechanical analysis is

TABLE 12.—*Average mechanical analysis of the soils of Sorsogon Province* [a]

Soil type No.	Soil types	Sand	Silt	Clay	Colloid
		Per cent	*Per cent*	*Per cent*	*Per cent*
277	Irosin silt loam	46.8	36.0	17.2	27.2
273	Irosin sandy loam	57.8	24.6	17.6	22.4
245	Donsol sandy clay	35.6	30.0	34.4	44.4
250	Sorsogon silty clay loam	33.2	30.0	36.8	48.8
249	Sorsogon sandy loam	44.4	33.4	22.2	33.0
274	Macabare sandy clay loam	64.4	14.0	21.6	27.6
247	Macabare sandy loam	76.8	13.6	9.6	13.2
235	Bascaran clay	21.5	21.3	57.2	68.0
351	Bascaran sandy loam	50.8	26.0	19.2	39.2
350	Bascaran sandy loam	27.4	40.0	32.6	46.2
465	Panganiran clay	27.4	24.6	48.0	55.2
252	Silay fine sandy loam	32.8	38.4	28.8	64.2
246	Cas guran clay loam	44.8	18.2	37.0	45.8
248	Bulusan loam	51.4	30.4	18.2	28.2
172	Ubay clay loam	38.6	30.4	30.8	38.9
153	Bolinao clay	28.8	8.0	63.2	68.2
239	Luisiana clay	41.0	10.4	48.6	52.0
244	Castilla clay loam	29.0	30.4	40.0	58.2
98	Annam clay loam	31.4	21.8	46.8	59.8
275	Bulusan sandy loam	57.0	30.8	12.0	14.0
174	Sevilla clay	33.2	20.2	46.6	54.8

[a] The modified Bouyoucos method of analysis was followed. Data for surface soil only. Analyzed by E. R. Villegas and D. Dimalanta of the Divisions of Conservation Surveys and Soil Laboratories, respectively.

followed. In some cases, there are groups of clayey soils, which, because of their high humus content, exhibit a high state of friability, mellowness, and ease of cultivation. These kinds of soils carry whatever is the field classification given, except when the mechanical analysis is followed.

FIELD DETERMINATION OF SOIL TEXTURAL CLASS

The determination of the soil textural 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 late Professor C. F. Shaw worked out the following 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 will readily fall 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 fine grades of sand and only a small amount of clay, over half 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

LAND CAPABILITY CLASS A

Soil Types: Irosin sandy loam
Irosin silt loam

Deep, level, well drained easily worked soil

Class A land is nearly level. The soils are deep, dark, and usually fertile or can be made fertile under good management. They are usually deep alluvial soils which vary from silty to sandy texture. Erosion is not much of a problem. They do not need drainage or other special practices. The land is rarely flooded. They are easy to work and can be cultivated safely with ordinary good farming methods.

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

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

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

LAND CAPABILITY CLASS Bw

Soil Types: Bascaran clay
Bascaran sandy loam
Bascaran sandy clay
Donsol sandy clay
Macabare sandy loam
Macabare sandy clay loam
Panganiran clay
Silay fine sandy loam
Sorsogon silty clay loam
Sorsogon sandy 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 effort to drain the excess water is needed. Included in this class are wet lands that can be easily drained. They usually occur on low bottoms near large streams. The soils are deep but the subsoils are heavy or the water table is very shallow and restrict water movement. Small ditches are needed to drain off surplus water. Diversion ditches should be constructed to prevent damage from runoff from adjoining uplands. Protection from occasional overflows of nearby streams may be needed.

When properly drained, corn, sugar cane, legumes, and many other row crops common in the area may be grown. Lowland rice is especially suited to this land with the construction of paddies.

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

LAND CAPABILITY Be

Soil Types: Luisiana clay
Bolinao clay
Sevilla clay
Casiguran clay loam
Annam clay loam
Castilla clay loam

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

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

All crops common to the area can be grown. Liming and fertilizing with the recommended quantities and kinds should be done. Crop rotation, with a legume or soil improving crop such as mungo or soybean at least once in 3 or 4 years,

should be observed. For all legumes the soil should be well supplied with lime and phosphate-carrying fertilizers and if the soil does not contain the right kind of bacteria inoculation should be done. The use of farm manures or compost is recommended.

LAND CAPABILITY CLASS Ce

Soil Types: Castilla–Bolinao complex
Bulusan sandy loam
Bulusan loam
Ubay clay loam
Luisiana clay
Bolinao clay
Sevilla clay

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

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

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

After establishing the needed conservation measures, a good soil management program should be adopted. This 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 contouring should be observed. Fruit trees should be planted on the contours and a leguminous cover crop should be maintained to protect the soil, from erosion.

LAND CAPABILITY CLASS De

Soil Types: Bolinao clay
Luisiana clay
Sevilla clay
Ubay clay loam
Bulusan loam
Bulusan sandy loam
Castilla–Bolinao complex

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

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

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

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

Where erosion on a moderately deep soil is not 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. In this case legume seeds will need inoculation.

LAND CAPABILITY CLASS Ds

Soil Type: Beach sand

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

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

This class of land are also subject to some degree of soil erosion during rainfalls of heavy intensity or when there is an excess application of irrigation water.

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

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

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

LAND CAPABILITY CLASS M

Soil Types: Bulusan sandy loam
Sevilla clay
Luisiana clay
Bolinao clay
Ubay clay loam
Bulusan loam

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

Class M land is usually on steep slopes up to 40 per cent. The soil is generally shallow or highly eroded making it unfit for seasonal cultivation. Stones or gravels may be present or even numerous that they interfere with tillage operations. The land may be used for pasture or trees but with careful management. 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 around the heads of active gullies, if any, should be constructed. Gullies that are about to develop should be smoothened and sodded. Newly developed pastures should not be grazed severely. On well established pastures grazing should be well controlled and rotated. Wherever possible, stock ponds should be constructed to supply water to the animals.

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

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

LAND CAPABILITY CLASS N

Soil Types: Bulusan loam
Bulusan sandy loam
Ubay clay loam
Castilla–Bolinao complex

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 those which are needed to establish permanent vegetation for permanent pasture land or woodland. This class has slopes up to or more than 40 per cent. The land is rugged broken by many large gullies. The soil is badly eroded or very shallow. Stones may also be very abundant making cultivation difficult or impractical.

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

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

LAND CAPABILITY CLASS X

Soil Type: Hydrosol
Land suited only for wildlife or recreation.

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

This land class may be used for salt bed or fish pond sites. Ordinarily, this land is covered by mangroves or nipa palms when inundated by sea water or grasses as in the case of fresh water ponds. When the site is made for either fish ponds or salt beds the trees or palms may be disposed off but wide strip should be left standing along the outer borders of the shore line 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 algae, which is the feed for most fishes, the water in the pond should be fertilized.

KEY TO THE SOILS OF SORSOGON PROVINCE

TABLE 14.—*Key to the soils of Sorsogon Province and soil conservation practices needed*

Soil type No.	Soil types	Parent material	Relief	Drainage		Suitability	Conservation practices
				External	Internal		
235 351 350	Bascaran clay Bascaran sandy loam Bascaran sandy clay	Alluvium	Nearly level	Poor	Poor	Lowland rice	Good tillage operation, fertilization, addition of organic matter, and construction of artificial drainage.
250 249	Sorsogon silty clay loam Sorsogon sandy loam	Alluvium	Nearly level	Fair	Good	Lowland rice, abaca, coconut, corn, and other crops.	Good tillage, application of fertilizer, addition of organic matter, and crop rotation.
247 274	Macabare sandy loam Macabare sandy clay loam	Alluvium	Nearly level	Poor	Poor	Lowland rice	Good tillage, artificial drainage, application of commercial fertilizer, organic matter, and green manuring.
245	Donsol sandy clay	Alluvium	Nearly level	Fair	Fair	Lowland rice	Good tillage, application of commercial fertilizer, addition of organic matter, crop rotation, and green manuring.
252	Silay fine sandy loam	Alluvium	Nearly level	Poor	Poor	Lowland rice, corn, and other crops.	Good tillage, application of commercial fertilizer, addition of organic matter, green manuring, and artificial drainage.
465	Panganiran clay	Alluvium	Nearly level	Poor	Poor		
273	Irosin sandy loam	Alluvium	Nearly level	Good	Good	Lowland rice, corn, coconut, root crops, and other crops.	Good tillage, application of commercial fertilizer, green manuring, crop rotation and addition of organic matter.
277	Irosin silt loam	Alluvium	Nearly level	Good	Good		
244	Castilla clay loam	Calcareous tuff clay, agglomerates, and basalts.	Rolling to hilly and roughly undulating.	Good to excessive	Poor	Pasture land, permanent planting and woodland.	Cover cropping, permanent planting, and woodland.

Soil type No.	Soil types	Parent material	Relief	Drainage		Suitability	Conservation practices
				External	Internal		
242	Castilla–Bolinao complex	Calcareous tuff clay, basalt, agglomerate and coralline limestone.	Slightly undulating to gently rolling	Good to excessive.	Poor	Adapted to clean-tillage with intensive conservation measures.	Terracing, contour tillage, crop rotation, good tillage, and and application of commercial fertilizers.
158	Bolinao clay	Coralline limestone	Rolling to hilly	Good to excessive.	Poor	Fruit trees and permanent planting.	Terracing, countour tillage, crop rotation, cover cropping, permanent planting.
99	Annam clay loam	Igneous rocks, mainly basalt and andesite.	Rolling to mountainous.	Good to excessive.	Fair	Pasture land, permanent planting and woodland.	Cover cropping, permanent planting, and woodland.
240	Casiguran clay loam	Volcanic massive rocks, agglomerates, tuff, basalt and andesite.	Rolling to flat upland.	Good to excessive.	Poor	Rice, coconut, abaca, and other crops	Terracing, crop rotation, cover cropping, good tillage, and fertilization.
277	Bulusan sandy loam	Massive volcanic rocks, sandstone, conglomerates, basalt and andesite.	Roughly rolling to mountainous.	Good to excessive.		Pasture land, permanent planting, and woodland.	Cover cropping, permanent planting, and woodland.
248	Bulusan loam	Massive volcanic rocks, sandstone, conglomerates, basalt and andesite.	Undulating to rolling.	Good to excessive.	Fair	Abaca, coconut, and fruit trees.	Permanent planting, of abaca, coconut, fruit trees.
176	Sevilla clay	Calcareous, shale, sandstone, and limestone.	Rolling to hilly	Good to excessive.	Poor	Pasture and woodland.	Cover cropping, permanent planting and woodland.
172	Ubay clay loam	Sedimentary rocks, mainly shale, sandstone and conglomerate.	Undulating to rolling.	Good to excessive.	Poor	Coconut, abaca, upland rice, corn, and root crops.	Terracing, crop rotation, cover cropping, permanent planting and fertilization.
289	Luzuriaga clay	Igneous rocks, mainly basalt andesite.	Undulating to rolling.	Good to excessive.	Fair	Pasture and permanent planting.	Permanent planting and wood land.

PRODUCTIVITY RATINGS OF THE SOILS OF SORSOGON

The soils of Sorsogon Province are given productivity ratings for each of the principal crops grown in the province as shown in table 15. The figures presented cover the average production over a period of years based on current management practices which, in all cases, are without the use of amendment.

The figures presented in table 15 are estimates and not yield records because each of the soil types has no available crop yield data. They were determined primarily from interviews with farmers, records from municipal and provincial agriculturists, and from publications on the agriculture of the province, such as bulletins, pamphlets, and government census and statistics.

These productivity estimates were arrived at to show the relative productivity of the soils of Sorsogon Province. It may be stated, however, that the rating may not apply directly to a specific tract of land for any particular year. This is because the soils delineated in the province have varied fertility, each farm receives farming practices in varying degree, and the climatic conditions fluctuate from year to year.

The rating of each soil type for each of the crops considered are compared to a standard index of 100. This standard index represents the average hectare yield of the more extensive and better soils of the Philippines where the crop is principally grown without the use of amendment. A rating of 100 shows that the soil is as productive for the specified crop as the soil with the standard index. But a rating of 50 means that the soil is about half as productive for the specified crop as the soil with the standard index.

The soils of Sorsogon Province are arranged in the order of their general productivity. The arrangement is to give information as to the general productivity of each of the soils of the province and should not be taken to mean the suitability of certain soils for the particular crops.

Under Sorsogon Province conditions, Donsol sandy clay gives the highest yield in lowland rice which is followed by Irosin silt loam, Irosin sandy clay, and the Sorsogon soils. The soils that give the highest yield in upland rice are Ubay clay loam and Castilla clay loam, while Bulusan sandy loam, Bulusan loam, and Ubay clay loam are the best for corn. For coconut, Ubay clay loam, Casiguran clay loam, and Bulusan sandy loam registered the best and for abaca are Sevilla clay,

Donsol sandy clay, and Irosin sandy loam. The soils having high yields for camote are Sevilla clay, Annam clay, and Luisiana clay. The same is true with cassava.

From the productivity rating table, it is realized that the soils of Sorsogon Province, as shown in the map, vary in their production of the major crops grown in the province. It is also noted that except for coconut, the soils of the province are generally less productive than the soils with the standard index. This may be attributed to the fact that the yields are influenced by several factors of production, some of which are climate, soil (including physical, chemical, and biological characteristics), slope, pests and diseases, drainage, erosion and management practices.

Productivity as measured by yields shows only the relative productivity of the individual soil according to current practices and not its relative importance for growing crops. While the productivity is influenced to some degree by the factor of production, it cannot be used alone to measure the importance of the suitability of the soils for particular crops. It should be noted that the relative importance of a soil for growing crops is determined by various considerations. Therefore, it is important that the scheme or pattern of land classification for the relative worth and suitability of land for agriculture should lay more emphasis on the full recognition of the factors that influence the yields and not on productivity ratings alone.

TABLE 15.—*Productivity ratings of the soils of Sorsogon Province*

Soil type	Crop productivity index						
	Rice		Coconut 100 = 3,750 nuts/ha	Abaca 100 = 15 picul/ha.	Corn 100 = 17 cavans/ha.	Camote 100 = 8 tons/ha.	Cassava 100 = 15 tons/ha.
	Lowland 100 = 60 cavans/ha.	Upland 100 = 20 cavans/ha.					
Donsol sandy clay	75		100	75	70	70	80
Irosin sandy loam	70		100	75	60	65	75
Irosin silt loam	70		100	100	65	65	70
Sorsogon silty clay loam	65		85	100	60	65	75
Sorsogon sandy loam	65		125		70	60	60
Macabare sandy clay loam	65		80		70	60	60
Macabare sandy loam	60		115		55	60	60
Hascaran clay	60		95		65	70	55
Hascaran sandy loam	55		115		55	60	70
Hascaran sandy clay	55		70		65	65	65
Panganiran clay	60				70		
Silay fine sandy loam	55		50		55	60	60
Casiguran clay loam	60	60	135	60	70	65	70
Bulusan loam		75	95	65	60	60	70
Ubay clay loam	60	110	145	65	60	60	75
Balinao clay		90	105	55	70	60	75
Luisiana clay		95	70	70	70	80	80
Castilla clay loam		100	80	60	55	70	70
Annam clay loam		85	75	70	70	85	80
Bulusan sandy loam		75	135	65	60	75	75
Sevilla clay		80	100	100	70	90	80

LAND USE AND SOIL MANAGEMENT

Correct land-use and proper soil management are necessary to attain permanence in agriculture. The term "land-use" refers to the broad uses of the land on the farm such as cropland, pasture land, and forest land. Soil management refers to the different practices needed such as proper cultivation and drainage, liming, addition of organic matter, application of fertilizers, and other supporting conservation practices.

The use capability of any land is determined wholly on the basis of the physical characteristics of the land. The four groups of factors to be considered are (1) permanence of the soil if cultivated (susceptibility to erosion), (2) capacity of the soil to produce, e.i., the inherent fertility, capacity to retain water, salt content, organic matter content, aeration, etc., (3) presence of hardpan layer or rock outcrops that will interfere with cultivation, and (4) climatic factors, such as temperature and rainfall. After considering all these factors, the uses of the land could be determined. Likewise, the different soil management practices necessary should be so considered to restore the fertility level of the soil. Different areas require different ways or techniques of soil management, hence a thorough knowledge of the character of soil itself is important. This will serve as a guidepost to minimize misuse and ill-management of the soil to preserve it for posterity.

Based on topography, the soils of Sorsogon Province may be divided in two general groups; namely, the soils of the plains and valleys and the soils of the flat uplands, undulating, rolling, and hilly areas. The soils of the plains and valleys are extensively grown to lowland rice, corn, cassava, peanut, gabi, banana, vegetables, and fruit trees. The farmers do not follow any system of crop rotation in the cultivation of these crops. The planting of legume crops, such as cowpeas, soybeans, mongo, and beans in rotation with rice or corn and plowing them under at their flowering stage is a good practice of incorporating organic matter besides increasing the nitrogen content of the soil. Farm manures will also help supply organic matter to the soil.

The flat uplands, undulating, rolling and hilly areas are devoted to the cultivation of upland rice, coconut, abaca, camote, cassava and other minor crops. Clearings are made on previously forested areas and are cultivated to short-season crops. After the harvest of these crops the land is left unprotected thus soil deterioration starts in these areas. The land with a rolling to hilly relief should not be devoid of vegetation and, if possible, be planted to permanent crops.

If ever cultivation to clean-tilled crops is to be done on those areas, conservation measures such as contouring, buffer strip cropping, terracing, etc., should be practiced to prevent excessive soil washing. The plowing up and down the slope practice of the farmers should be stopped because this system only creates a good avenue for the rainwater to pass through resulting in serious erosion. Erosion removes the entire physical mass of the soil—the plant nutrient, mineral particles, living microscopic organisms, and other soil constituents. Some of the soils of Sorsogon Province have suffered much from this loss especially those hilly areas that were cleared and being planted to seasonal crops without any conservation measures applied. Terracing will help much to prevent further soil removal on those places if properly installed and managed.

WATER CONTROL ON THE LAND

Water control on the land concerns primarily the maintenance of favorable soil moisture conditions to keep the soil more productive, and the regulation of runoff to prevent soil erosion which impoverishes the soil. Whether the moisture supply is inadequate or excessive, it affects the agricultural practices as well as the productiveness of the soil.

There are factors that essentially affect the keeping of water in the soil, such as the intensity and distribution of rainfall, the slope of the land, the crops grown on the soil, the tillage operation, and the nature and character of the soil itself. On the other hand, the control of water on the land can be achieved through agricultural practices that regulate runoff and maintain favorable soil moisture conditions for plant growth. These practices are the control of runoff and erosion, drainage, irrigation, and protection from flood.

Flood seldom occur in Sorsogon Province and as such there are no control measures devised, nor has there been any control measures undertaken before to protect the land from flood or overflow of streams. Reforesting the headwaters may reduce the danger of flood. Forest is effective in regulating runoff and in the control of overflowing of streams.

Some of the lowland soils of the province are naturally irrigated and/or can be irrigated easily. Irrigation water is used to supplement rainfall especially during dry periods. The use of irrigation water, however, should be controlled in order to bring about an adequate and even supply of water. Good diking of fields, proper planting of crops, and controlling the velocity of the flow of irrigation water should be practiced. Waste irrigation water may cause land damage by erosion alkali accumulation, leaching, or waterlogging.

The poorly drained lowland soils need ditching and/or construction of artificial drainage which, however, are not practiced to improve drainage conditions. These measures will improve the drainage condition of these soils and materially increase the yield of crops.

The control of runoff and erosion is a major problem in Sorsogon Province considering that there are about 175,090 hectares or 85.15 per cent of the total area of the province having relief ranging from undulating to rolling to steep, hilly and mountainous. The slopes range from 3 to 60 per cent or more. The higher the slope, the greater is the velocity of runoff and the less moisture absorbed for plant growth. It also causes all stages of accelerated erosion thereby depleting or destroying the productive capacity of the soil.

Crop rotation, using legumes as one of the crops, when so adjusted may be effective to control runoff. Cover cropping and close growing crops are advantageous in these soils also. They retard the velocity of runoff and in effect lessen surface washing. Such vegetative covers, however, should grow vigorously in order that they may be effective in the control of runoff and erosion. The use of lime, manure, and fertilizers in sufficient amount will help make the desired growth of the plants besides maintaining the soil in good physical conditions.

Good tillage is beneficial. Proper tillage retards runoff and at the same time improves the water holding capacity of the soil. Contour cultivation and contour strip cropping are helpful especially on steeper and longer slopes. They generally impede runoff and reduce erosion losses.

Terracing is expensive and lowers productivity of some soils, but when properly constructed and maintained helps control runoff effectively. Terraces involve engineering works and because this is an expensive measure, its use is conditioned by the financial ability of the farmers. It should be employed

only when very necessary and after other measures are found inadequate.

In general, effective water control on the land is accomplished through soil and water conservation by the use of good and proper soil management practices. Soil and water in agriculture are inseparable, and whatever improvement may be introduced in soil management will, in effect, conserve soil moisture and runoff.

Soil and water conservation makes impoverished soil more productive and improves those soils that have been eroded. Excess water from rainfall that goes as runoff is stored in the soil for use in the succeeding crops and in effect reduces erosion as well as floods because this much water is out of streams. Work on soil and water conservation, however, should fit according to the capability and need of the various kinds of soils. This being so, it is important to have a good knowledge of the soil itself.

Water control on the land is indispensable in a successful agriculture. It can be achieved through proper soil management practices by using vegetative and mechanical measures, fertilization, addition of organic matter, and good tillage suited to the capability and need of the various kinds of soil.

THE CHEMICAL CHARACTERISTICS OF THE DIFFERENT SOIL TYPES OF SORSOGON PROVINCE

BY

EUSEBIO A. AFAGA, GLORIA B. QUERIJERO AND RAMON SAMANIEGO [1]

Different soil types vary in their fertility due to the following factors: (*a*) the difference in climate and vegetation acting upon the different parent materials of varying topography over a long period of time, (*b*) the rate of soil-forming processes, and (*c*) the activities of man. Assessing the fertility status of these soils is, therefore, of prime importance in order to be able to formulate an efficient program of soil management and cropping practices. The method employed is the available constituent test. The determinations made were: (*a*) soil reaction or pH value, (*b*) plant nutrient elements either in the deficiency or sufficiency level, and (*c*) lime and fertilizer requirements.

METHODS OF ANALYSIS

The standard procedures followed in these determination are: (*a*) Peech and English Method [2] for potassium, calcium, magnesium, manganese, and iron, (*b*) Truog Method [3] for phosphorus, (*c*) Spurway Method [4] for ammonia and nitrates, (*d*) Modified Kjeldal Method [5] for nitrogen, (*e*) Black and Walkley Method [6] for organic matter. The soil reactions or pH values were determined by the use of a Beckman pH meter. The results obtained from these determinations are tabulated in table 16.

INTERPRETATION OF RESULTS

Soil reaction or pH value.—Soil reaction refers to the hydrogen ion concentration in soils expressed as the pH value. A pH value of 7 is neutral, it is neither acidic nor alkaline.

[1] Soil Physicist, Supervising Analytical Chemist, and Chief, Soil Research Division respectively.

[2] Peech, Michael and Leah English. 1944. "Rapid Micro-chemical Soil Test." *Soil Science* 57: 167–195.

[3] Truog, Emil. 1930. "The determination of the Readily Available Phosphorus of Soils," *Jour. Amer. Soc. Agron.* 22: 874–882.

[4] Spurway, C. H. 1939. *A Practical of Soil Diagnosis.* Mich. Agri. Expt. Sta. Tech. Bull. 132.

[5] Association of Agricultural Chemists. 1945. Official Tentative Methods of Analysis. Sixth Edition. Asso. of Off. Agr. Chemist, Washington, D. C.

[6] Walkley, A. and I. A. Black. "Determination of Organic Matter in Soils," *Soil Science*, 37: 29–38 (1934).

A pH value below 7 is acidic, the degree of acidity increases with decreasing pH values. On the other hand, a pH value above 7 is alkaline, the degree of alkalinity increases with increasing pH values. The need for soil amendments as lime and flower of sulfur may be indicated by the soil reaction.

The pH values of the surface soils of this province fall under 4 classes of soil reaction; namely, (*a*) very strong acidity, (*b*) strong acidity, (*c*) medium acidity, and (*d*) slight acidity. Irosin silt loam, Irosin sandy loam and Bascaran sandy clay fall under very strong acidity class. They are derived from alluvial materials and contain low available calcium. Castilla clay loam and Donsol sandy clay have soil reactions of strong acidity, pH 5.25 and 5.30, respectively. Bolinao clay, Silay fine sandy loam, Macabare sandy loam, Sorsogon sandy loam, Sorsogon silty clay loam, Annam clay loam, Casiguran clay loam, Bulusan sandy loam, Bulusan loam, and Sevilla clay fall under medium acidity class. Their pH values range from 5.5 to 6. Bascaran clay has a pH value of 6.10 and falls under the slight acidity class. These soil types are derived mainly from various parent materials such as alluvium, limestone, shale, sandstone, basalt and andesite.

TABLE 16.—*Chemical analysis of the different soil types of Sorsogon Province*

Soil types	pH value	Organic matter %	Total N %	Available constituents in parts per million (p.p.m.)							
				NH_3	NO_3	P	K	Ca	Mg	Mn	Fe
Bascaran clay	6.10	9.40	0.23	25	2	8	100	3,500	2,400	37	5
Bascaran sandy clay	4.90	9.15	0.20	10	25	7	31	900	480	53	60
Sorsogon silty clay loam	5.75	8.92	0.26	10	2	12	101	2,500	630	137	6
Sorsogon sandy loam	5.85	8.77	0.23	10	trace	26	55	1,700	440	trace	9
Macabare sandy loam	5.80	0.30	0.18	2	5	12	99	1,500	430	39	3
Donsol sandy clay	5.30	2.08	0.17	10	trace	5	87	1,600	1,380	49	20
Silay fine sandy loam	5.55	4.72	0.15	2	5	8	87	1,000	100	67	5
Irosin sandy loam	4.80	5.47	0.16	10	125	11	109	1,000	1,020	24	33
Irosin silt loam	4.75	7.29	0.27	150	25	12	183	1,500	1,030	3	206
Castilla clay loam	5.25	2.79	0.09	10	5	4	213	1,900	1,640	98	7
Bolinao clay	5.55	4.83	0.14	10	5	22	89	2,100	220	25	2
Annam clay loam	5.90	3.59	0.15	10	trace	3	66	1,500	2,330	105	3
Casiguran clay loam	5.65	5.07	0.15	10	2	4	447	1,700	260	105	3
Bulusan sandy loam	5.60	3.63	0.29	25	25	5	256	800	210	3	3
Bulusan loam	5.90	4.24	0.21	10	10	1	260	700	220	trace	2
Sevilla clay	5.80	2.00	0.17	10	2	4	49	3,600	730	39	3

They influence the soil reactions of these soils. Acid forming substances as flower of sulfur and organic matter, residual effects of fertilizers, soil managements, cropping practices and removal of bases by crops, leaching and drainage water produce acidity in soils.

The importance of soil reaction in crop production are: (*a*) Soil reaction is a limiting factor of plant growth and

development. Definite range of soil reaction or pH value preference is required by different plants for their optimum growth and development. The pH requirements of some of the economic plants are shown in table 17. The pH preference of rice, pineapple and tobacco is pH 5.5 to 6.1. Under the productivity index (table 15) Donsol sandy clay has the highest index for lowland rice. Its soil reaction is 5.3. Silay fine sandy loam has a soil reaction within the optimum pH range but its productivity rating is low. It is suggestive then that, although soil reaction is a limiting factor for plant growth and development, optimum pH requirement is not the only basis for crop production. Climate, soil types, variety, seeds, pests, diseases and farming practices affect also crop yields.

(*b*) Soil reaction affects the availability of plant nutrients in soils. Generally most of these nutrients are available at pH 6.5. Figure 22, Pettinger's Chart as published by Truog,[1]

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

Plant	Strongly acid pH 4.295.4	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 [1]	Y	X	X	Y	O	O
Coffee [1]	Y	X	X	Y	O	O
Cowpea [2]	Y	Y	X	Y	Y	O
Corn [2]	Y	Y	X	X	Y	Y
Durian [1]	Y	X	X	X	Y	O
Peanut [2]	Y	Y	X	X	X	
Petsai [4]	Y	Y	X	X	X	X
Rice [1]	Y	X	X	Y	Y	O
Sugar cane [2]	O	X	X	X	X	Y
Tobacco [2]	Y	X	Y	O	O	O
Sweet potato [1]	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 [2]	Y	Y	X	X	Y	Y
Onion [3]	O	Y	X	Y	Y	Y
Soybean [3]	Y	X	X	X	Y	Y
Orange [3]		Y	X	X	X	Y

X—most favorable reaction.
Y—reaction at which plants grow fairly well or normally.
O—unfavorable reaction.

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

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

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

[4] From Arciaga, Antonio N., and N. L. Galvez, 1948. The effect of soil reaction on the growth of pet-sai plants and their nitrogen calcium and phosphorus content, Philippine agriculture 32:55–59. Normal growth reported was in pH 4.2 8–6; optimum range was pH 5.9–8.6.

[1] Troug, Emil. 1948. "Lime in Relation to Availability of Plant Nutrients." *Soil Science* 65; 1–7.

is reproduced in this report. It indicates the general relationship between the availability of plant food elements and soil reactions. Each element is represented by a band. The width of the band at any pH value shows the relative favorability of this soil reaction to the presence of the element in its readily available form. The wider the band the more favorable the influence of reaction on the availability of the nutrient elements. Wide band does not necessarily mean a satisfactory supply of available nutrient. Narrow band, on the other hand, does not necessarily mean deficiency of the nutrient element, but as far as soil reaction is concerned, the condition is not favorable for adequate supply of the element in its available form. Other factors than soil reaction may promote the presence of adequate supply of nutrients in soils.

(*c*) It influences the optimum activity of soil microorganisms. The various species of organisms thrive best in soils whose soil reaction is nearly neutral. They play an important role in the transformations of plant nutrients into their available forms. A good example is the decomposition and mineralization of organic matter from which carbon, nitrogen, sulfur and phosphorus are liberated in their available forms. Hydrogen and oxygen are also liberated during these processes.

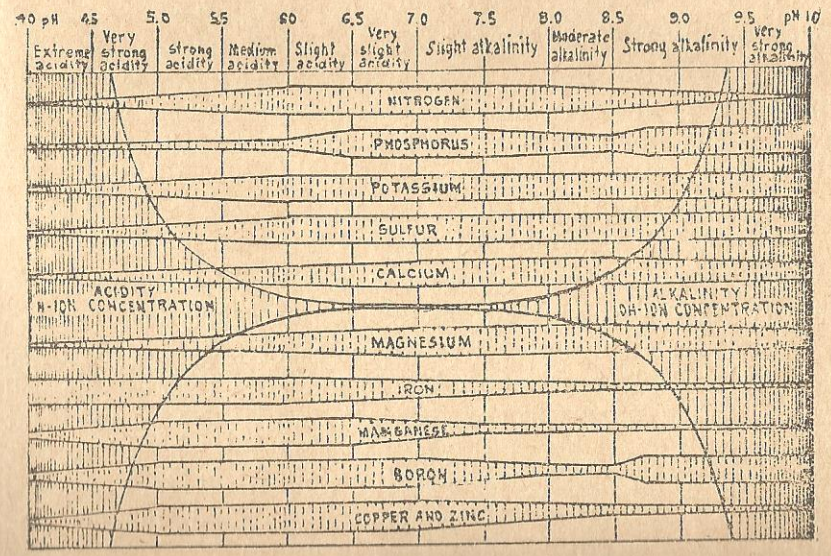

Figure 22. Chart showing general trend of relation of reaction to availability of plant nutrients.

The plant nutrients are divided into three classes on the basis of the amount requirement of plants and on their importance to plant nutrition. These classes are: (*a*) major elements as carbon, hydrogen, oxygen, nitrogen, phosphorus and potassium, (*b*) secondary elements as calcium, magnesium and sulfur, and (*c*) minor or trace elements as manganese, iron, zinc, copper, boron and molybdenum. Carbon, hydrogen and oxygen are derived from the air while the other elements come from the soils.

Marfori [1] stated that for Philippine soils the amounts of available nutrient elements tentatively considered as adequate supply for normal growth and development of most economic crops are as follows:

(*a*) ammonia and nitrates, 10–25 p.p.m.
(*b*) phosphorus, 30–40 p.p.m.
(*c*) potassium, 100–150 p.p.m.
(*d*) calcium, 2,000–6,000 p.p.m.

The need for liming the soil, especially for "high lime" crops as sugar cane, alfalfa and other legumes, is indicated by a rather low available calcium and low pH value.

(*e*) magnesium, 600–1,700 p.p.m.

For certain species of citrus (Pummelo or *Citrus maxima* Brun. Merr.) magnesium deficiency symptoms had been observed on soils containing as much as 950 p.p.m. of available magnesium.

(*f*) iron, 2–30 p.p.m., and
(*g*) manganese, 15–250 p.p.m.

Philippine cultivated soils (surface soils) so far analyzed contain 0.14 per cent total nitrogen on the average.

Basing from these tentative estimates of adequacy of these readily available nutrients, table 16 indicates that all the soil types so far analyzed are deficient in one or more plant nutrients. For instance, Sorsogon sandy loam, Macabare sandy loam and Silay fine sandy loam are deficient in ammonia, nitrates, phosphorus, potassium, calcium and magnesium. Nitrogen in the form of nitrate is in excess for Irosin sandy loam, while nitrogen in its ammonia form is likewise in excess for Irosin silt loam. One hundred parts per million or more of ammonia and nitrates are considered very high

[1] Marfori, R. T. BSC Form No. 56. "Interpretation of Chemical Analysis."

or excessive. Excessive nitrogen adversely affects crop yields especially for grain crops but favors leafy vegetables. Nitrogen content of each of the soil types is on or above the average total nitrogen of Philippine cultivated soils, except Castilla clay loam. All soil types found in Sorsogon Province are deficient in phosphorus.

Irosin silt loam, Bascaran clay, Sorsogon silty clay loam, Irosin sandy loam, Castilla clay loam, Casiguran clay loam, Bulusan sandy loam and Bulusan loam contain adequate supply of potassium in its available form. Nevertheless, Bascaran clay, Sorsogon silty clay loam, Irosin sandy loam require potassic fertilizer for maintenance of potassium sufficiency level throughout the growing period of the crop.

All the soil types are deficient in available calcium except for Bascaran clay, Sorsogon silty clay loam, Bolinao clay and Sevilla clay. The first two soil types are derived from alluvial soils deposited from the higher surrounding soil types whose parent materials are chiefly of calcareous materials. The last two soil types are derived mainly from shale, coralline limestone, limestone and other calcareous materials.

Available magnesium is deficient in Bascaran sandy clay, Sorsogon sandy loam, Macabare sandy loam, Silay fine sandy loam, Bolinao clay, Casiguran clay loam, Bulusan sandy loam and Bulusan loam.

Manganese and iron are needed by plants in small amounts so that their requirements for these elements are usually satisfied. These nutrients are usually deficient in calcareous soils but available in acid soils. Sorsogon sandy loam, Irosin silt loam, Bulusan sandy loam and Bulusan loam contain low supply of available manganese. All the soil types have adequate supply of iron.

Lime and Fertilizer Requirements

Favorable growth factors and a well-balanced plant food elements for well-adapted crops influence marked increase in crop yields, especially in soils with low available plant nutrients, organic matter and with unfavorable conditions. For a well-balanced plant nutrients condition, organic matter and fertilizers should be applied and must not be used alone as each serves definite functions.

Broadcasting and localized placement are the common methods of fertilization. Whatever method is used, the fertilizer should be placed within the reach of the absorbing

rootlets of the plants. Fertilizer containing immobile nutrient element as superphosphate is applied preferably in bands to minimize phosphorus fixation. When an element is fixed it becomes unavailable to plants. Favorable climatic conditions, sufficient soil moisture and absence of water droplets on plant leaves are the best time to apply fertilizer. Basic slag, rock phosphate, or any kind of fertilizers which are not readily available to plants is applied at least one month before planting.

Lime can be applied in the same manner as fertilizers and under the same conditions. It is usually applied at least one month before planting. When lime requirement is relatively high, two or more split applications rather than one heavy application are preferable. Split applications of lime prevent overliming of certain spots of the area. Besides, a change of more than one unit of pH value in the soil reaction is detrimental to plants and microorganisms as well.

Amount of reserved acidity in soils vary so that soils having the same pH or the same intensity of acidity require different amounts of lime to effect the desired change of soil reaction. The higher the reserve acidity the more lime is required. Acid fine-textured soils, soil high in organic matter and temperate soils have a high reserved acidity.

The lime and fertilizer requirements of the different soil types of Sorsogon for lowland and upland rice, corn, and coconut are given under table 18. These amounts were based from the results of the chemical analysis of these soil types.

TABLE 18.—*Fertilizer and lime requirements for the different soil types of Sorsogon Province for onions crops.*

Soil types	Agricultural lime Tons/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Superphosphate (20% P_2O_5) Kg./Ha.	Muriate of potash (60% K_2O) Kg./Ha.
	For Lowland Rice			
Bascaran clay	----	----	250	100
Bascaran sandy clay	2.75	----	300	250
Sorsogon silty clay loam	----	200	250	100
Sorsogon sandy loam	0.75	200	100	200
Macabare sandy loam	1.25	200	250	100
Donsol sandy clay	1.00	200	300	150
Silay fine sandy loam	2.50	200	250	150
Irosin sandy loam	2.50	----	250	100
Irosin silt loam	1.25	----	250	----
Castilla clay loam	----	----	----	----
Bolinao clay	----	----	----	----
Annam clay loam	----	----	----	----
Casiguran clay loam	0.75	200	300	----
Bulusan sandy loam	----	----	----	----
Bulusan loam	----	----	----	----
Sevilla clay	----	----	----	----

TABLE 18.—*Fertilizer and lime requirements for the different soil types of Sorsogon Province*—Continued

Soil types	Agricultural lime Tons/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Superphosphate (20% P_2O_5) Kg./Ha.	Muriate of potash (60% K_2O) Kg./Ha.
	For Coconut			
Bascaran clay	----	100	250	100
Bascaran sandy clay	2.75	----	300	250
Sorsogon silty clay loam	----	300	250	100
Sorsogon sandy loam	0.75	300	100	200
Macabare sandy loam	1.25	300	250	100
Donsol sandy clay	1.00	300	300	150
Silay fine sandy loam	2.50	300	250	150
Irosin sandy loam	2.50	----	250	100
Irosin silt loam	1.25	----	250	----
Castilla clay loam	0.25	300	300	----
Bolinao clay	----	300	150	100
Annam clay loam	1.25	300	300	150
Casiguran clay loam	0.75	300	300	----
Bulusan sandy loam	3.00	----	300	----
Bulusan loam	3.25	150	350	----
Sevilla clay	----	300	300	200
	For Upland Rice			
Bascaran clay	----	100	250	100
Bascaran sandy clay	5.50	----	300	250
Sorsogon silty clay loam	----	300	250	100
Sorsogon sandy loam	1.50	300	100	200
Macabare sandy loam	2.50	300	250	100
Donsol sandy clay	2.00	300	300	150
Silay fine sandy loam	5.00	300	250	150
Irosin sandy loam	5.00	----	250	100
Irosin silt loam	2.50	----	250	----
Castilla clay loam	0.50	300	300	----
Bolinao clay	----	300	150	100
Annam clay loam	2.50	200	300	150
Casiguran clay loam	1.50	200	300	----
Bulusan sandy loam	6.00	----	300	----
Bulusan loam	6.50	100	350	----
Sevilla clay	----	200	300	200
	For Corn			
Bascaran clay	----	100	250	150
Bascaran sandy clay	5.50	----	300	350
Sorsogon silty clay loam	----	300	250	150
Sorsogon sandy loam	1.50	300	100	250
Macabare sandy loam	2.50	300	250	150
Donsol sandy clay	2.00	300	300	200
Silay fine sandy loam	5.00	300	250	200
Irosin sandy loam	5.00	----	250	150
Irosin silt loam	2.50	----	250	----
Castilla clay loam	0.50	300	300	----
Bolinao clay	----	300	150	150
Annam clay loam	2.50	300	300	200
Casiguran clay loam	1.50	300	300	----
Bulusan sandy loam	6.00	----	300	----
Bulusan loam	6.50	150	350	----
Sevilla clay	----	300	300	250
	For Abaca			
Bascaran clay	----	100	250	200
Bascaran sandy clay	2.75	----	300	500
Sorsogon silty clay loam	----	500	250	200
Sorsogon sandy loam	0.75	500	100	400
Macabare sandy loam	1.25	500	250	200
Donsol sandy clay	1.00	500	300	300
Silay fine sandy loam	2.50	500	250	300
Irosin sandy loam	2.50	----	250	200
Irosin silt loam	1.25	----	250	----
Castilla clay loam	0.50	500	300	----
Bolinao clay	----	500	150	300
Annam clay loam	1.25	500	300	300
Casiguran clay loam	0.75	500	300	----
Bulusan sandy loam	3.00	500	300	----
Bulusan loam	3.25	----	350	----
Sevilla clay	----	500	300	400

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN SORSOGON PROVINCE

Common Name	Scientific Name	Family Name
Abaca	*Musa textilis* Nee.	Musaceae
Agiñgai	*Rottboellia exaltata* Linn.	Gramineae
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceae
Amorseco	*Andropogon aciculatus* Retz.	Gramineae
Akle	*Albizzia acle* Merr.	Leguminosae
Apitong	*Depterocarpus grandiflorus* Blanco	Dipterocarpaceae
Api-api	*Avicennia marina* (Forsk.) Vierb var. *alba* (Bla.) Bakh.	Verbenaceae
Anubing	*Artocarpus cumingiana* Trec.	Moraceae
Arrowroot	*Maranta arundinaceae* Linn.	Marantaceae
Aroma	*Acacia farnesiana* (Linn.) Wild	Leguminosae
Avocado	*Persea americana* Mill.	Lauraceae
Balete	*Ficus altissima* Blume Bijdr.	Moraceae
Bakauan	*Rhizophora mucronata* Lam.	Rhizophoraceae
Banana	*Musa sapientum* Linn.	Musaceae
Balimbing	*Averrhoa carambola* Linn.	Oxalidaceae
Bamboo	*Bambusa spinosa* Roxb.	Gramineae
Banaba	*Lagerstroemia speciosa* (Linn.) Pers.	Lythraceae
Binayoyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceae
Breadfruit	*Artocarpus communis* Forst.	Moraceae
Bermuda grass	*Cynodon dactylon* (Linn.) Pers.	Gramineae
Buyo	*Piper betle* Linn.	Diperaceae
Betel nut	*Areca catechu* Linn.	Palmae
Buri	*Corypha elata* Roxb.	Palmae
Cadios	*Cajanus cajan* (Linn.) Milsp.	Leguminosae
Caimito	*Chrysophyllum cainito* Linn.	Sapotaceae
Cabbage	*Brassica oleracea* Linn. var. *capitata* Linn.	Cruciferae
Calopogonium	*Calopogonium mucunoides* Desv.	Leguminosae
Cacao	*Theobroma cacao* Linn.	Sterculiaceae
Camote	*Ipomoea batatas* (Linn.) Poir	Convolvulaceae
Cashew	*Anacardium occidentale* Linn.	Sapotaceae
Cassava	*Manihot esculenta* Crantz	Euphorbiaceae
Chico	*Achras sapota* Linn.	Sapotaceae
Coconut	*Cocos nucifera* Linn.	Palmae
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineae
Coffee	*Coffea arabica* Linn.	Rubiaceae
Cotton	*Gossypium hirsutum* Linn.	Malvaceae
Corn	*Zea mays* Linn.	Gramineae
Cowpea	*Vigna sinensis* (Linn.) Savi	Leguminosae
Cucumber	*Cucumis sativus* Linn.	Cucurbitaceae

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Common Name	Scientific Name	Family Name
Dao	*Dracontomelum dao* (Blanco) Merr. and Rolfe	Anacardiaceae
Dapdap	*Erythrina variegata* Linn.	Leguminosae
Derries	*Derris elliptica* (Roxb.) Benth	Leguminosae
Dita	*Alstonia scholaris* (Linn.) R. Br.	Apocynaceae
Duhat	*Eugenia cumini* (Linn.) Druce	Myrtaceae
Dungon-late	*Heritiera littoralis* Dryand	Sterculiaceae
Eggplant	*Solanum melongena* Linn.	Solanaceae
Gabi	*Colocasia esculentum* (Linn.) Schott	Araceae
Garlic	*Allium sativum* Linn.	Liliaceae
Ginger	*Zingiber officinale* Rosc.	Zingiberaceae
Guava	*Psidium guajava* Linn.	Myrtaceae
Guijo	*Shorea guiso* (Blanco) Blm.	Dipterocarpaceae
Guayabano	*Anona muricata* Linn.	Anonaceae
Ipil	*Instia bijuga* (Colebr.) O Kuntze	Leguminosae
Ipil-ipil	*Leucaena glauca* (Linn.) Benth	Leguminosae
Jackfruit	*Artocarpus heterophyllus* Lam.	Moraceae
Kalamansi	*Citrus microcarpa* Bunge	Rutaceae
Kamanchile	*Pithecolobium dulce* (Roxb.) Benth	Leguminosae
Kondol	*Benincasa hispida* (Thunb) Cogn.	Cucurbitaceae
Kapok	*Ceiba pentandra* (Linn.) Gaertn.	Bombacaceae
Kamias	*Averrhoa bilimbi* Linn.	Oxalidaceae
Lauan (Red)	*Shorea negrosensis* Foxw.	Dipterocarpaceae
Lauan (White)	*Pentacme contorta* (Vidal) Merr. and Rolfe	Dipterocarpaceae
Lanzones	*Lansium domesticum* Correa	Meliaceae
Lemon	*Citrus limonia* Osbeck	Rutaceae
Lemon grass	*Andropogon citratus* Dc.	Gramineae
Lettuce	*Lactuca sativa* Roxb.	Compositae
Maguey	*Agave cantala* Roxb.	Amaryllidaceae
Malungay	*Moringa oleifera* Lam.	Moringaceae
Mango	*Mangifera indica* Linn.	Anacardiaceae
Molave	*Vitex parviflora* Juss.	Verbenaceae
Mungo	*Phaseolus aureus* Roxb.	Leguminosae
Narra	*Pterocarpus indicus* Willd	Leguminosae
Nipa palm	*Nypa fructicans* Wurmb.	Palmae
Onion	*Allium cepa* Linn.	Liliaceae
Orange	*Citrus aurantium* Linn.	Rutaceae
Papaya	*Carica papaya* Linn.	Caricaceae
Patani	*Phaseolus lunatus* Linn.	Leguminosae
Patola	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceae
Peanut	*Arachis hypogaea* Linn.	Leguminosae
Pechay	*Brassica chinensis* Linn.	Cruciferae
Pepper	*Capsicum frutescens* Linn.	Solanaceae
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceae
Pili nut	*Canarium luzonicum* (Blm.) A. Gray	Burseraceae
Pummelo	*Citrus maxima* (Burm.) Merr	Rutaceae

Common Name	Scientific Name	Family Name
Radish	*Raphanus sativus* Linn.	Cruciferae
Rattan	*Calamus blancoi* Kunth	Palmae
Rice	*Oryza sativa* Linn.	Gramineae
Santol	*Sandoricum koetjape* (Brun. F) Merr.	Meliaceae
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosae
Soybean	*Glycine max* (Linn.) Merr.	Leguminosae
Siniguelas	*Spondias purpurea* Linn.	Anacardiaceae
Sugar cane	*Saccharum officinarum* Linn.	Gramineae
Squash	*Cucurbita maxima* Duchesne	Cucurbitaceae
Sweet potato	*Ipomoea batatas* (Linn.) Poir	Convolvulaceae
Tamarind	*Tamarindus indica* Linn.	Leguminosae
Tanguile	*Shorea polysperma* (Blanco) Merr.	Dipterocarpaceae
Talahib	*Saccharum spontaneum* Linn. Subsp. *indicum* Hack	Gramineae
Tobacco	*Nicotiana tabacum* Linn.	Solanaceae
Tomato	*Lycopersicum esculentum* Mill.	Solanaceae
Tindalo	*Pahudia rhomboidea* (Blanco) Prain.	Leguminosae
Tinglog	*Acanthus ilicifolius* Linn.	Acanthaceae
Tugue	*Dioscorea esculenta* (Lour.) Burkill	Dioscoreaceae
Ubi	*Dioscorea alata* Linn.	Dioscoreaceae
Upo	*Lagenaria leucantha* (Duch.)	Cucurbitaceae
Vetiver grass	*Andropogon zizanioides* Linn.	Gramineae
Watermelon	*Citrullus vulgaris* Schrad	Cucurbitaceae
Yakal	*Shorea gisok* Foxw.	Dipterocarpaceae

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