SOIL SURVEY DIVISION

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

Soil Report 22

SOIL SURVEY OF ALBAY PROVINCE PHILIPPINES

RECONNAISSANCE SOIL SURVEY

By

ISAAC J. ARISTORENAS
Chief of Party

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Members

MANILA
BUREAU OF PRINTING
1965

024776

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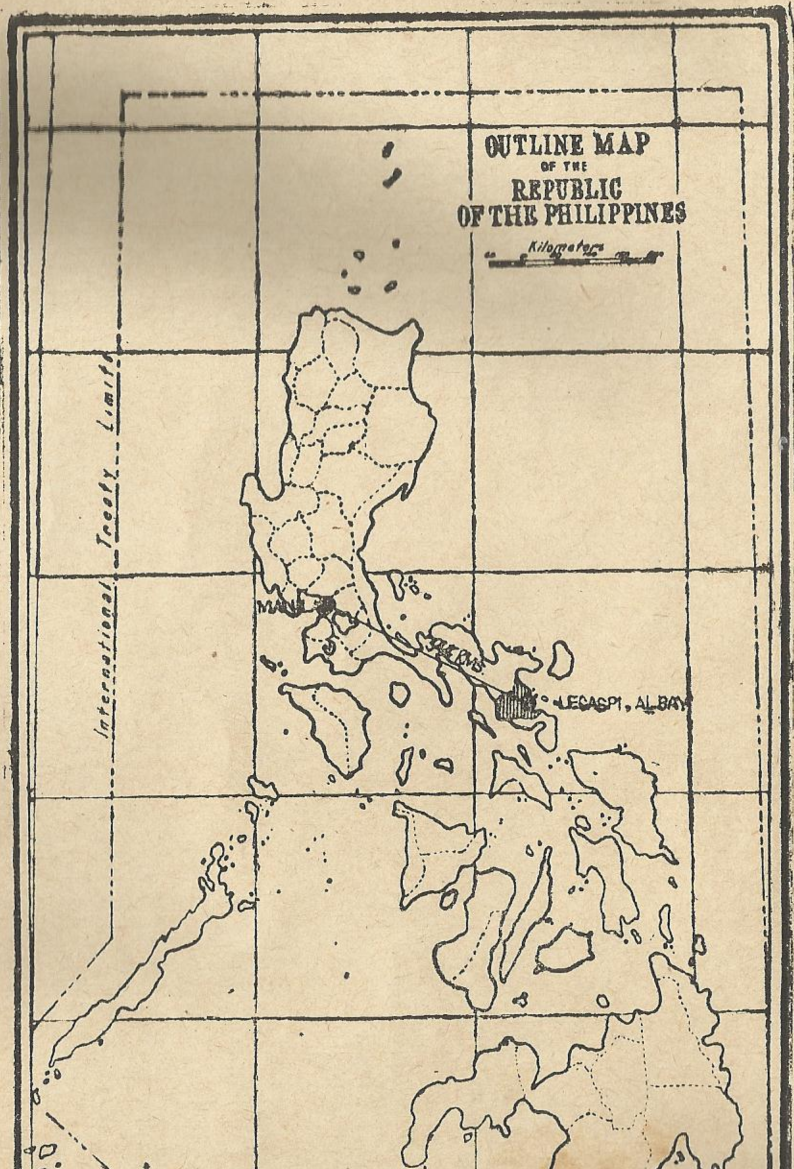

Figure 1. Outline map of the Republic of the Philippines showing the location of Albay.

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WITH A DISCUSSION ON THE SOIL FERTILITY CHARACTERISTICS OF THE SURFACE SOILS OF THE DIFFERENT SOIL TYPES OF ALBAY PROVINCE

By

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MANILA
BUREAU OF PRINTING
1965

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ILLUSTRATIONS

TEXT FIGURES

INTRODUCTION

Most of the areas under cultivation in the Philippines today have been planted to a single crop or to a set of crops continuously for several years. The practice, in most cases, was unsystematic and exploitative. Consequently, the soils were depleted of their fertility or eroded.

Before the country loses one of its most important, if not its most important natural resource, soils surveys were initiated. These surveys were undertaken to study the physical characteristics of soils as they exist in the field, the degree to which they have been subjected to erosion, the prevailing farm practices, and the crops and natural vegetation existing. From the survey, their productivity, fertility, chemical and biological characteristics are deduced or determined. The field and laboratory studies will then furnish a working knowledge on how to use the soils wisely and productively, the system of cropping, the crops suited for each soil, the fertilizers necessary, and all other pertinent data which promote the economic and agricultural advancement of the country.

The reconnaissance soil survey of Albay was conducted from April 9 to June 30, 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. This soil report was updated and edited by Agripino F. Corpuz, Soil Survey Supervisor, and proofread by Mr. Juan N. Rodenas, Soil Technologist.

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SUMMARY

Albay Province is one of the most progressive agricultural provinces in the Bicol Region. It has a total area of 2,579.05 square kilometers, or 257,905 hectares, including the islands of San Miguel, Cagraray, Batan, and Rapu-rapu. The capital of the province, Legaspi City, is 357 air miles, or 560.7 kilometers, from Manila.

The topography of Albay ranges from level to gently sloping, rolling, hilly, and mountainous. The level areas consist of a narrow coastal plain from Tabaco to Tiwi, an interior plain which is a part of the Great Bicol Plain, the rice granary of the Bicol Region.

The undulating and rolling areas occupy a greater section of the province. The northeast coast is a line of volcanoes: Mounts Mayon, Masaraga, Malinao, and Catburauan. Mount Mayon has an elevation of 2,421 meters and is considered perfect cone; Masaraga has an elevation of 1,337 meters; Malinao, 1,548 meters, and Catburauan, 473 meters. Mount Mayon erupted many times; the last eruption was in December, 1947.

The islands of San Miguel, Rapu-rapu, Batan, and Cagraray are generally gently rolling to mountainous. Narrow coastal plains and valleys indent the irregular coast lines of these islands. They are mostly under forest except San Miguel Island which is extensively cultivated.

Calauan, Yawa, Soboc, Ugat, Lagonoy, and Guinali Rivers are the principal rivers that drain the province. Besides these rivers, there are also streams and creeks that complete the intricate drainage pattern of the province.

Potable water is usually available in every part of the province. A water system exists practically on all the municipalities.

Forests are mostly found in the hills and mountains, while grasses cover extensively the low-lying hills and rolling areas. The swamps and waterlogged areas are covered with mangrove; most of the cultivated crops are found in the plains and valleys.

Albay Province was believed to have been visited by Captain Luis Enriquez de Guzman and Juan de Salcedo in 1569 and 1573, respectively, the latter founding the town of Libon. Before the arrival of the Spaniards, several centers of population had been in existence which later became towns. These

are Camalig in 1569, Libon in 1573, Oas in 1587, Polangui in 1589, and Malinao in 1600.

At first Albay exercised full jurisdiction over a big territory which almost included the whole southeastern Luzon. Later, Sorsogon proper was made a separate province; then in 1846, the islands of Masbate and Ticao were segregated and created into a Comandancia Politico-Militar. This diminution of territory, however, did not hinder the progress of the province.

The year 1834 was the beginning of prosperity for the province. Roads, bridges, and public edifices were constructed. Agriculture was encouraged and as a result the province was made an "Alcaldia" of the first class in 1860.

A civil government under American rule was established in Albay on April 26, 1901.

The population of the province was 28,496 in 1755, 80,205 in 1799, and 106,333 in 1810. In the census of 1918, the recorded population of the province was 323,234, while in 1938 it reached 432,485. However, the 1948 census registered a population of 294,690, or a decrease of 37,795 from that recorded in 1938 census.

During the survey of the province there were 508.46 kilometers of roads consisting of 274.30 kilometers of first-class road, 159.35 kilometers of second class, and 74.81 kilometers of third class. The Manila railroad has its terminal at Legaspi City. An airport of the Philippine Air Lines, Inc., is also found in the city making available a daily trip except Sunday from Manila to Legaspi City and to other parts of the country.

Foreign and interisland vessels at Tabaco and Legaspi, Tiwi-Ligao, Bacacay, and Malacbalac offer docking facilities to small motor vessels, sailboats and launches.

Each town has its own market. Tabaco, Daraga, and Legaspi are the commercial centers of the province.

The Bureau of Public Schools takes charge of the public education of the children. Private institutions offering elementary, secondary and collegiate courses are also found in Albay Province.

There are hospitals in the province besides puericulture centers which are found in almost every town to look after the health of the populace.

Majority of the people profess the Roman Catholic religion. Other religions existing in the province are Protestant, Seventh Day Adventist and Aglipay.

Farming is the main industry of the people. Fishing, com-

merce, lumbering, weaving, rope making, pottery, and manufacturing are the other industries.

The second and the fourth type of climates or Intermediate type B of rainfall in the Philippines occur in the province. The former has no dry season with a very pronounced maximum rain period from January to March. It occurs on the whole eastern part of the province. The latter type of climate covers the rest of the province. It is characterized by no very pronounced minimum rain period without dry season.

Albay is an agricultural province. The 1948 census shows that the total value of farm land in that year was ₱42,486,485. In the same year, there were 125,617.14 hectares cultivated to different crops and the total value of the produce was ₱32,036,901. The value of livestock and poultry for the same year was ₱5,730,220.

Diversified farming is practiced, but the methods have not much improved from the century old method of tilling the soil. There is, however, a trend to employ scientific methods. Rice is the main food crop, while copra and abaca are the main export crops. Corn, sugar cane, tobacco, camote, cassava, peanuts, banana, vegetables, and fruit trees are the other crops grown.

The soils of Albay Province have been classified into three groups, namely, (1) the soils of the plains and valleys, (2) soils of the uplands, hills and mountains, and (3) miscellaneous land types.

The soils of the plains and valleys have a total area of 34,480 hectares comprising seven soil series with nine soil types. These are the important agricultural soils of the province. They are alluvial and cultivated to lowland rice and other seasonal crops.

The soils of the uplands, hills and mountains have a total area of 167,996 hectares and are composed of eight soil series with eight soil types and one soil complex. The lower slopes and the rolling areas should be planted to permanent crops and if they are cultivated to annual crops, intensive soil conservation measures should be practiced. The higher slopes should be left under forest.

There are four miscellaneous land types with a total area of 55,429 hectares, or 21.49 per cent of the area of the province. These miscellaneous land types have no agricultural value.

The soils of the province have been placed under nine land capability classes according to their physical suitability for crop production, namely, Classes A, B, C, D, L, M, N, X, and Y. Classes A, B, and C are croplands; D, L, and M are pasture lands and/or forest lands; class N is forest land; X is good for fish ponds and/or wildlife; and Y is good for forest and wildlife.

The soils of the province are given productivity ratings based on current management practices without the use of amendments. Table 14 indicates the productivity ratings of the soils of Albay for each of the principal crops grown in the province.

Based on origin, degree of profile development, and general relief, the soils identified and studied in the province are classified into six profile classes, namely, Profile groups A, B, C, D, E, and F.

Profile classes A and B consist of alluvial soils, while Profile classes C, D, E and F are primary soils.

RECONNAISSANCE SOIL SURVEY

DESCRIPTION OF THE AREA

Location and extent.—Albay Province, like a distorted trapezoid, is one of the most progressive agricultural provinces of the Bicol Region in the central section of the southeastern volcanic region of the Island of Luzon (fig. 1). It is bounded on the north by Camarines Sur and Lagonoy Gulf, on the east by the Pacific Ocean, on the south by the province of Sorsogon and Panganiran Bay, and on the west by Burias Pass. It has a total area of 2,579.05 square kilometers or 257,905 hectares, including San Miguel, Cagraray, Batan, and Rapu-rapu islands. Legaspi City, 357 nautical miles or 560.7 kilometers by land from Manila, is the capital (fig. 1).

Relief and drainage.—The general topography of Albay ranges from level to gently sloping, rolling to hilly and mountainous. The level areas consist of the interior and the coastal plains. The interior plain is the continuation of the Great Bicol Plain and is the rice granary of the province. It is flanked by the Malinao and Masarawa ranges on the north and Mounts Pantao and Catburauan and other low-lying hilly ranges on the south. The plain is dissected by rivers of various sizes which meander towards the coast lines. The coastal plain is narrow occupying the regions from Tabaco on the south to Tiwi on the north.

The undulating and rolling areas west of Oas and south of Ligao are parts of the ridge that forms the northeast flank of the Albay syncline. The low rounded hills and upland plateau-like regions from Guinobatan southward to the Sorsogon provincial boundary represent the rolling areas. The northeast coast of the province is lined by volcanoes, namely, Mounts Mayon with an elevation of 2,421 meters; Masaraga, 1,337 meters; Malinao, 1,548 meters; and Catburauan with an elevation of 473 meters.

Mount Mayon is the most symmetrical volcano. It is known for its recurring eruptions, that of 1814 being the most destructive; the eruptions of 1828 and 1947 resulted in a thick deposition of lava and ashes over the northeastern part of the province.

Narrow fertile valleys, alluvial fans, and bouldery ravines meander into the rolling areas, mountain ranges and hills, towards the irregular coast or open out to coastal plain or marshes.

Rapu-rapu, Batan, Cagranay, and San Miguel Islands are generally gently rolling to mountainous. Narrow coastal plains and valleys indent the irregular coast lines of these Islands. They are forested except San Miguel which is more or less wholly cultivated.

Except the flood plains, the province is well to excessively drained. Among the big and important rivers that drain the province are the Calauan, Yawa, Soboc, Ugat, Lagonoy, and Guinali Rivers. During heavy rains these rivers inundate the surrounding lowlands, depositing soil materials, but also destroy crops. Besides these big rivers, there are also streams and creeks that complete the intricate drainage pattern of the province.

Water supply.—Potable water is usually available in every part of the province. However, it was observed that the quality differs considerably. It is claimed that water in the province is highly mineralized and has been found to be corrosive to radiators, boilers, and metal pipes.

In the majority of cases, water system in the province are located in the poblacion. These system supply raw water usually by gravity, pumping, dugged wells, and by open springs. Tables 1 and 2 show the data on the water supply of Albay.

TABLE 1.—*Water supply in Albay Province* [1]

Locale	Population served	Type or system	Capacity in gallons per day
Bacacay	3,000	Gravity	288,000
Camalig	2,500	Gravity	100,000
Daraga–Legaspi	20,000	Gravity	470,000
Daraga–Legaspi (Army Cadre)	600	Gravity	
Guinobatan	5,000	Gravity	288,000
Jovellar	2,500	Gravity	122,000
Legaspi–Raagan Barracks	5,000	Pumping	259,200
Ligao–Oas	12,000	Gravity	430,000
Polangui	8,500	Gravity	136,000
Tabaco	5,500	Gravity	216,000
Tabaco, Barrio San Miguel	400	Gravity	5,760
Tiwi	3,000	Gravity	100,000
Rapu-rapu	3,000	Gravity	76,000

[1] Compiled from the Terrain Intelligence Report for southern Luzon.

NOTE.—The water of the Daraga–Legaspi water system is found to be highly mineralized, corrosive to radiation, boilers and metal pipes.

TABLE 2.—*Distribution of wells in Albay showing quality of water* [1]

Municipality	Depth Feet	Total solids	Parts per million							
			SiO_2	Fe	Ca	Mg	Cl	SO_4	CO_3	HCO_3
Bacacay, Pool	338	3,700	71.0	1.0	83.0	60.0	700	310	------	------
Cagraray	338	400	85.2	Tr.	38.9	51.4	------	Tr	------	------
Camalig	153	460	85.0	0.8	47.0	22.0	26	110	------	240
Guinobatan	445	1,800	74.0	13.0	210.0	240.0	36	295	------	200
Camalig	129	570	80.0	1.6	50.0	33.0	30	140	------	280
Guinobatan	160	445	77.0	0.6	55.0	18.0	18	100	10.0	190
Legaspi	368	1,836	64.0	3.6	23.0	Tr	964	33	------	2,000
Ligao	293	460	69.0	0.68	18.0	10.0	29	Tr	------	420
Malinao	348	990	67.0	Tr	51.5	43.0	218	95	------	------
Malilipot	172	220	60.0	0.60	7.5	17.0	11	------	------	180
Oas	463	605	68.0	3.60	11.0	10.0	107	Tr	------	------
Oas	186	940	54.0	1.50	50.0	19.0	275	Tr	------	415
Polangui	176	620	80.0	2.8	78.0	38.0	43	Tr	------	640
Polangui	82	460	73.0	2.4	76.0	24.0	7.6	Tr	------	431
Tabaco	485	570	65.0	0.5	8.9	12.0	85.0	Tr	------	300
Tabaco	371	280	60.0	3.7	1.2	------	6.2	88	------	------
Tabaco	145	210	105.0	0.06	9.7	1.6	5.5	------	------	80
Tiwi	312	1,100	150.0	Tr	7.0	8.7	190.0	120	------	450

[1] Terrain Intelligence Report of Southern Luzon, prepared by Geological Survey, U. S. Department of Interior, December, 1944.

Vegetation.—Native vegetation expresses the composite physical environment. It is the integration of all physical factors, past as well as present, and as a consequence provides a better basis for classifying and judging the potentialities of environments than any single or set of factors. The suitability of virgin soil for certain types of land use and crops is often clearly indicated by the vegetation cover. The existence of plant communities is mainly and closely an association of the principal climatic and vegetation types. Any modifications within the plant communities may be due to soil, relief and drainage differences, environment changes, and influences and activities of man.

There are three types of vegetation in Albay namely, (1) the forests, (2) grasses, savannah, and croplands, and (3) halophytes or salt and fresh-water vegetations.

The forest resources of the province is found mainly in the rugged slopes of northern Cordillera—Mounts Masarawag and Malinao, in the upper slopes of Mount Mayon, and in the steep and rugged slopes and summits of the ranges in Rapu-rapu, Batan, and Cagraray Islands. Ssome of the important commercial forest trees in the province are as follows:

Dao	Molave
Yakal	Tabigue
Guijo	Palosapis
Narra	Lauan, red
Apitong	Lauan, white

Grass covers extensively the low-lying hills in the western section of the province, in the vicinity of Mounts Catburauan and Pantao or the hilly coastal regions of the municipalities of Ligao and Guinobatan, and the northwesternmost section of the town of Libon. The most common and extensive grass cover is cogon. This extensive cogonal area is spotted with trees and shrubs and is usually utilized for raising cattle.

The halophytic vegetation is the soil cover of the coastal swamp and waterlogged areas. The most dominant are the nipa palms, *bangkal, bakawan, api-api, langaray,* and *dugonlate,* the last five are good firewood. Nipa leaves are used as thatching materials for houses, while the inflorescence are tapped for vinegar and the manufacture of alcohol. Table 3 shows the actual soil cover of Albay in 1946.

Organization and population.—Little is known regarding the first exploration of the regions which now comprise Albay Province. It was believed, however, that Capt. Enriquez de Guzman, Spanish Military Adviser, who explored Masbate, Ticao, and Burias Islands in 1569, also visited a portion of southern Albay. It was also believed that Juan de Salcedo in 1573 explored parts of what is now Albay, founding the town of Libon.

Several centers of population in the form of barangay had already existed in the whole region before the arrival of the Spaniards. Later, several towns were organized out of these centers of population, such as the creation of Camalig in 1569, Libon in 1573, Oas in 1578, Polangui in 1589, and Malinao in 1600. Albay was created in 1636 and was made the capital of the province. Other towns were organized and created during the later part of the Spanish occupation.

TABLE 3.—*Actual soil cover of Albay as of June 30, 1946*[1]

Type of Land	Area in Hectares	Percentage
Commercial forest	29,900	11.59
Noncommercial forest	17,425	6.76
Open-cultivated land	210,080	81.46
Swamps (Fresh and salt water marshes)	500	0.09
Total	257,905	100.00

During the period, Albay exercised full jurisdiction over a big territory which almost included the whole of southeastern Luzon. Later on, Sorsogon proper was made a separate province. Again in 1846, Albay suffered a slight diminution of territory because of the partial segregation of Masbate and Ticao Islands which were created into a Comandancia Politico-Militar in October of the same year. At the same time, Albay ceded to Camarines Sur the regions of Lagonoy, Caramoan, and Sagnay in the Caramoan Peninsula in exchange for Camalig, Guinobatan, Mauraro, Ligao, Oas, Polangui, Libon, Donsol, and Quipia. This diminution of territory did not at all hinder the progress of the province.

[1] Yearbook of Philippine Statistics, 1946.

The prosperity of Albay Province began during the administration of Governor Jose Maria Peñaranda in 1834. He was responsible for the construction of roads, bridges, and public edifices of the province. He actively encouraged agriculture. For decades, after Peñaranda's enlightened rule, the province continued to progress, so that in July 1860, the province was made an "Alcaldia" of the first class.

At the outbreak of the revolution, Albay did not take active participation. Later, however, when it came under the revolutionary government, such prominent military leaders as Pawa and Belarmino came out.

Civil government was established in Albay on April 26, 1901. The province continued to prosper in population, commerce, agriculture and industry. Recently, Legaspi was inaugurated as Chartered City.

During the second half of the 18th century and the first two decades of the 19th century the population of Albay showed great increase. The number of people recorded as living in the province in 1755 was 28,496. This figure rose to 80,205 in 1799, and to 106,333 in 1810. In 1814, the recorded population of Albay was only 92,065 showing a great decrease from that of 1810. This was due to a great extent to the destructive effects of the eruption of Mayon Volcano in February of the same year.

In 1850, Albay had more than recovered the population it lost in 1814. The growth of population continued unhindered through the years and in 1918 the recorded population was 323,234, in spite of the fact that Catanduanes, a subprovince became an independent province. In 1938 her population was 432,485 and the present population based on the 1948 census is 394,690.

Transportation, communication, and market.—Albay Province is well dissected by the national, provincial, municipal, and barrio roads which connect the different barrios to the towns and to the capital of the province. This network of roads ranges from asphalted, MacAdamized to fourth class barrio roads. During the war, many roads and bridges were destroyed and traveling in the province became difficult. Roads are being rapidly rehabilitated and pushed through as funds are made available. There are also new road projects opened to make the agricultural sections of the province accessible to good markets.

The census of 1946 shows the length of the national and provincial roads of Albay Province as follows:

	Kilometers	
National roads:		
1st class	153.90	
2nd class	55.85	
3rd class	21.41	
Total		231.16
Provincial roads:	Kilometers	
1st class	120.40	
2nd class	103.50	
3rd class	53.40	
Total		277.30
GRAND TOTAL		508.46

Several transportation companies have systematic scheduled routes to different places within and outside the province. However, the carts remain as the principal motive power for the small farmers in transporting their produce from the farm to the transportation stations or terminals.

Before World War II, railroad line connecting Manila with Legaspi and passing through Camarines Norte and Camarines Sur was destroyed during the Japanese occupation, but this line was rehabilitated lately. Daily train trips are made from Manila. It takes 14 to 16 hours ride from Manila to Legaspi. It is projected that this railroad line will be extended as far as Matnog, Sorsogon. Improvement of this line is still going on as fast as funds are made available.

Air transportation is provided by the Philippine Air Lines, Inc. There are daily trips except Sunday from Manila to

Legaspi and to other points of the country. The distance from Manila to Legaspi can be covered in approximately one and a half hours by air trip.

The coastal towns and those located along the navigable rivers have bancas and sailboats as their principal local transportation aside from the land facilities. These facilities make coastal contact very fast and convenient from barrio to barrio or from town to town.

Aside from these local water transportation, there are inter-island motor vessels and foreign freight ships at Tabaco and Legaspi which make call from time to time to load copra, abaca, and other export commodities for foreign countries. Several ports of calls such as Tiwi, Ligao, Bacacay, Malacbalac, and other points offer convenience to small motor vessels, sailboats and launches. These vessels may come from Masbate, Burias, Ticao, and Catanduanes.

Other means of communications are the postal telegraph, telephone and radio services available in every first class town and in Legaspi City.

Almost every town, big and accessible barrio of the province has its own market and market days. But Tabaco, Daraga, and Legaspi markets act as the nuclei for all the barrio and municipal markets where most farm and industrial products are brought. They serve as commercial centers wherein distribution of products is effected and transactions are usually consummated.

Cultural development and improvement.—Cultural development of the province dates back to the Spanish regime, when religion was introduced into the life of the people. Early commerce have also contributed to the early culture of the populace. The pioneering ability of the Spaniards as regards culture was expressed through the establishments of religious schools in the province. But more opportunities along the educational facilities of the province were noted during the establishment of a civil government in 1901. The growth was so rapid that in 1918 census, a total of 292 primary schools, 11 intermediate, 2 high schools and 3 vocational schools with a total enrollment of 22,676 students was listed. The growth of these educational centers has been arrested in 1946 as shown by a decreased number of schools although enrolment during that school year was more than double and there was accelerated establishment of higher institution of collegiate courses. The latest total number of schools in the province is 179 elementary schools, 2 secondary and 1 collegiate courses. The latest total number of schools in the province is 179 elementary schools, 2 secondary and 1 collegiate schools with enrollment of 47,513; 1,803; and 139 students, respectively, or a total of 49,455 students.

There are also private institutions which play an important role in the cultural development of the population, these are: Saint Agnes College, Legaspi Junior Colleges, Manuel L. Quezon Vocational School, Albay Institute, and others which offer secondary and collegiate courses. The province is divided into regional districts with one high school each.

Majority of the people of Albay professes the Roman Catholic religion. Every town and barrio of the province has a chapel or a church. The other religions found in the province are the Protestant, the Seventh Day Adventist, the Aglipayan, and others.

There are also hospitals in the province and almost every town has a puericulture center that looks after the health of the populace.

Industries.—The important industries of the people are farming, fishing, commerce, lumbering, weaving, rope making, pottery, manufacturing, and other minor industries.

Farming is the most important occupation of the people. Rice is the main food crop, while copra and abaca are the main export crops. Other crops raised are corn, sugar cane, tobacco, camote, cassava, peanuts, bananas, vegetables, and fruit trees.

Fishing is also an important industry of the people especially those living along the coastal towns. The fishing region is located in the southern part of the province, of which Tabaco and Manito are the centers. It supplies the entire province with salt-water fishes. In addition fishes come from the northwestern section of Sorsogon. Nets are generally used in catching deep-sea fishes.

Fresh-water fishes are caught mostly in Lake Bato and are mostly sold in the northwestern and western towns of the province. In 1938, Albay was credited with 742,025 kilos of fish of all kinds valued at ₱197,386.

Lumbering is not so extensive in the province. In 1946, there were 66 lumbering establishments in the province with a gross sales of ₱201,152.

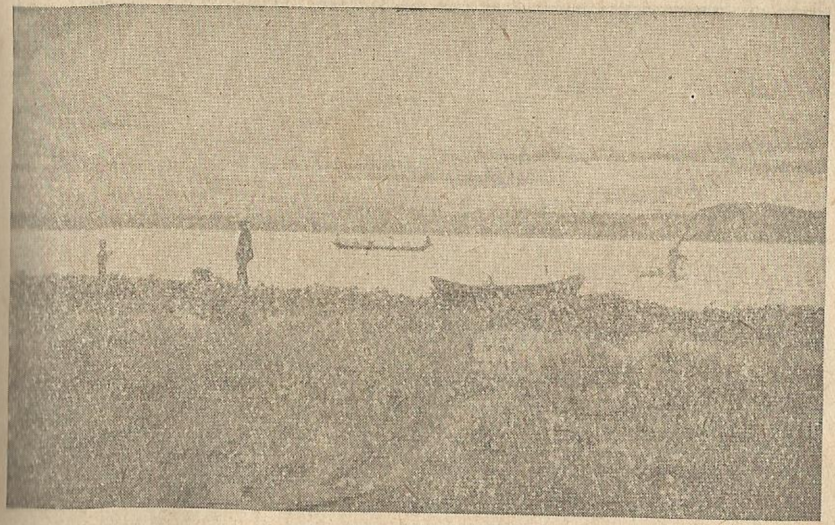

Figure 2. Lake Bato where fresh water fishes abound.

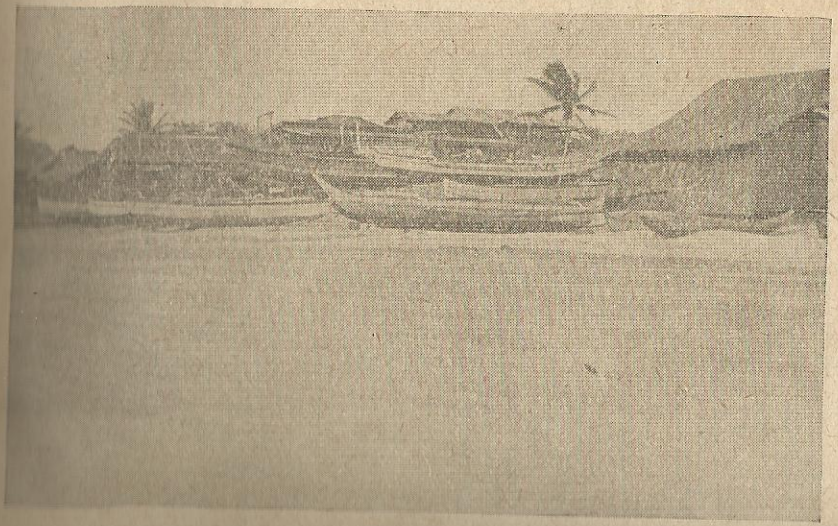

Figure 3. A fishing village along the seacoast.

PLATE I

Temperature is comparatively uniform throughout the province. The lowest and highest recorded temperatures have a difference of about three degrees centigrade. The main change in temperature occurs in altitude difference. December, January, and February are relatively the coolest months, while April, May, and June are the hottest.

TABLE 4.—*Monthly average temperature, Legaspi, Albay*[1]

Month	Years of record—47 yrs. Centigrade
January	25.72
February	25.88
March	26.72
April	27.72
May	28.82
June	28.06
July	27.44
August	27.44
September	27.28
October	27.11
November	27.11
December	26.17
Annual	27.06

[1] Weather Bureau, "Monthly Average Temperature in the Philippines." (Manila: Weather Bureau, 1956), p. 2. (Mimeographed.) Degree Farenheit converted to degree centigrade.

TABLE 5.—*Monthly average rainfall, number of rainy days,*[1] *relative humidity, and cloudiness in Albay*[2]

Station	Legaspi					
Years of record	Monthly average rainfall (47 yrs.)	No. of rainy days (47 yrs.)	Relative humidity%		Cloudiness (0–10)	
			Mean	Normal (35 yrs.)	Mean	Normal (35 yrs.)
Month	*mm.*					
January	374.6	23	85	83	8	7
February	269.7	16	85	82	8	6
March	213.6	17	83	81	7	5
April	150.6	14	85	79	8	5
May	171.7	14	85	80	8	5
June	194.5	15	85	82	8	6
July	239.2	19	87	83	8	7
August	206.2	17	87	83	9	7
September	248.1	19	87	85	9	7
October	317.2	21	86	84	8	7
November	481.0	22	86	84	9	7
December	513.3	24	89	84	10	7
Annual	3,380.3	24	86	82	9	6

[1] Weather Bureau, "Monthly Average Rainfall and Rainy Days in the Philippines." (Manila: Weather Bureau, 1956), pp. 1 & 17. (Mimeographed.)

[2] Weather Bureau, "Annual Climatological Review, 1956." (Manila: Weather Bureau, 1956), p.43.

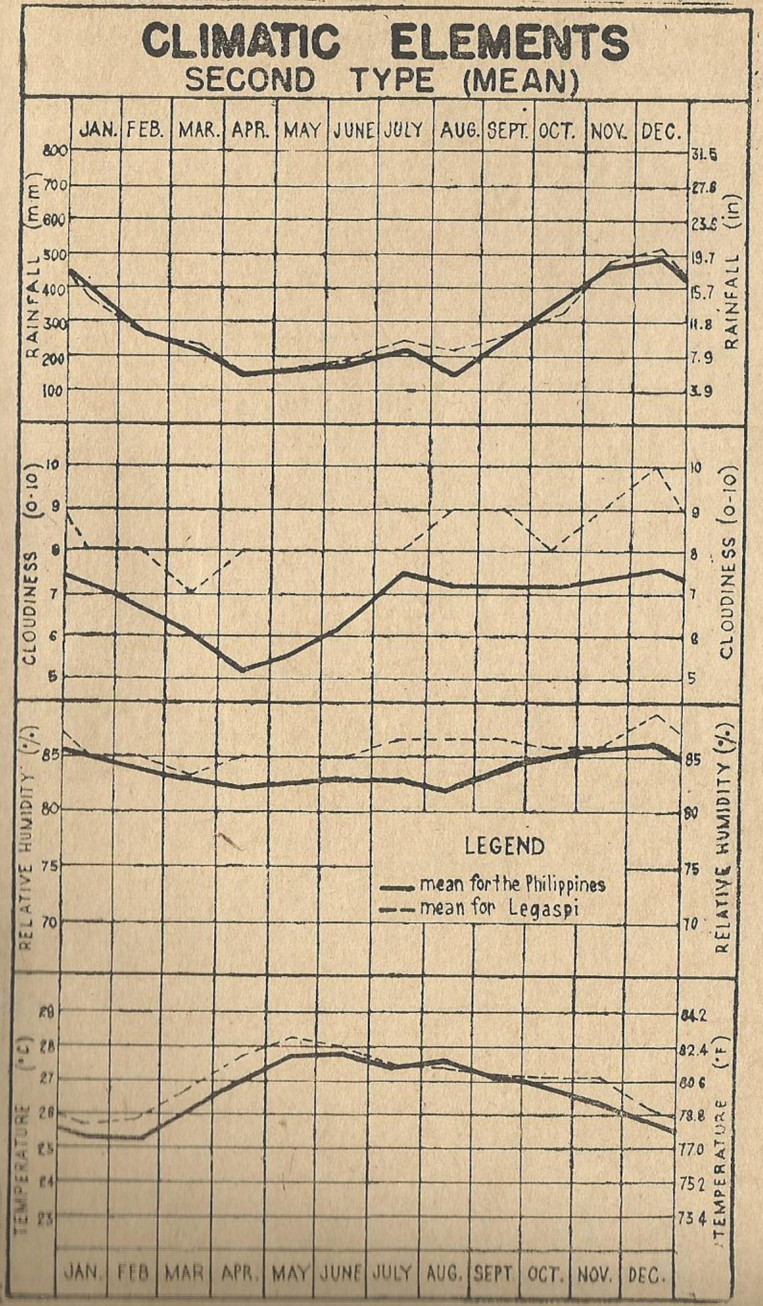

Figure 6. Graphical presentation of the second type of climate in the Philippines and of Legaspi

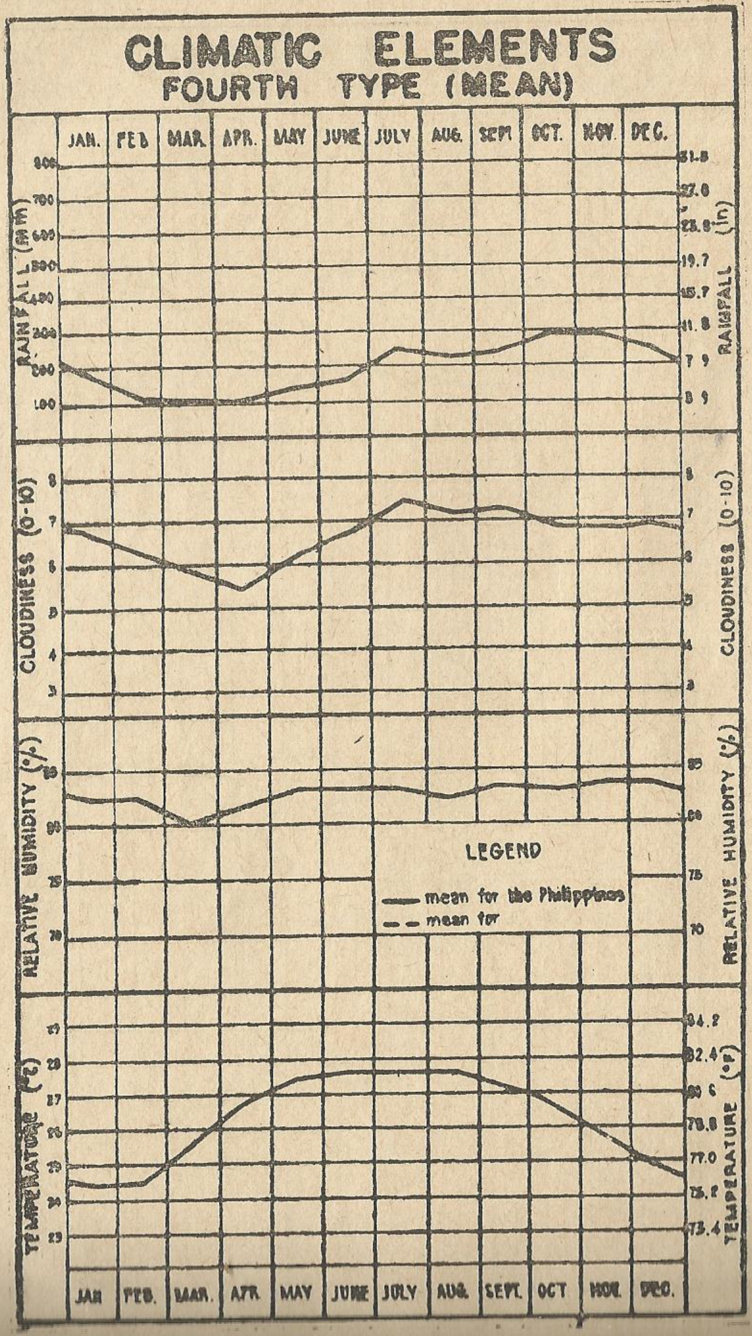

Figure 7. Graphical presentation of the fourth type of climate.

The relative humidity in the second type of climate is highest from July through December. The mean annual average is 86 per cent. Under the fourth type of climate, relative humidity in Albay is high and fairly uniform.

The cloudiest period under the second type of climate in Albay occurs from July through January. Cloudiness is expressed in terms of "tenths" of sky covered with clouds.

Typhoons frequently visit the province. Cyclonic and northeast monsoon rains as well as thunderstorms also occur in the province.

AGRICULTURE

The early agricultural practices in Albay Province were simple. Agricultural practices to maintain soil fertility and soil-improving crops were unknown. The settlers would clear a tract of land, farm it for several years, and then abandon it as soon as it becomes unproductive. This was the practice when lands were plentiful and the settlers would clear any tract of land they wished to cultivate. But transportation and communication were slow and there were no markets to sell their surplus products, thus the production of crops was adjusted to satisfy their needs.

Prosperous settlements were already in existence before the first Spaniards set foot in the province. These were called Balangays in which the towns of Camalig, Libon, Oas, Polangui and Malinao were organized and became the nuclei of agriculture in the province. Balangays were later modified by the Spaniard into barangays. As the population increased the areas cultivated to subsistence crops also grew in proportion, and cultivation started to become permanent. In one way or another, the frequent eruptions of Mayon Volcano affected agriculture in this region, although it did not hinder its progress.

Marked progress of economic development in Albay was noted during the administration of Governor Jose Maria Peñaranda in 1834, who sparked the constructions of roads and bridges and encouraged agriculture. The extension of the Manila railroad up to Legaspi also helped in the rapid development of agriculture in Albay. Today, Albay is one of the well-developed agricultural provinces of the country.

The 1918 census showed that the total area cultivated in the province was 110,670 hectares and the value of the produce amounted to ₱1,315,546 but in the 1938 census, the total area cultivated was 109,264.81 hectares and the produce was valued at ₱2,208,878. Whereas, in the 1948 census the total area cultivated was 125,617.14 hectares and the produce was valued at ₱32,036,901. The total value of livestock and poultry of the same year was ₱5,730,220. The total value of farm lands was ₱42,846,485.

Farming in Albay is not so well diversified although the climate of the province and most parts of the agricultural areas are adapted to diversified farming. There is generally only one crop raised in most of the farms. Abaca and coconut are the two export crops, while rice, camote, and corn are the three most important food crops. Table 7 shows the ten leading crops of the province, arranged in the descending order of cultivated hectarage, together with the total production and value of the produce of each crop as of 1948.

CROPS

Abaca.—Abaca ranks first in area cultivated among the crops raised in the province, but third to coconut in the value of the produce; rice is second. The total area planted to this crop as shown in 1939 census was 39,468.09 hectares with a total production of 10,640,330 kilos valued at ₱727,552, while in 1948 census it was 40,930 hectares giving a total production of 14,140,332 kilos valued at ₱6,590,361. The average production ranges from 288 to 345 kilos per hectare, or 4.3 to 5.5 piculs of 63 kilos a picul.

This crop suffered during the Japanese occupation from 1942 to 1944, yet there was an increase in the area cultivated and production over that of 1938 of about 1,443.91 hectares and 3,500.002 kilos, respectively. This increase may be attributed to the good price of abaca fiber after the liberation which encouraged the farmers to plant more area to this crop. However, the average production remains stationary from 4.3 to 5.5 piculs per hectare. One reason for this low production was that most of the old abaca fields did not receive good management. The old plantations need renovation and proper management to increase the yields of abaca. Another reason is that this province has been often visited by typhoons destroying the standing crops.

Coconut.—This crop ranks second in importance on the basis of hectarage, but is first in peso value. The census of 1939

recorded a total area of 40,001.96 hectares planted to this crop and the total value of the produce was ₱918,560, but the 1949 census shows that 36,623.20 hectares were planted to coconut giving a total value of ₱10,912,026.

TABLE 6.—*Ten leading crops, area planted, production, and value of produce in pesos in Albay Province* [1]

Crops	Area in hectares	Total production	Total value
			Pesos
Abaca	40,930.02	14,140,332 kilos	6,591,361
Coconut	36,023.20	99,865,293 nuts	10,912,026
Rice	33,116.99	809,775 cavans	10,147,620
Camote	6,861.06	6,675,006 kilos	608,534
Corn	4,621.33	49,757 cavans	538,604
Cassava	1,601.86	2,011,105 kilos	177,839
Sugar cane	599.86	6,280 tons	82,669
Gabi	300.68	465,397 kilos	63,741
Peanut	185.96	92,515 kilos	43,251
Eggplant	105.20	88,304 kilos	14,697
Total	124,346.16		29,180,342

[1] Data taken from the Census of 1948.

The decrease in the hectarage may be due to the infestation of kadang-kadang, a disease which, if not controlled, would wipe out the whole coconut plantations in the province.

San Miguel Island, one of the coconut-producing regions of the province, has practically lost its coconut trees because of kadang-kadang. This coconut region in the island is now being converted into orchards and upland rice fields. The same situation is happening in other coconut-producing regions of Albay. The seasonal occurrence of typhoon in the province also affects the coconut industry.

Copra, oil, and *tuba* are the coconut products in the province. Copra and oil are exported; the latter is also used locally. *Tuba*, a local name of the native drink, is derived from the sap of the tapped inflorescence. It is sold in the local markets.

Practically all the soil types mapped in the province are planted to coconut.

Rice.—Rice is the third important crop of the province in the extent of area cultivated, but is second to coconut in the value of the produce. This is the main food crop of the people in the province. In the 1918 census, a total production of 587,095 cavans was recorded for the province, but in the 1939 census there was a total of 509,775 cavans produced from 24,736.24 hectares and valued at ₱1,235,432, while the 1948 census recorded a total production of 809,775 cavans from 36,023.20 hectares with a total value of ₱10,147,670.

All available lands in the plains suited to this cereal are planted. Hillsides and plateaus in some parts of the province are cultivated to upland rice. As of 1948 census, a total of 22,923.74 hectares of lowland was planted to rice for the first and second crops, 16,677.80 hectares of which were irrigated. This is about two-thirds, or 73.75 per cent, of the total area cultivated to lowland rice.

The production of lowland rice for the first crop ranges from 30 to 60 cavans per hectare and 15 to 30 cavans for the second crop. The upland rice ranges from 8 to 15 cavans per hectare. The introduction of more standard rice varieties, use of commercial fertilizers, better tillage operation, and good soil management would bring the production of this cereal to a higher level.

Malinao, Oas, Polangui, Ligao, Libon, Legaspi and Daraga are the leading rice-producing towns of Albay. The important soil types devoted to this crop are Libon silt loam, Malinao fine sandy loam, Ligao loam, Umingan fine sandy loam, Bascaran clay and Legaspi fine sandy loam.

Corn.—Corn is the other food crop of the people of Albay. This is planted three times a year in the province. A total of 1,741.44 hectares was recorded planted to this crop in 1938 census which gave a total production of 19,026 cavans and 269,288 green ears valued at ₱33,324. The 1948 census gave a total area of 4,621.33 hectares planted to corn and a production of 49,757 cavans valued at ₱538,604.

The municipalities of Libon and Oas are the largest producers of corn. Guinobatan, Polangui, Ligao, Camalig, and Jovellar are also important corn-producing towns in the province.

This crop is planted in the lowland as well as in the upland. But in both cases the production per unit area is almost the same, 6 to 12 cavans per hectare. The White and the Yellow Flint are the two important varieties planted. A white glutinous variety is also planted, but less extensive than the first two varieties. This crop is not fertilized. With the use of commercial fertilizers, better tillage operations and good soil management, the yield of this crop can be improved.

Sugar cane.—Sugar cane is also an important crop of the province, but it is not planted on a commercial scale. This is sold in stalks for chewing or manufacturing *panocha* and *basi* for local consumption. The areas planted to sugar cane range from 2 hectares to less than one hectare.

The census of 1938 shows that the total area planted to this crop was 761.90 hectares with a total production valued at ₱30,173, while the 1948 census shows there was 599.86 hectares and the value of the produce was ₱82,669. There was a decrease in the area planted from 1939 to 1948 of about 162.04 hectares, which might have been planted to other crops.

Root crops.—Root crops are the other food crops in the province. The important root crops grown in Albay are camote, cassava, peanut, gabi, and ubi. Camote is considered the fourth important crop with respect to area and the value of the produce, while cassava is the sixth both in area and in the value of the produce. Gabi and peanut are in the eight and ninth places, respectively.

The total area planted to these crops as shown in 1939 census was 2,146.93 hectares with a total value of the produce amounting to ₱58,752. Nine years later, the 1948 census gave 8,974.56 hectares and the produce was valued to ₱900,199. These crops are most adapted to the light soils of the province both in the lowlands and in the uplands.

Vegetables.—The supply of both fruits and leafy vegetables in the province is sufficient. Eggplant, mungo, cabbages, tomatoes, onion, pechay, amargoso, squash, patola and upo are some of the leafy and fruit vegetables of the province. They are planted mostly in home gardens. Most of the products are consumed locally.

Fruit trees.—The growing of fruit trees in Albay is as old as agriculture itself. Farmers get a substantial income from the fruit trees. The total value of fruits in Albay in 1939 was ₱318,104. But in 1948, it was ₱13,599,298 including nuts.

The climate of the province is favorable to the culture of fruit trees. However, the seasonal occurrence of typhoon presents a hazard. The five leading fruit trees in the province are shown in Table 7, including the total number of trees, total production, and total value.

Miscellaneous crops.—Some of the miscellaneous crops grown in the province include adlay, anipay, bamboo, beans, carrots, cotton, cowpeas, derris, garlic, ginger, etc. The total value of the miscellaneous crops in 1938 was ₱5,909 and in 1948 was ₱140,106. Some of these crops could be raised commercially in the province because the soil and climatic condition are favorable to their cultures.

AGRICULTURAL PRACTICES

The increased use of commercial fertilizers and the improved methods of cultivation especially of rice and corn are recent important changes in the agricultural practices in the province. Selected and improved seeds are introduced. Thorough preparation of the land before planting is now being done. On the other hand, the old practice of clearing new lands when the yields decrease on land under cultivation still prevails in some upland and hillside regions in the province.

TABLE 7.—*Fruit trees in Albay Province*[1]

Trees	Total trees planted	Total production	Total value
			Pesos
Banana	1,499,053	1,242,141 bunches	1,359,100
Jackfruit	124,582	643,378 fruits	135,406
Betelnut Palm	116,939	18,814,428 nuts	39,039
Papaya	75,663	1,361,388 fruits	98,488
Pili	36,204	1,512,720 kilos	467,011
Total	1,852,441		2,099,044

[1] Data taken from the Census of 1948.

Clean cultivated cropping system in the rolling and sloping areas are common, hence erosion has become an increasing problem. Terracing that will prevent runoff and control erosion is not practiced. Strip cropping, contour farming, and close-growing crops to reduce surface runoff and soil erosion are not practiced. There has been no attempt to improve or build the soils of these eroded areas. Crop rotation is sometimes practiced in a simulated way.

The farmers have been using the old method of cultivation with the native plows and harrows and the carabaos as sources of power. This method seems practical for rice paddy fields. The use of farm machinery is not found feasible in the paddies but tractors are used in some higher areas to improve tillage operations.

Irrigation water is used in most of the lowland rice farms. On the other hand, drainage condition of some farms is a problem, as there is no drainage system and consequently the crop yields are low.

An extensive area of the province planted to abaca and coconut farms is not well taken care of. There are abaca farms which are too weedy and have not been cultivated for quite a number of years. This neglect resulted in poor

production. Coconut farms present the same conditions. Cover cropping is not practiced, while thick cogon and shrubs became the underbush. The coconut farms are mixture of apparently healthy plants and kadang-kadang infested plants. Consequently, infestation of this disease have become serious and in most coconut fields there could hardly be found healthy coconut trees.

LIVESTOCK AND LIVESTOCK PRODUCTS

Raising livestock is a secondary occupation in Albay. Generally, cattle and carabao are raised in every farm as sources of power and for food when they are too old to work in the farm. Horses are raised for transportation purposes. As a result of the serious kadang-kadang infestation in most of the coconut farms, there seemed a growing consciousness of the farmers to devote the coconut fields more for livestocks or to grow other crops. Table 8 shows the number of livestock and poultry in Albay Province in 1939 and 1948.

Farmers usually keep one or three carabaos or cattle; however, there are some farmers who have farms for cattle for semi–commercial purposes. In San Miguel Island a livestock farm is being maintained. In 1939 there was a total of 10,975 cattle in the province, 3,021 of which were foreign breeds. In 1948, only a total of 1,727 cattle was recorded, 368 of which were foreign breeds. Camalig, Tabaco, and Libon have the greatest number of cattle.

Every home keeps chickens and hogs either for home supply or for local markets. In 1939 there were 237,879 chickens recorded in the province, 5,412 of which were grade chickens while in 1948, there were 217,642 native chickens and 9,124 of other breeds in the province, producing a total number of 1,974 eggs valued at ₱213,768.

There are no dairy projects in Albay. The milking of cows, carabaos, and goats is done by individuals who sell the milk locally. The production of milk in the province as shown in the 1939 and 1948 census is as follows:

	1939	1948
	Liters	*Liters*
Carabao	225	13,400
Cattle	401	610
Goat	219	40
Total	845	14,050

TABLE 8.—*Number of livestock and poultry in Albay Province in 1939 and 1948*

Livestock	1939 [1]		1948 [2]	
	Number	Value in pesos	Number	Value in pesos
Carabao	36,480	809,116	39,324	4,455,135
Cattle	10,975	148,258	1,727	190,536
Horse	611	10,315	272	26,711
Goat	1,197	3,060	1,222	13,113
Sheep	190	584	22	308
Hog	51,639	449,622	81,674	2,634,422
Chicken	231,879	124,617	332,763	376,868
Duck	3,235	3,386	11,548	19,465
Goose	478	1,420	325	945
Turkey	77	304	37	216
Pigeon	--------	--------	226	227
Total value		1,550,682		7,717,946

[1] Data from 1939 census.

[2] Data from 1948 census.

LAND-USE CHANGES

Practically all the potential agricultural lands of the province have been under cultivation, hence there is very little room for expansion. According to the 1939 census, the total number of farms of Albay was 31,913 comprising 137,833.24 hectares, 103,896.94 hectares of which, or 75.37 per cent, were cultivated. The remaining 24.63 per cent were idle land, pasture land, forest land, and other lands. In 1948 census, however, the number of farms recorded was 35,258 with a total area of 118,261.77 hectares, 87,786.31 hectares of which, or 74.23 per cent, were cultivated, and the rest which was 25.77 per cent, includes idle land, pasture land, forest land, and other lands. Table 9 shows the number of farm area and farm land classified according to use for 1939 as compared to 1948. From this table, it can be noted that idle land in 1939 decreased by about 45 per cent in 1948, while forest land increased by about 42 per cent. Pasture land and other lands were also increased by about 54 and 29 per cent, respectively, from 1939 to 1948.

The decrease in the area of cultivated farm lands might have been due to their becoming submarginal and have been added to the forest lands or other lands. This situation is true of the idle lands. However, there are hillsides, rolling areas, and plateaus which are not covered up by farm lands and might have been under forest zones, but have now been brought to cultivation. On the other hand, some farm area on account of unsuitability of cultivation may become forest lands.

TABLE 9.—*Land-use classification*

Kind of land	1939 [1]		1948 [2]	
	Area	Per cent	Area	Per cent
Cultivated land	103,896.94	75.37	87,786.31	74.23
Idle land	20,396.19	14.81	11,292.44	9.55
Pasture land	3,951.21	2.87	6,107.08	5.16
Forest land	5,292.97	3.84	7,529.02	6.37
Other lands	4,295.93	3.11	5,546.92	4.69
Total farm area	137,833.24	100.00	118,261.77	100.00

[1] Data from 1939 census.

[2] Data from 1948 census.

FARM TENURE

Table 10 shows that in 1939, there was a total area of 103,896.94 hectares cultivated, or 75.37 per cent of the total farm area, and in 1948 the total farm area cultivated was 87,786.77 hectares, or 74.23 per cent of the total farm area of that year, or a decrease of 16,110.17 hectares equivalent to 15.42 per cent. During the same period the population decreased from 432,485 in 1939 to 394,694 in 1948, a total of 37,791, or 8.73 per cent.

The farmers of the province are classified into owners, part owners, tenants, and managers. The tenants are further classified into share tenants, share cash tenants and cash tenants. According to the 1939 census, Bulletin No. 3–A, the "classification of tenure has been made upon the basis of the propriety relationship of the farmer to the land and upon the method of paying the rent in the case of farms operated by persons who do not own the land they work."

Table 10 shows that in 1939 and 1948, the great majority of the farmers in Albay are owners of the farm they operate, while tenants constitute a large number. This is also true of the number of farms in hectares operated by each class. The owners operate more hectarage than do the other classes, but the tenants operate substantial hectarage. Of the whole farms of Albay, the owners operate 56.63 and 60.34 per cent in 1939 and 1948, respectively; while the tenants operate a total of 30.09 and 25.30 per cent in 1939 and 1948, respectively. The area in hectares operated by owners in 1939 and 1948 was 77,215.10 and 71,350.83 hectares, respectively; and that for the tenants was 41,487.31 hectares in 1939 and 28,919.05 in 1948.

TABLE 10.—*Number of farms and area of farms operated by owners, part-owners, tenants and managers in Albay Province*

Kind of farmers	1939[1]				1948[2]			
	No. of farm operated	Per cent	Farm area operated	Per cent	No, of farm Operated	Per cent	Farm area operated	Per cent
Owners	19,416	60.84	77,213.10	56.03	17,946	50.87	71,350.83	60.34
Part owners	3,562	11.16	14,920.18	10.83	4,849	13.76	15,673.49	13.25
Share tenants	8,851	27.74	41,226.99	29.91	11,463	32.53	26,978.89	22.82
Share cash tenants	24	.08	118.54	.08	166	.47	543.89	.46
Cash tenants	44	.13	141.78	.10	198	.56	868.61	.73
Other tenants					596	1.69	1,527.66	1.29
Farm managers	16	.05	4,212.65	3.04	40	.12	1,318.40	1.11
Total	31,913	100.00	137,833.24	100.00	35,285	100.00	118,261.76	100.00

[1] Data from 1939 census.
[2] Data from 1948 census.

FARM INVESTMENTS

Records of farm investment in the province is not available; however, the census of 1939 and 1948 listed some farm equipment with their values. The number of working animals are also shown in table 11.

TABLE 11.—*Farm investments in Albay*

Farm investment	1939[1]		1948[2]	
	Number	Value in pesos	Number	Value in pesos
Plows	14,719		18,253	
Harrows	14,625	224,498	16,161	885,235
Carts	1,089		1,341	
Sleds	2,904		6,263	
Tractors			3	
Striping Machine			1,157	
Work animals	[3] 24,854		19,267	[4] 4,816,750

[1] Data from 1939 census.
[2] Data from 1948 census.
[3] Computed on pre-war basis.
[4] Computed on post-war basis.

TYPES OF FARM

Bulletin No. 3–A, Census of 1939, explain that "type of farm is the relationship of the area planted in a particular crop or in group of crops to the area of cultivated land in each farm." On this basis, the farms of Albay are classified into 11 types of farms, which the same Bulletin describes as follows:

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

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

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

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

5. Coconut farms are farms on which 50 per cent or more of the cultivated land is planted to coconuts.

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

7. Tobacco farms are farms on which the area planted to

tobacco is equal to 50 per cent or more of the area of cultivated land.

8. Root crop farms are farms on which the area planted to camote, cassava, and/or potato is equal to 50 per cent or more of the area of cultivated land.

9. Vegetable farms are farms on which the area planted to camote, mungo, soybean, tomato, sitao, cowpeas, patani, beans, cadios, onion, radish, eggplant, cabbage, gabi, watermelon, and/or potato is equal to 50 per cent or more of the area of cultivated land.

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

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

The eleven types of farm in Albay are summarized in table 12, with the number of farms and the per cent of each type. From this table can be gleaned how diversified farming is practiced in Albay Province. In 1939, there was a total of 8,349 palay farms, or 26.16 per cent, which was increased to 13,110, or 37.19 per cent of the total number of farms in 1948. On the other hand, there was a decrease in the number of farms of abaca and coconut from 1939 by 70 and 23.14 per cent, respectively. No data on tobacco and root crop farms are found in the same table for 1939 but in 1948 the same crops had 0.07 and 6.02 per cent respectively of the total number of farms in Albay. This simply means that where a

TABLE 12.—*Type of farms in Albay Province*

No.	Type of farm	1939 [1]		1948 [2]	
		No. of farm	Per cent	No. of farm	Per cent
1	Palay	8,349	26.16	13,110	37.19
2	Corn	58	.18	287	.81
3	Abaca	10,525	32.99	3,161	8.97
4	Sugar cane	207	.65	294	.83
5	Coconut	10,025	31.41	8,706	24.70
6	Fruit	81	.25	779	2.30
7	Tobacco	----	----	25	.07
8	Root crops	----	----	2,123	6.02
9	Vegetable	364	1.14	25	.07
10	Livestock	9	.02	3	.01
11	Other crops	2,295	7.20	6,745	19.13
	Total	31,913	100.00	35,258	100.00

[1] Data taken from 1939 census in Agriculture.

[2] Data taken from 1948 census in Agriculture.

farm is no more productive to its previous crop it could be planted to other suitable crops and become a different type of farm. Hence the number of farms for each type of farm increases or decreases as circumstances arise. From this Table, it could also be seen that rice, coconut, and abaca are the three most important crops of Albay Province.

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 can not 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.

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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 Guinobatan series was first found and classified in the municipality of Guinobatan, Albay.

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, Guinobatan sandy loam is a soil type within the Guinobatan 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 degrees of erosion are shown as 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 can not 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 Macolod, Pili, etc., 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 Macolod, or Pili 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, telephones and telegraph lines; barrios, towns, and cities; rivers and lakes; prominent mountains, and many others.

THE SOILS OF ALBAY PROVINCE

Soil is the principal medium in crop production. The origin of this important portion of the earth's surface is a long and complicated process. It represents the final product of the five interacting soil forming factors, namely, parent material, relief, age, climate, and vegetation; the last two of which are known as the active factors. The action of these factors in various combinations and degrees of intensity develops thousands of individual soils, each of which possesses definite characteristics, its own capacity to produce, crop suitability, and distinct responses.

The soils of the province differ in color, texture, depth, drainage, relief, permeability, fertility, tilth, and adaptability to crops. The soils of the province were classified into 15 soil series consisting of 17 soil types, one soil complex, four miscellaneous land types. These soils were divided into three groups according to relief as follows:

Soil Types	Soil type No.
I. Soils of the plains and valleys:	
1. Legaspi fine sandy loam	227
2. Legaspi fine sandy loam, stony phase	230
3. Legaspi sandy clay loam	231
4. Umingan fine sandy loam	122
5. Bascaran clay	235
6. Libon silty clay	233
7. Ligao loam	234
8. Malinao fine sandy loam	232
9. Panganiran clay	465

II. Soils of uplands, hills and mountains:

1.	Guinobatan sandy loam	243
2.	Mayon gravelly sandy loam	242
3.	Annam clay loam	98
4.	Luisiana clay	239
5.	Mauraro gravelly sandy loam	241
6.	Tigaon clay	186
7.	Sevilla clay	174
8.	Faraon clay	132
9.	Macolod-Pili complex	187

III. Miscellaneous land types:

1.	Hydrosol	1
2.	Mountain soils undifferentiated	45
3.	Beach sand	118
4.	Lava flow	341

Soils of the Plains and Valleys

LEGASPI SERIES

The soils of Legaspi series were developed from recent alluvial deposits brought down through water action from the surrounding uplands especially from the slopes of Mayon Volcano. The areas occupied by the soils of this series are narrow and irregular, mostly coastal and embracing half of the northeastern, eastern, and southern slopes of Mayon Volcano. The general relief ranges from level to nearly level with a few moderately sloping and undulating areas. This series has fair to good drainage.

The surface soil is deep and gray, brownish black to light reddish brown in color. The subsoil is brown, brownish red to yellowish brown gravelly sandy loam to gravelly silty clay loam. Some surface soil in the higher areas have already been washed away. The elevation ranges from 10 to 220 feet above sea level.

Legaspi fine sandy loam (227).—This soil type is found on the level and almost level to slightly sloping places in the towns of Daraga, Legaspi, Bacacay, Tabaco, and Libog. The area is well dissected by streams which originated from Mount Mayon. These streams act as natural drainage for the area. Internal drainage of this soil type is good. The slightly sloping areas need terracing and other conservation measures to minimize erosion. The total area of this soil type is about 8,670 hectares.

The profile characteristics of Legaspi fine sandy loam are as follows:

Depth (Cm.)	Characteristics
0–30	Surface soil; fine sandy loam; brownish black, dark gray, grayish brown; medium granular structure; friable when dry; mellow when moist; good in organic matter content. Boundary with lower surface soil is diffused and wavy.
30–50	Lower surface soil, sandy loam; light grayish brown, yellowish brown to light reddish brown; fine granular structure; friable, porous but slightly compact; fair in organic matter content. Boundary with underlying layer is abrupt and wavy.
50–75	Upper subsoil, silty clay; brownish red, yellowish brown to brown; grayish brown to black with gray mottlings; coarse granular structure; slightly plastic when wet, crumbly to brittle when dry. Boundary with underlying layer is wavy and abrupt.
75–95	Lower subsoil, gravelly sandy loam; grayish brown, orange brown, yellowish brown; structureless, moderately compact; gravels present in this layer.
95–150	Substratum, sandy loam to medium sand; brownish gray, purplish gray, light gray; structureless; mellow, loose, and friable; free from stones and gravels.

This is a deep soil, easy to till, suitable to diversified farming, and responds readily to good management. It is utilized mainly to lowland rice. The varieties grown are Kinawayan, Apostol, and Senador with average yields of from 15 to 30 cavans of palay per hectare. This low yield may be attributed to continuous cropping and lack or inadequate use of fertilizer.

The higher and sloping well drained places are planted to coconut and abaca. The coconut trees are infected with kadang-kadang and coconut production is rather low. Abaca plantations have been neglected. Consequently abaca yield is low, about 8 to 10 piculs per hectare. The other crops planted on this soil type are tobacco, corn, root crops, vegetables, and some fruit trees. Commercial fertilizer application, green manuring, and other scientific soil management practices are necessary to increase production.

Legaspi fine sandy loam, stony phase (230).—This soil phase is similar to the preceding soil type described except for the presence of stones and boulders on the surface. Some of these stones and boulders are of such sizes as to hinder effective cultivation. This soil phase is found in the municipalities of Libog and Daraga, and on the flat and slightly sloping areas between Camalig and Guinobatan. It has a total area of about 3,810 hectares or 1.48 per cent of the provincial total.

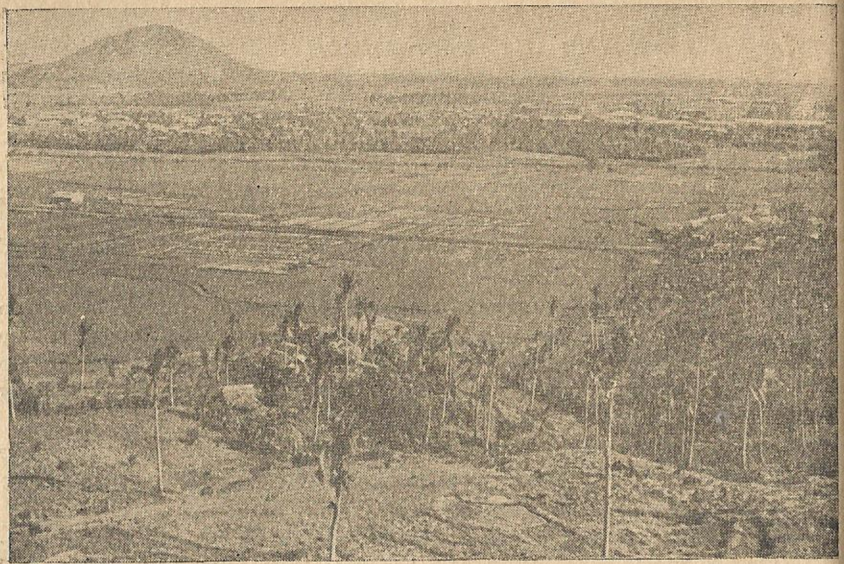

Figure 8. Landscape of Legaspi series.

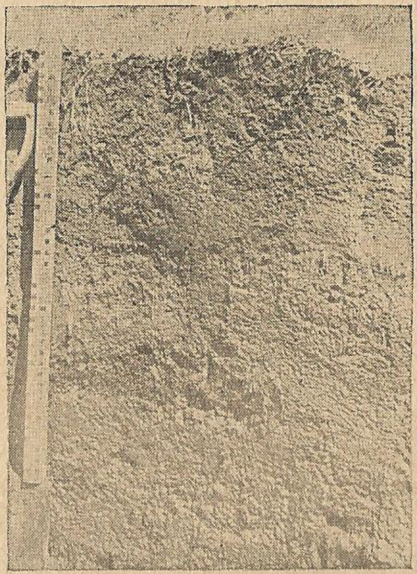

Figure 9. A soil profile of Legaspi sandy clay loam.

PLATE 3

This soil phase is planted principally to lowland rice twice a year without the benefit of commercial fertilizer application. The other crops grown are coconut, banana and other fruit trees, abaca, camote, cassava, and vegetables.

Despite the availability of irrigation water rice production is only about 15 to 25 cavans of palay per hectare. This may be attributed to poor soil management. The land is usually inadequately prepared before planting. Rice straw instead of being made to decompose are burned outright.

Legaspi sandy clay loam (231).—The soil type of the Legaspi series comprises the lowland areas, the barrios of Tagaytay, Camalig, Busay of the municipality of Daraga. Its relief is nearly level with an elevation of about 200 feet above sea level. It covers an area of about 450 hectares.

Except for the sandy clay loam surface soil, this soil type has similar profile characteristics to those of the Legaspi fine sandy loam. The heavy texture of the surface soil may be due to the continuous deposition of clay soil materials from the surrounding uplands. This soil type is also planted to lowland rice twice a year with an average annual production of from 15 to 30 cavans of palay per hectare. Corn, cassava, camote, vegetables, and fruit trees are the secondary crops.

UMINGAN SERIES

The soils of this series were developed from alluvial deposits. The relief is level and the degree of profile development ranges from slight to moderate. This series is well drained and because of its nearness to rivers it is subjected to flooding. The distinguishing characteristic of this soil series is the presence of a gravelly or stony layer within the profile which ranges in thickness between a few centimeters to about a meter. Due to this layer of stones or gravels soils of this series tend to be droughty.

Umingan fine sandy loam (122).—The surface soil varies in color, ranging from pale gray to dark gray or grayish brown to dark brown. It is structureless, loose, and friable. Due to the looseness of the soil, this soil type is very susceptible to erosion. It has an acidic reaction which vary in degree depending upon prevailing cropping and cultural practices.

The subsoil is sandy loam and has a lighter color than the surface soil. Roots easily penetrate this layer which ranges in thickness from 20 to 40 centimeters. The boundary between the subsoil and the underlying layer is clear and smooth.

Typically, the gravelly and stony layer is found below the subsoil which is again underlain by a layer of stone-free soil.

The typical profile characteristics of Umingan series as represented by the fine sandy loam type are as follows:

Depth (Cm.)	Characteristics
0–25	Surface soil, fine sandy loam; brown to dark grayish brown; structureless, friable and loose when either wet or dry; fair organic matter content. Boundary with the subsoil is clear and smooth.
25–60	Subsoil, silt loam; light brown to brown; structureless to medium granular; friable; highly permeable; affords deep root penetration.
60–80	Lower subsoil, loam to silt loam; light brown, grayish brown to brown; structureless to coarse granular; soft, friable, and slightly compact. Boundary with underlying layer is clear and smooth.
80–100	Water-worn gravel and cobblestone deposit mixed with sand and silt loam.
100 and below	Substratum, sand; light brown to grayish brown; loose and structureless.

This soil type which is found in places fringing the foothills has a coarser texture than on areas farther from the mountain sides. Sometimes gravels and cobblestones are found on the surface which adversely affect production. In general, the Umingan fine sandy loam in the province is of high agricultural value. It is deep, easy to cultivate, well adapted to crops of the locality and responsive to good management. This soil type is devoted mainly to lowland rice. The other crops found suitable and grown on this soil are corn, camote, mungo, cowpeas, banana, coconut, and some fruit trees. The average production of lowland rice ranges from 20 to 40 cavans of palay per hectare. The varieties grown are Senador, Dumali, and Inapostol. Corn yields from 8 to 15 cavans per hectare. These crops are not fertilized.

This soil type is found in the municipality of Molinao and covers an area of about 1,500 hectares or about 0.58 per cent of the provincial total.

BASCARAN SERIES

The soils of Bascaran series are found on the older alluvial valleys of the province. They consist of alluvial, colluvial and

creep soil materials transported from surrounding uplands by gravity and water action. The relief is level to nearly level. External drainage is fair while internal drainage is poor. The series has an elevation of about 280 feet above sea level.

The surface layer consists of brownish gray to reddish gray soil with some gravels and underlain by brownish gray to light gray slightly compact clay mixed with highly weathered yellowish orange gravels.

Bascaran clay (235).—Bascaran clay is deep and productive. It is not susceptible to erosion. The total area of this soil type is about 1,110 hectares.

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

Depth (Cm.)	Characteristics
0–40	Surface soil, clay; brownish gray, reddish brown, or gray with light gray splotches; blocky structure; gravels found in this layer. Boundary with subsoil is smooth and diffused.
40–65	Subsoil, silty clay to clay; grayish brown to dark brown with brick red streaks and gray specks; coarse columnar structure; a few weathered yellowish gravels are imbedded.
65–115	Lower subsoil, clay; brownish gray to light gray with red splotches; coarse columnar structure; yellowish orange gravels are embedded in this layer. Boundary with substratum wavy and diffused.
115–150	Substratum, clay; yellowish brown to grayish brown; massive; sticky and plastic when wet, brittle and hard when dry; no coarse skeleton.

This soil type should be plowed at optimum moisture condition. If plowed soon after a heavy rain its soil structure is adversely affected and the soil becomes unsuitable for early planting. Good soil management would enhance production.

Lowland rice is the principal crop and is planted twice a year. Under normal conditions the first crop yields from 50 to 60 cavans of palay per hectare; the second crop about 30 to 40 cavans. Corn, fruit trees, vegetables, and root crops are also planted. Fertilization is not practiced.

LIBON SERIES

Libon series was developed from recent alluvial deposits. It has a level to nearly level relief. External drainage is poor; internal drainage is fair. The elevation ranges from 120 to 240 feet above sea level. Soils of the series have long been devoted to lowland rice culture.

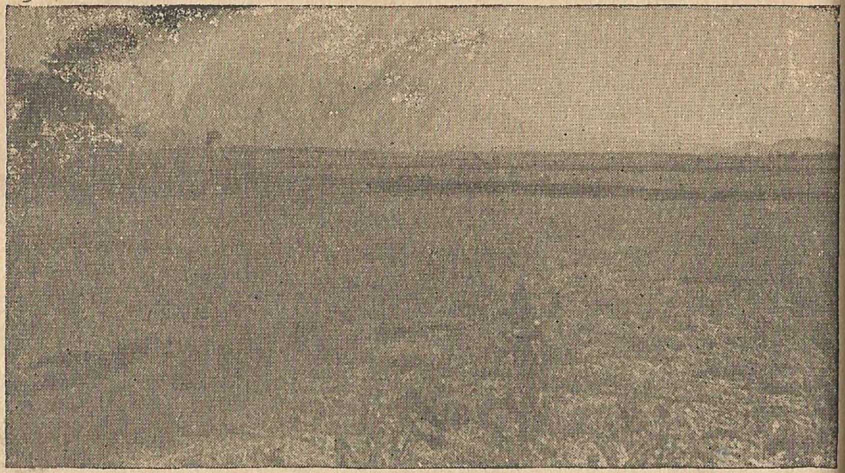

Figure 10. Landscape of Libon series taken near the vicinity of Lake Bato.

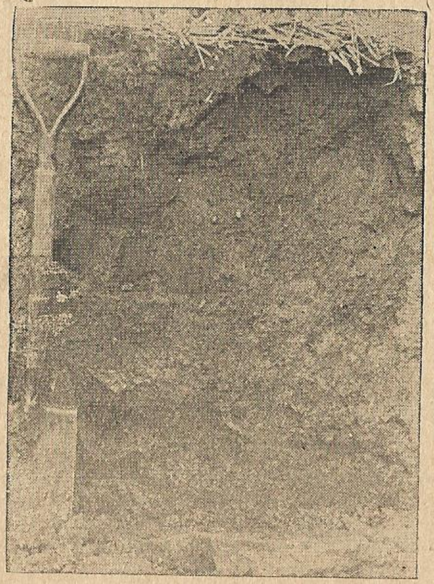

Figure 11. A soil profile of Libon silty clay.

PLATE 4

Libon silty clay (233).—This is a deep alluvial soil occupying the lowland and nearly level areas of the towns of Libon, Polangui, Oas, and Ligao. This soil type is not very susceptible to erosion. At times it is inundated by the streams which flow through it towards Lake Bato. It has a total area of 11,240 hectares. The typical profile characteristics of this soil type are as follows:

Depth (Cm.)	Characteristics
0–40	Surface soil, silty clay; brown, grayish brown to dark gray; coarse columnar to blocky structure; sticky when wet, slightly compact and crumbly when dry. Good in organic matter content; free from coarse skeleton. Reddish brown and orange brown streaks are found at the lower portion of this layer. Boundary with subsoil is smooth and diffused.
40–90	Subsoil, clay; brown, grayish brown to brownish black, massive; sticky when wet, slightly compact and hard when dry; free from coarse skeleton. Boundary with underlying layer is smooth and diffused.
90–140	Lower subsoil, silt loam to silty clay loam; light brown, grayish brown to gray; coarse granular to blocky structure; friable.
140 and below	Substratum, loam to silt loam; brown to grayish brown; columnar to blocky structure; mellow when moist, crumbly when dry.

This soil type is principally planted to lowland rice which is grown twice a year. The varieties grown are Kinawayan, Senador, and Apostol. Without fertilization rice yields about 30 to 40 cavans of palay per hectare. Other crops are corn, cassava, camote, coconut, banana, vegetables, peanut, and some fruit trees. Without fertilization corn yields about 8 to 12 cavans of shelled corn per hectare.

LIGAO SERIES

The soils of the Ligao series were developed from alluvial deposits. The relief of this series is level to nearly level. External drainage is good. Internal drainage is poor due to the compact gravelly layer in the subsoil. Shallow bank streams traverse the area. The elevation ranges from 220 to 260 feet above sea level.

Ligao loam (234).—Ligao loam covers about 3,450 hectares. The typical profile characteristics of this soil type are as follows:

Figure 12. Landscape of Ligao series.

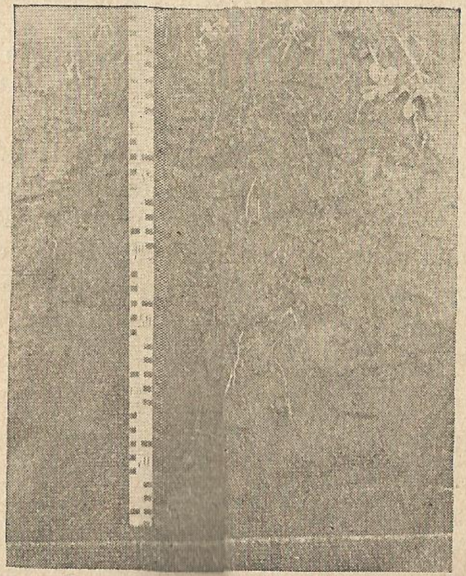

Figure 13. A soil profile of Ligao loam

PLATE 5

Depth (Cm.)	Characteristics
0–10	Surface soil, loam; grayish brown, light gray to dark gray; structureless to fine granular; mellow and friable; free from coarse skeleton. Fair organic matter content. Boundary with subsoil is smooth and abrupt.
10–15	Subsoil, gravelly sandy loam; reddish orange, yellowish brown to dark brown; massive, compact and impervious; orange concretions present which increase and become coarser with depth.
15–45	Lower subsoil, silt loam; light brown to grayish brown with gray and black mottlings; structureless; crumbly and compact when dry.
45–55	Compact gravelly fine sandy loam to loam; brown, reddish brown to grayish brown; structureless; concretions present.
55–150	Substratum, medium and coarse sand; light gray to dark gray or black; structureless, loose and porous.

The soil is irrigated but it is not very productive mainly because of its physical characteristics. The surface soil is too shallow, only about 10 centimeters, with very poor organic matter content, and underlain with an impervious and compact gravelly layer. Crops are stunted and chlorotic.

Lowland rice is the main crop. It yields from 8 to 15 cavans of palay per hectare. Corn yields about 5 to 7 cavans of shelled corn. Camote, cassava, peanut and vegetables are also planted. Fertilization is not practiced.

This soil needs fertilization, drainage, green manuring, and better soil preparation to attain a higher productivity level.

MALINAO SERIES

The Malinao series is a coastal lowland soil found in the northern part of the province. Soils of the series were developed from alluvial materials from the surrounding uplands transported and deposited through volcanic action and water. It is named after the Malinao Mountain. The relief of the series is nearly level to gently sloping with an elevation ranging from 20 to 150 feet above sea level. External drainage is poor; internal drainage is fair. The surface soil of this series is lighter in color than that of the Legaspi series and is further differentiated by the presence of reddish streaks and orange splotches. The subsoil is light gray, brownish gray to grayish brown loam to sandy loam.

Malinao fine sandy loam (232).—This soil occurs on nearly level to very slightly sloping relief with a fair to poor drainage

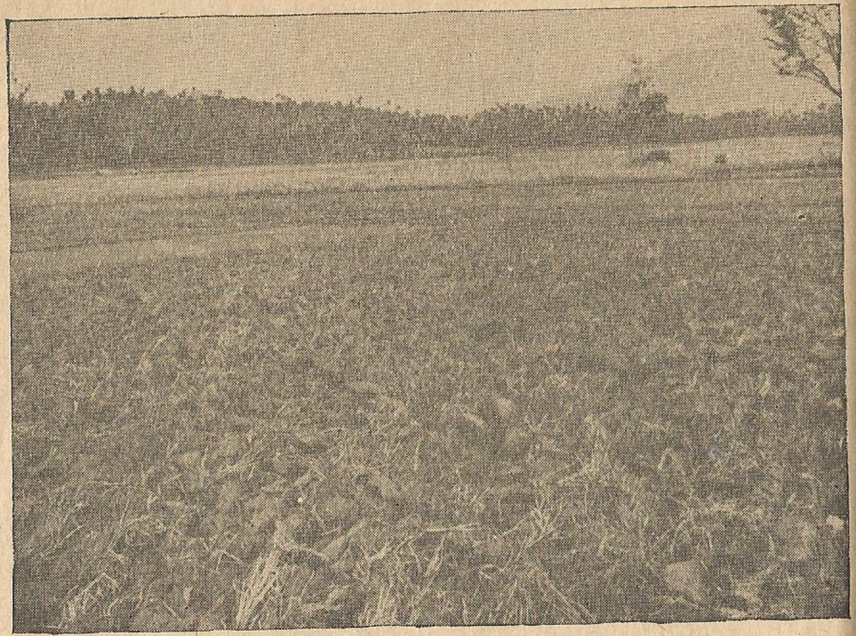

Figure 14. Landscape of Malinao series.

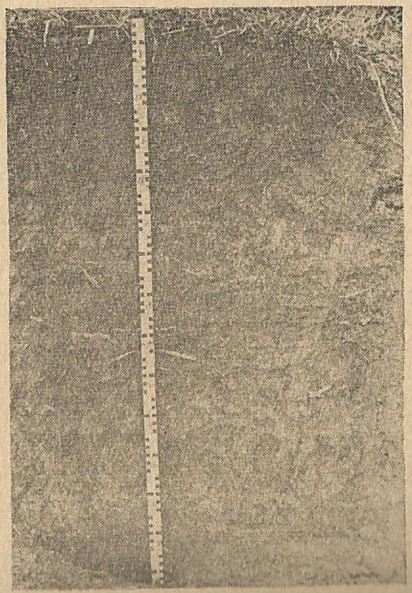

Figure 15. A soil profile of Malinao fine sandy loam.

PLATE 6

conditions. Soil erosion is not much of a problem for this soil type; diking the field to regulate surface runoff is adequate to check surface washing. A total area of 3,580 hectares of this soil type was mapped.

Malinao fine sandy loam is deep, is tilled easily, and can be adapted to locally grown crops. Its productivity can be increased by the judicious application of fertilizers, addition of organic matter, green manuring, and better tillage operation. This soil has the following profile characteristics:

Depth (Cm.)	Characteristics
0–20	Surface soil, fine sandy loam; grayish brown to yellowish brown with red streaks and orange splotches; fine granular structure; soft and friable, slightly compact when dry; no coarse skeleton. Boundary with subsoil is smooth and obscure.
20–50	Subsoil, silt loam; light gray to brownish gray with reddish streaks; fine to medium granular structure; slightly compact friable. Boundary with underlying layer is smooth and diffused.
50–75	Lower subsoil, silt loam; reddish brown, light grayish brown to yellowish brown with plenty of reddish streaks; massive to granular structure; some gravels are found in this layer.
75–100	Sandy loam; grayish brown with reddish streaks and splotches; structureless to fine granular; very friable; some gravels present. Boundary with substratum is obscure and smooth.
100–150	Substratum, medium to coarse sand; gray to black with white and brown speckles.

The texture and structure of this soil type vary slightly within the area because of the different natures and varying intensities of deposition. The soil color and drainage also vary for different places due to aeration and water table fluctuation conditions. In well drained areas the soil is brown, but in poorly drained places it is grayish brown or gray.

This soil type is principally planted to lowland rice. The stand of the crop during the survey was rather poor. The production ranges from 10 to 20 cavans of palay per hectare. This low production can be attributed mainly to continuous cultivation to the same crop as well as lack of proper soil management. It may also be noted that the area is near the Tiwi sulfur deposits. Other crops raised on this soil are corn, cassava, camote, vegetables, banana, coconut, and some fruit trees.

PANGANIRAN SERIES

One of the most fertile lowland soils of Albay belongs to the Panganiran series which was first identified in the barrio of Panganiran, Guinobatan, Albay. Soils of the series were developed from stream deposited materials washed down from the surrounding hills, and uplands of limestone origin. The series occupies the narrow coastal plain in the Panganiran-Malacbalac area. Its area is not very extensive and is level to nearly level. External drainage is fair while internal drainage is poor owing to the fine texture of the soil. Soils of the series are deep and are planted to diversified crops such as bananas, coconuts, rice, sugar cane, corn, camote, vegetables, and other annual crops.

The surface layer is very dark gray to black, with gray and yellowish brown speckles. Only one soil type, Panganiran clay, was mapped under this series.

Panganiran clay (465).—This soil type is not extensive and covers only about 670 hectares. It is level to slightly sloping and therefore, is not susceptible to erosion. This soil type has the following profile characteristics:

Depth (cm.)	Characteristics
0–40	Surface soil, clay; dark gray to black; blocky to columnar in structure; plastic when wet, crumbly to brittle when dry; free from coarse skeleton; fairly high in organic matter content; easily penetrated by roots; boundary with underlying layer is diffused and wavy.
40–70	Upper subsoil, clay; grayish brown and speckled dark gray, orange, or yellowish brown; columnar in structure; sticky and plastic when wet, brittle and hard when dry; free from coarse skeleton; boundary with lower subsoil is diffused and wavy.
70–100	Lower subsoil, clay; similar characteristics with overlying upper subsoil.
100–150	Substratum, gravelly clay; gray to black; very sticky and plastic when wet, hard and compact when dry.

This soil type is deep with a high water holding capacity. Owing to its fine texture, plasticity, and stickiness its tilth is rather poor, but at optimum moisture condition, however, the soil is not very difficult to cultivate. With proper soil management it maybe made productive.

SOILS OF THE UPLANDS, HILLS AND MOUNTAIN

The development of the soils of the uplands, hills, and mountain regions of the province was dominantly influenced by

volcanic activity. A series of volcanic depositions and afterwards through geologic and soil-forming processes ten distinct soil series with well-developed soil profile characteristics emerged.

Most common of the parent materials of the soils of this group were derived from igneous and metamorphic rocks and some sedimentary rocks, such as shale, sandstones, conglomerate, and limestone. The soils are generally lighter in color and their textures range from sandy loam to clay loam to clay. Aside from the cultivated portions under cogonal vegetation with scattered trees and shrubs, others are either under second-growth or primary forests. The total area is approximately 173,440 hectares or 67.26 per cent of the total area of the province.

GUINOBATAN SERIES

Intimately associated with the Mauraro series is the Guinobatan series. The Guinobatan series differs from the former in its having a roughly sloping, rolling to mountainous relief. It is well to excessively drained externally. The internal drainage is fair to good. This series covers the western rough slope of Mount Mayon and has an elevation of from 350 to 2,580 feet. It is developed in place from the weathered products of volcanic ejecta, such as massive lava rocks, agglomerates, tuff, breccia, gravelly conglomerates, sandstones, and volcanic ash. The subsoil is grayish brown to grayish black, speckled orange and reddish yellow, medium to coarse sand. The presence of alternate layers of volcanic ash deposits in its profile is a distinguishing feature of this soil from the other upland soils of Albay. Boulders and outcrops are found on the surface and sometimes imbedded in the profile.

Guinobatan sandy loam (243).—This soil occupies the western slope of Mount Mayon with a total area of 9,270 hectares. The external drainage is good to excessive; the internal drainage is good. Boulders and rock outcrops are found on the surface and also imbedded in the profile. Both sheet and gully erosions are severe in the clean-cultivated areas. Although the physical characteristics of this soil make it favorable for general agriculture, terracing the cultivated areas is rather difficult. Hence it should best be devoted to permanent crops. The less steep slopes if cultivated to clean culture crops need terracing. Contour farming, strip cropping, crop rotation, and the planting of close growing crops are essential and necessary for this soil type. Its typical profile characteristics are as follows:

Depth (Cm.)	Characteristics
0–45	Surface soil, sandy loam; brownish gray, brown to grayish brown; structureless to very fine granular structure; soft and mellow when wet, porous, friable, and slightly compact when dry. Good in organic matter content; gravels are present in the layer. Boundary with the subsoil is clear and smooth.
45–60	Subsoil, medium to coarse sand; grayish brown to dark gray with yellowish to reddish speckles; single grain to structureless; slightly porous and loose. Gravels are present.
60–105	Lower subsoil, sand; loam to silt loam; brownish yellow to grayish brown; structureless; silt, mellow, friable, and slightly compact.
105–115	Fine gray sand; loose, porous with a mixture of gravels and stones. At some places, partially weathered pebbles are found in this layer.
115–135	A layer similar to lower subsoil.
135–150	Substratum, coarse sand; gray to black; slightly compact and structureless. Below this layer is a horizon of orange speckled brown to grayish brown, sandy loam to silt loam.

Coconut and abaca are the principal crops grown on this soil type. Upland rice, corn, banana, fruit trees, root crops, and vegetables are also raised. The annual production of coconut and abaca are from 1,500 to 2,000 nuts and 4 to 7 piculs of abaca fiber per hectare, respectively. Abaca plantations are not well managed, while coconut trees are infested with kadang-kadang. Proper soil conservation practices and good management will improve production considerably.

MAYON SERIES

The soils of the Mayon series were developed mostly from the products of weathered massive lava rocks, volcanic ashes agglomerates, tuff and breccias. It embraces the eastern half of Mayon Volcano with a moderately to roughly sloping relief, generally cut by gullies and deep ravines radiating from the summit of Mount Mayon. It is well to excessively drained externally but poorly drained internally. The elevation is from 300 to 2,700 feet above sea level. The surface soil is grayish brown to brown. The subsoil is brown to yellowish brown with gray mottlings sandy loam. Boulders are found on the surface as well as imbedded in the profile. Under the

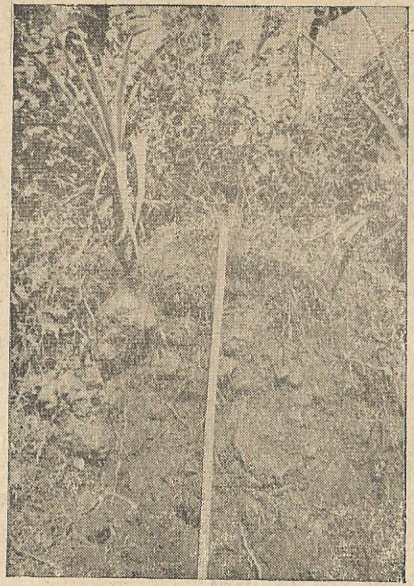

Figure 16. A soil profile of Mayon gravelly sandy loam.

Figure 17. A soil profile of Sevilla clay

PLATE 7

substratum is a deposit of volcanic sand, gravels, cobblestones and boulders.

Mayon gravelly sandy loam (242).—A total area of 14,023 hectares of this soil type on moderately to roughly sloping relief was mapped in the eastern half of Mayon Volcano. External drainage is good to excessive but the internal drainage is poor to fair. Soil lost through erosion has been excessive. The moderately sloping areas should be terraced while the roughly sloping areas should be under permanent vegetative covers. The typical profile characteristics of this soil are as follows:

Depth (Cm.)	Characteristics
0–30	Surface soil, gravelly sandy loam; grayish brown, brown to dark brown; structureless; loose, porous, soft and mellow when wet, very friable when dry. Boulders are present on the surface which sometimes hamper cultivation, good in organic matter content. Boundary with underlying layer is smooth and diffused.
30–75	Subsoil, sandy loam; brown to yellowish brown with black mottlings; structureless to granular; soft when wet; porous and friable when dry. Fair in organic matter content. A few boulders are imbedded in this layer. Boundary with the substratum is clear and smooth.
75–below	Substratum, a deposit of sand, rounded and smooth-edged gravels, cobblestones and boulders, light to dark gray with black speckles.

The profile characteristics of this soil portray a recent deposition resulting from a series of volcanic eruptions. The unstability of the profile characteristics is due to the intermittent deposition of lava and ashes, together with volcanic rocks over the area. Thus the degree of development of the solum is less distinct except the color changes. Neither is there a clear transition line for zones of eluviation and illuviation.

This soil is principally utilized for specialized farming. The rocky and roughly sloping areas are devoted to some fruits and coconut but mostly to abaca. The moderately to slightly sloping and less stony areas are devoted to gabi, upland rice, camote, cassava, peanut, beans and other seasonal crops. The production of abaca is quite low; only about 3 to 4 piculs per hectare. This low production may be attributed to poor soil and plantation management.

Figure 18. Landscape of Annam series.

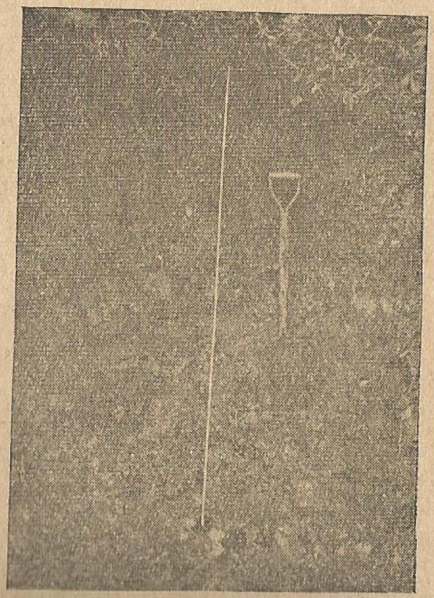

Figure 19. A soil profile of Annam clay loam.

PLATE 8

ANNAM SERIES

The soils of the Annam series were developed through the weathering of basalt, andesite, conglomerates, sandstone and tuffaceous materials. This series was first identified in Nueva Ecija Province. The relief is rolling to hilly and mountainous. It occupies the uplands of Daraga, Legaspi, Manito, East Libon and the islands of Rapu-rapu, Batan, Cagraray, and San Miguel. It has an elevation of from 1,000 to 1,800 feet above sea level. The external drainage is good to excessive, while the internal drainage is poor to fair. The surface soil is brown, grayish brown to light reddish brown granular clay loam. The subsoil is brown to brownish red clay loam to clay, columnar and prismatic. Weathered gravels, tuffaceous materials, andesite and basalt boulders are present on the surface as well as imbedded in the profile.

Annam clay loam (98).—The relief of this soil type is rolling to hilly and mountainous. It has a total area of 40,845.5 hectares covering the upland areas of East Daraga, Legaspi, Manito, East Libon and the islands of Rapu-rapu, Batan, Cagraray, and San Miguel. Internal drainage is poor while external drainage is good to excessive. Since water penetrates the subsoil slowly surface runoff enhances soil erosion. Terracing, grassed waterways, strip cropping, and contour cultivation are therefore necessary measures for the area. The roughly rolling areas, the hilly and mountainous portions should be under permanent forest cover. Both surface soil and subsoil exhibit slight acidic reactions. Annam clay loam has the following profile characteristics:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay loam; brown to reddish brown; granular to blocky structure; slightly sticky and plastic when wet; friable to very crumbly when dry. Boulders are present on the surface as rock outcrops. Sometimes, orange brown concretions, 2 millimeters in diameter, are also found in some spots. Boundary with the subsoil is diffused and smooth.
40–85	Subsoil, clay loam to clay; reddish brown to chocolate brown; coarse granular and blocky to columnar; moderately sticky and plastic when wet; crumbly, slightly hard and compact when dry. In the lower section of the subsoil are some buckshot like concretions and plenty of weathered gravels and boulders. Boundary with the substratum is wavy and abrupt.

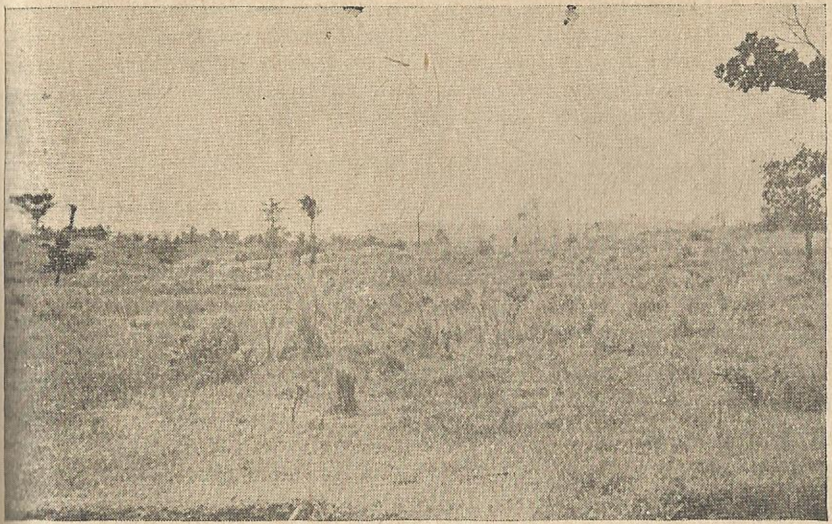

Figure 20. Landscape of Luisiana series.

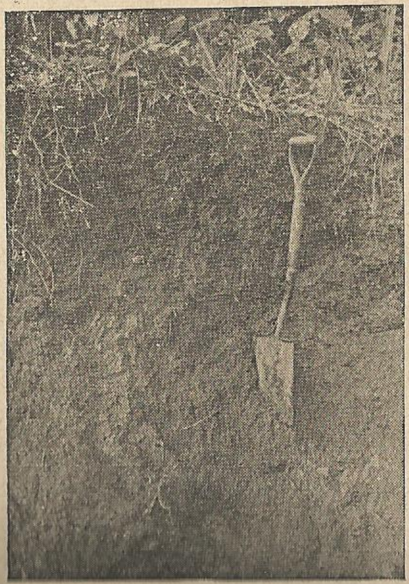

Figure 21 A soil profile of Luisiana clay.

PLATE 9

85–150	Substratum, gravelly to stony clay; brown to dark brown, mottled red; nutty structure. Concretions, weathered gravels and boulders are found in this layer. Below the substratum is a layer of highly weathered andesite, shale, sandstone, conglomerates and basalt rocks.

LUISIANA SERIES

Luisiana series is represented by Luisiana clay in Albay Province. It is considered one of the most advanced soils of the country. It is a primary soil developed from the weathered products of basalt and andesite rocks. In places, these rocks have weathered to a depth of 3 meters or more. This soil has a brown to reddish brown surface soil and yellowish brown to light reddish brown cheesy clay subsoil resting on a reddish brown to yellowish brown clay. It occurs on a rolling to hilly and mountainous relief. It is well to excessively drained in the surface but the internal drainage is fair. Both sheet and gully erosion are severe on the more sloping and hilly areas which are placed under clean cultivation. This soil was mapped as a narrow tract of land intimately blended with the Annam soil along the highway between the towns of Albay and Manito and extending up to the border of Sorsogon. The elevation ranges from 300 to 1,400 feet.

Luisiana clay (239).—This is a deep soil and would have been a good agricultural soil if it were not for its unfavorable relief which make cultivation very difficult. Erosion has been severe in many areas especially those under clean cultivation. Sheet erosion is very detrimental to bare areas, hence a well-constructed and well laid-out terrace in the clean cultivated fields are necessary to control runoff and erosion. Only the areas with gentle slopes which could be easily terraced should be cultivated to annual crops. Strongly rolling and sloping areas should be put under permanent crops to control erosion. A total area of 3,790 hectares was mapped. The profile characteristics are as follows:

Depth (Cm.)	Characteristics
0–40	Surface soil, brown to reddish brown and brick reddish brown, cheesy clay. It is coarse granular, and prismatic to columnar, and soft to slightly friable when dry. No coarse skeleton is present in this layer and the boundary to lower layer is diffused.
40–85	Subsoil, yellowish brown, to light reddish brown and brick reddish brown cheesy to waxy clay. It is coarse granular

	or columnar to blocky, highly plastic and sticky when wet, slightly compact, cloddy and brittle when dry. No coarse skeleton. Boundary to substratum is diffused and smooth.
85–below	Substratum, reddish brown and brick reddish brown fine granular clay. Fresh cut shows splotches of light gray, yellowish brown, orange brown, orange gray, and orange yellow usually with admixture of highly weathered basalts, andesites and other volcanic igneous rocks.

The cultivated area is principally planted to coconut, abaca and fruit trees. Patches of cultivated land are grown to upland rice, corn, cassava, camote and vegetables. The greater part of the area is cogonal and is suited to pasture purposes. Second growth and primary forest cover a relatively large area.

Coconut yields 2,300 to 2,700 nuts per hectare per year; and corn from 8 to 12 cavans; upland rice, 10 to 20 cavans to the hectare. These crops are not fertilized. Coconut trees are infested with kadang-kadang in different degrees.

MAURARO SERIES

Mauraro series is a new soil series first found and described in the barrio of Mauraro, Guinobatan. It was developed from the weathered products of basalt, tuff, and gravelly conglomerates basically from sandstone, shales and limestone. It presents a profile composing of several distinct layers varying in the degree of development. The surface soil is reddish brown to dark grayish brown; the subsoil is brown to reddish brown moderately compact gravelly clay. It occupies a broad rectangular area southwest of Mayon Volcano, running in southwesterly and southeasterly directions from barrios Pinaglaban and Malabog of Daraga up to Sitio Cagonsagnan, Aliang of Ligao and Barrio San Juan of Oas. It has a flat upland to gently rolling and hilly topography with an elevation of from 220 to 550 above sea level. The external drainage is good to excessive but the internal drainage is poor. Sheet and gully erosions are severe in clean cultivated areas.

Mauraro gravelly sandy loam (241).—A total area of 19,149.5 hectares of this soil type was mapped on a flat upland, gently rolling to hilly relief. It has good to excessive external drainage and poor internal drainage. This soil type is susceptible to erosion and in areas under clean tilled cropping, sheet and gully erosion are serious. Sloping areas should be terraced in order to prevent excessive runoff. Some sections of the area should be under permanent crops, such as coconut, abaca and fruit trees to prevent too much surface washing while other portions really unfit for cultivation should be forested. The profile characteristics of this soil type are as follows:

Depth (Cm.)	Characteristics
0–40	Surface soil, gravelly sandy loam; reddish brown to dark grayish brown; columnar to blocky; slightly compact; numerous dark brown rounded and angular concretions present; fair to good organic matter content. Boundary with subsoil is abrupt and smooth.
40–70	Subsoil, gravelly clay, brown to reddish brown; coarse columnar. There are more gravel concretions in this layer than in the surface soil.
70–85	Lower subsoil, gravelly clay loam; brown to yellowish brown with grayish brown speckles, structureless to coarse columnar structure; compact. Gravels are abundant in this layer. Boundary with substratum is abrupt and smooth.
85–below	Substratum, clay loam to clay; brown to light brown; structureless to coarse columnar; concretions like those found in the surface layer are abundant.

This soil should be plowed at optimum moisture condition to avoid puddling and the formation of hard clods. The presence of gravels do not affect the consistency and structure of this soil.

This is one of the best abaca soils of the province and it is planted to this crop extensively. However, due to faulty plantation management, the production of abaca fiber is very low. The average yield of abaca is estimated at only 3 to 4 piculs per hectare. This low production is also partly due to the fact that abaca in the plantations are as old as fifty years. This soil can be made more productive through proper soil management and cultural practices.

Coconut, upland rice, corn, fruit trees, banana, cassava, camote, vegetables, and other fruit trees are also grown.

TIGAON SERIES

The soil of the Tigaon series as mapped in Albay Province is a continuation of the Tigaon series previously studied in the province of Camarines Sur. It is a volcanic soil developed from the weathered products of basalt, andesites, shale and gabbro. It comprises the area in the northern part of the province, including the foot-slopes and ranges of Mounts Malinao and Masaraga, joining the same soil body in Camarines Sur. It

has a rolling to mountainous relief. The external drainage is good to excessive while the internal drainage is poor. Erosion has been active on clean cultivated areas. The elevation is from 50 to 4,000 feet.

This soil series has a brown to reddish brown clay surface soil, underlain by a deep light brown, chocolate brown and light reddish brown cheesy clay subsoil. The profile at places is imbedded with boulders and gravels of different degrees of weathering. Boulders of basalt, andesite, and gabbro are found in the surface which in some places interfere with farm operation. This series is represented by Tigaon clay.

Tigaon clay (186).—This soil type as mapped in Albay Province has a total area of 2,630 hectares. It is not agriculturally important in Albay as only a small area could be brought under crops because most of the area is under primary and second growth forests and cogons. The cultivated areas are mostly planted to coconut and abaca. Patches are cultivated to corn, upland rice, camote, and peanut.

This soil has a steeply rolling to mountainous relief and is well to excessively drained externally. The internal drainage is poor. It is severely eroded and many deep gullies have formed. The lower slopes should be carefully terraced and the terraces maintained if the soil is to be used for clean-tilled crops. The steeply rolling and mountainous areas should remain under forest or grass cover to control erosion. The profile characteristics of the soil are as follows:

Depth (cm.)	Characteristics
0–30	Surface soil, reddish brown to brown, cheesy clay, granular to fine blocky. Boulders of andesite, basalt and gabbro are present on the surface as rock outcrops, which sometimes interfere with farm operations. Boundary to the subsoil is diffused and broken.
30–80	Subsoil, reddish brown, chocolate brown to light grayish brown, slightly compact cheesy or waxy clay, columnar in structure. It is sticky and plastic when wet and becomes hard upon drying. No coarse skeleton present. Boundary to the substratum is clear and smooth.
80–150	Substratum, brownish to grayish brown, mottled chocolate brown and gray waxy clay, resting on weathered volcanic boulders and massive shale.

The production of coconut is from 2,400 to 2,800 nuts per hectare per year; abaca, 10 to 12 piculs of abaca fiber to the hectare. The coconut trees are infested with kadang-kadang while the abaca plantations are not properly managed. Upland rice yields 15 to 20 cavans to the hectare, and corn gives a yield of 8 to 12 cavans per hectare. These crops are not fertilized.

SEVILLA SERIES

The soils of the Sevilla series is one of the most extensive soils in the province. It is developed from the weathered products of calcareous rocks, such as shale and sandstone. It occupies the great expanse of a piedmont country on the south and southwestern part of the province comprising low–lying hills having an elevation ranging from 200 to 600 feet above sea level. The external drainage is good to excessive while the internal drainage is poor. The soil of the surface layer is dark grayish brown to black and pale yellowish brown to brown clay subsoil with limestone precipitates and gravels. Highly eroded areas have the concretion mixed with the surface soil. Fig. 17 shows the soil profile of Sevilla clay.

This soil series is of "parang" type vegetation dominated by cogon and few scattered trees and shrubs. Narrow valleys between series of limestone hills are cultivated to lowland rice, corn, cassava, vegetables and other seasonal crops. Sevilla clay is the only soil type mapped.

Sevilla clay (174).—This soil type was mapped in the south and southwestern part of the province. It has a rolling and hilly topography. The internal drainage is fair to poor but the external drainage is good to excessive. It is easily eroded and terracing the sloping areas is necessary to minimize erosion. Contour cropping and cover cropping are essential soil conservation measures for this soil type. It has a total area of 66,108 hectares and has the following profile characteristics:

Depth (Cm.)	Characteristics
0–40	Surface soil, clay; grayish brown, dark brown to almost black; granular and fine columnar to blocky; plastic and slightly sticky when wet, slightly compact, and crumbly when dry. Occasional calcareous gravels and cobblestones are sometimes present in this layer as outcrops. Root penetration is good. Boundary with the underlying layer is clear and smooth.
40–120	Subsoil, clay; pale yellowish brown to brown; granular to columnar; sticky and plastic when wet, slightly compact and

Depth (Cm.)	Characteristics
	crumbly when dry. Limestone gravels and precipitates admixed with weathered sandstone and shale are present in some places within this layer. Roots of perennial crops penetrate this layer. Boundary with the substratum is diffused.
120–below	Substratum, clay; yellowish brown; sticky. This layer contains considerable amount of limestone gravel and fragments of weathered calcareous shale and sandstone. The shale appears usually in bands.

This soil type has a deep surface soil and is considered the best upland soil of the province. It is principally planted to corn. Upland rice, camote, cassava, peanut, and vegetables are also grown. Coconut is the main permanent crop. The yield of corn ranges from 8 to 12 cavans of shelled corn per hectare. Coconut yields from 2,500 to 2,800 nuts per hectare per year. These crops are not fertilized. With proper soil management and fertilization this soil type may be made more productive.

FARAON SERIES

Faraon soils are formed through the decomposition of coralline limestone. This soil series is found along the provincial boundary from the sea to the southwest shore of Lake Bato which is an extension of the same soil type from Camarines Sur. The relief of this series is usually rolling to hilly. External drainage is good under forest but is excessive in the open fields. Internal drainage is fair.

Soils under the Faraon series are black and usually clayey. When the land is highly eroded, the coral rocks are exposed and in extreme cases of soil erosion, the land is difficult to plow because of the rocks. These limestone rocks are comparatively soft, roughly angular and oftentimes colored.

Faraon clay (132).—This soil type is usually shallow. The surface soil is very fine textured. It is plastic and sticky when wet but friable when moist. The soil upon plowing tends to produce big clods which are very hard and difficult to break when dry. This soil type is cultivated to crops commonly found in the locality.

The profile characteristics of this soil type are as follows:

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

when dry. Fair in organic matter. Sometimes limestone rocks are found on the surface. An abrupt and irregular boundary separates surface soil and subsoil.

30–45 Subsoil, clay; dark yellowish gray; like the surface soil, very plastic when wet but hard when dry; moderate fine granular structure. Mixed in this layer are partially weathered limestone rocks. This layer is separated from underlying layer by a clear and smooth boundary.

45–60 Yellowish gray highly weathered limestome rocks; soft and weak; coarse granular structure.

60–150 Grayish to white porous limestone rocks, soft and easily broken.

MACOLOD-PILI COMPLEX

Directly north of the Libon series is a broad soil body with a rolling to roughly rolling and mountainous relief, classified as Macolod-Pili complex. It is an association of the Macolod and Pili soils in an intimate pattern that one can not be mapped separately from the other with the scale used. Thus the area is mapped as a complex of the two soils. It ranges in elevation from 640 to 700 feet. This area, which is well drained externally, has a total coverage of 11,400 hectares. Internal drainage is poor.

Macolod-Pili complex (187).—As an agricultural area, it is far more developed than the Annam and Luisiana soils. It is devoted to the growing of annual crops like upland rice, sugar cane, camote, cassava, peanuts, vegetables and such permanent crops as coconut, bananas, abaca, and other fruit trees. A greater portion of the area is cultivated and a minor portion is under the "parang" type of vegetation. Generally, the stand of the crops on this soil is fair to poor. Production of upland rice is from 10 to 20 cavans to the hectare and corn, 8 to 12 cavans.

The loss of surface soil due to erosion is rapid owing to frequent cultivation, use of *kaingin* system, and clean crop cultures. Thus, this complex has a shallow surface soil. Sometimes slightly weathered boulders and gravels are found in the cultivated fields and in grassy areas where vegetation is too scanty to prevent erosion.

This soil needs terracing with proper maintenance to control erosion. In some parts of the area, contour plowing and strip cropping may be advantageous, but in other places, permanent planting is necessary. However, some areas should be forested to prevent too much surface wash. Addition of sufficient organic matter, green manuring and the application of fertilizers are important in this soil complex to increase production.

Figure 22. Landscape of Macolod series.

Figure 23. A soil profile of Macolod clay.

PLATE 10

MISCELLANEOUS LAND TYPES

Miscellaneous land types are primarily classified in terms of land forms and secondarily in terms of materials. These are the areas whose soils do not fall under any of the soil types because (1) they have no true soil profiles or have little or no natural soils, (2) they have no agricultural value for the present, (3) they are nearly inaccessible for orderly examination, (4) they are gullied lands, or (5) they are swampy and uneconomical to drain. The miscellaneous land types in the province have a total area of 55,429 hectares, or 21.49 per cent of the provincial total.

Hydrosol (1).—The hydrosol areas of the province are covered by salt and fresh water marshes. The total area is 1,115 hectares, or 0.43 per cent of the total area of the province. The hydrosols are found along the northeastern, eastern, southwestern, and western coastal regions of the province. They are extensive at the mouths of big rivers and at Lake Bato. They are submerged almost throughout the year.

The salt water marsh or swamp consists of peaty and muddy subaqueous layer over grayish black to deep black silty clay to clay layer, resting on a limy deep horizon of black to bluish black clay. The most common vegetations are nipa palm, *api-api, bakawan, dap-dap, bangkal,* and some halophytic shrubs and grasses.

The fresh water marsh, on the other hand, has the subaqueous layer intimately mixed with decomposed and partially decomposed organic materials, mostly grasses, underlain by a bluish black, slimy, sticky, and plastic clay horizon. The fresh water marsh occupies the waterlogged areas bordering Lake Bato, vegetated mostly with grasses belonging to the sedge family and water lilies.

The salt and fresh-water marshes have no agricultural value. They are best suited for fishponds, as well as for recreational and wildlife purposes.

Mountain soils undifferentiated (45).—Mountain soils undifferentiated are mostly under primary and second-growth forests. A small area is under *parang* type of vegetation. At present this miscellaneous land type is of no agricultural importance, although logging activities are widespread where primary forests are located. It has a total area of 50,434 hectares, or 19.5 per cent of the total area of the province.

Beach sand (118).—Beach sand was mapped in the northwestern part of the province. Beach sand is not a true soil because it has an undeveloped soil profile. It has an aggregate area of 200 hectares.

Beach sand is excessively drained. It has a nearly level relief and usually inundated during high tide. The soil consists mostly of sand with mixture of stones and fragments of shells. It is loose and structureless. It is not usually used for agricultural purposes, although in some places, coconuts thrive favorably.

Lava flow (341).—Lava flow covers the bare areas near and around the crater of Mount Mayon as well as down the slopes to the base of the volcano.

TABLE 13.—*Key to the soil types of Albay*

Soil type No.	Soil type	Parent Material	Relief	Drainage: External	Drainage: Internal	Present use vegetation
227	Legaspi fine sandy loam	Recent alluvial deposits	Level to nearly level	Fair to good	Fair to good	Rice, corn, coconut, abaca, tobacco, root crops, mungo.
230	Legaspi fine sandy loam, stony phase	Recent alluvial deposits	Level to nearly level	Fair to good	Fair to good	Rice, coconut, banana, abaca, root crops, mungo.
231	Legaspi sandy clay loam	Recent alluvial deposits	Level to nearly level	Fair to good	Fair to good	Rice, corn, coconut, root crops, mungo, fruit trees.
122	Umingan fine sandy loam	Recent alluvial deposits	Level to nearly level	Good	Good to excessive	Rice, corn, mungo, peanut, root crops, banana, coconut.
235	Bascaran clay	Older alluvial deposits	Level to nearly level	Fair	Poor	Rice, corn, mungo, root crops, vegetables, coconut.
233	Libon silty clay	Older alluvial deposits	Level to nearly level	Poor	Fair	Rice, corn, mungo, root crops, banana, coconut, fruit trees.
465	Panganiran clay	Older alluvial deposits	Level to nearly level	Good	Poor	Rice, corn, mungo, peanut, root crops vegetables.
234	Ligao loam	Older alluvial deposits	Level to nearly level	Poor	Fair	Rice, corn, mungo, root crops, coconut, banana.
232	Malinao fine sandy loam	Older alluvial deposits	Nearly level to gently sloping			Coconut, abaca, upland rice, corn, banana, fruit trees, root crops, mungo.
243	Guinobatan sandy loam	Volcanic	Roughly sloping to hilly and mountainous			Abaca, coconut, fruit trees, upland rice, root crops, mungo, peanut.
242	Mayon gravelly sandy loam	Volcanic	Slightly sloping to rolling		Poor to Fair	Coconut, abaca,

TABLE 13.—*Key to the soil types of Albay*—Continued

Soil Type No	Soil Type	Parent Material	Relief	Drainage		Present Use Vegetation
				External	Internal	
98	Annam clay loam	Igneous rocks, mostly basalt and andesite	Rolling to hilly and mountainous	Good to Excessive		fruit trees, corn, upland rice, root crops, mungo.
239	Luisiana clay					Coconut, abaca, fruit trees; upland rice, root crops; forest; pasture.
241	Mauraro gravelly sandy loam		Level; gently rolling to hilly		Poor	Abaca, Coconut upland rice, corn,root crops, mungo, banana, fruit trees.
186	Tigaon clay		Rolling to hilly and mountainous			Abaca, coconut upland rice corn, root crops; cogon forest.
174	Sevilla clay	Shale	Rolling to hilly		Poor to fair	Corn, upland rice, root crops, peanut, mungo, coconut.
132	Faraon clay	Limestone	Nearly leve	Fair	Poor	Rice, sugar cane, corn, mungo, tobacco, root crops, banana, coconut, vegetables.
187	Macolod-Pili complex	Igneous rocks and alluvial deposits	Rolling to hilly and mountainous	Good		Upland rice, sugar cane, mungo, peanut root crops, vegetable, coconut, banana, abaca; grass.
1	Hydrosol	----------	----------	----------	----------	Mangrove, nipa palms; fishponds.
45	Mountain soils, undifferentiated	----------	Mountainous	----------	----------	Primary & secondary forest; grass.
118	Beach sand	----------	Level, to nearly level	Good	Excessive	Coconut.
341	Lava flow	----------	Sloping			

MORPHOLOGY AND GENESIS OF THE SOILS OF ALBAY

The physical weakening of bedrock due largely to temperature changes gives rise to the formation of the so called regolith. Regolith includes all of the unconsolidated materials above bedrock. But this physical disintegration of bedrock is only an initial phase of soil formation. The upper part of the regolith is subjected to relatively faster physical and chemical weathering than any other part lying underneath because this upper portion is in direct contact with the atmosphere. It is the physically and chemically weathered part of the regolith

which becomes the parent material for soils. The parent material together with microorganisms and higher plant life then undergo a phenomenon known as biochemical weathering wherein the microorganisms and higher plant life decay. This addition of organic matter is an essential feature of soil formation. In other words, the physical and chemical weathering of rocks should not be mistaken as the process of soil formation in itself; mostly the process of soil formation is directly or indirectly biological in nature.

At least there are five factors which largely control the kind of soil developed; namely, (1) climate, (2) living organisms, (3) nature of the parent material, (4) topography of the area, and (5) the time that the parent materials are subjected to soil formation. For instance the regolith within any given area may vary in depth, physical condition, and chemical composition. Their geologic origin also may or may not be the same. Furthermore, the position they occupy has either been reached through deposition and transportation or by the weathering in place of the country rock. Considering also the individual as well as the cumulative influence the different factors exert, the variability or heterogeneity of soils even within a small area is then accounted for.

Class A.—Soils under this class were developed from recent alluvial deposits. They have medium to coarse texture from their A down to their C horizons. The relief of soils under this class is generally level or nearly level. Drainage condition ranges from good to partly excessive. Their permeability is very rapid to moderately rapid. The soil series under this class are:

Legaspi series, and
Umingan series.

Class B.—Soils under this class were developed from older alluvial forms or terraces and have fine to very fine textures. The relief of soils under this class is generally flat with the whole plane in a zero to 3 per cent tilt which enhances external drainage. The fine-textured soils of the B and C horizons are generally sticky, slightly plastic, and compact which causes poor internal drainage. The permeability of these soils is very slow. The soil series under this class are:

Bascaran series,
Libon series,
Ligao series,
Malinao series, and
Panganiran series.

Class C.—The soils under this class belong to older terraces or upland areas developed from products of volcanic ejecta. Some of these volcanic materials were laid down after which the soils were developed from them while in other instances the materials were washed down after the initial deposition after which the soils were developed. As in the case of Taal and Tupi, volcanic sand instead of tuff was deposited, from which these two aforementioned soils were formed. The soils developed in this instance are loose, very friable, sandy loam to sand. The permeability of these soils is very rapid. These soils are primarily used for growing of vegetables and fruit trees. The series under this class are as follows:

Guinobatan series, and
Mayon series.

Class D.—Under this class are soils of upland areas developed from hard igneous rocks, such as andesites and basalts. The soils thus developed are fairly friable, reddish brown or dark brown to red. The internal drainage of these soils is good while their permeability is moderate. The relief of these soils is usually rolling to steeply rolling, oftentimes ending up in mountain ranges. Indications show that most of the soils under this class are those known as "latosols," or soils of low to very low calcium content and are rather acidic. Their phosphorous content is also very low and have a high rate of fixation. The undulating or rolling areas are cultivated to crops. Good crops of coffee, cacao, or rubber were observed on these soils. Areas on steep slopes are partly grasslands but mostly under dipterocarp forest. On these soils dipterocarp forest, which consists mostly of soft woods, grow rather well. The soft woods are produced on deep, friable soils, with plenty of available moisture. The soil series under this class are:

Annam series,
Luisiana series,

Mauraro series, and
Tigaon series.

Class E.—Under this class are soils of upland areas developed from shales. Their relief is rolling to hilly. The solum developed is from 15 to 60 centimeters and are of very fine texture. These soils are very sticky and plastic when wet and harden upon drying. The permeability of these soils is very slow, thus runoff on cleared areas is very excessive. These soils are generally low in fertility. A greater part of these soils are under grass while the rest are under forest. Only one series, Sevilla series, under this class is found in the province.

Class F.—Under this class are soils of older terraces or uplands developed through the weathering of limestone. The relief of these soils is undulating in the lower terraces and steeply rolling in the upper regions. The solum developed is very shallow, ranging from 20 to 40 centimeters deep. This is a type of soil development where only the A and B horizons may be present followed immediately by the limestone bedrock. The soils are usually clay to clay loam which in undisturbed areas are friable and of moderate permeability. Both Rendzina (gray to black friable clay) and Red soils are developed from coralline limestone. A great amount of gravels and stones of lime or even outcrops are present on the ground surface which make cultivation difficult. Only one series, Faraon series, under this class is found in the province.

LAND USE, SOIL MANAGEMENT, AND WATER CONTROL ON THE LAND

Most of the crops grown on the plains and valleys of Albay are more or less suited to most of the soils found in these areas. However, in most cases a one crop system is followed which depletes the soils of their organic matter content as well as destroys the good structure of some of these soils. Crop rotation in which legumes form a part of the rotation sequence should be practiced. In some instances where the soil is planted to two or three kinds of crops within a year, these crops or the sequence followed tend to deplete or exhaust the soil rather than build it up. In the uplands or hilly and mountainous regions *kaingin* farming, plowing up and down slopes, inadequate or total lack of soil conservation measures, and the disregard or lack of understanding of proper land use and planning all contribute to the lack of proper and maximum development of the agricultural potential of the province.

Educating the farmers on proper soil management should be given more emphasis. This problem is of course not one for the soil scientist, agricultural extension worker, and agronomist alone. The cooperation of every farmer is required, but just as important is the economic or financial support the government could give. This program of agricultural education is rather long range. While an Albay farmer may know and believe that thorough preparation of the land, aeration of the soil, application of lime and fertilizer when necessary, green manuring, cover cropping, strip cropping, contouring, crop rotation, and construction of terraces or drainage ditches where needed are singly or collectively necessary to produce more from his land and at the same time conserve his soil, he may also be a farmer with little money and cannot rely on delayed income. Only a handful of farmers in the province today observe proper soil management practices due to financial reasons or other causes which is beyond the scope of this report.

Water control concerns primarily the maintenance of favorable soil moisture conditions to keep the soil productive and to regulate surface runoff to minimize soil erosion.

Floods in Albay occur but rarely. However, a single flood can damage wide areas of soils and crops. The flood in 1948 wrought great damage to the province. There has been no control measures undertaken to protect the land from floods or the overflow of streams.

Most of the lowland soils of the province are irrigated. There are existing irrigation facilities while other units are being planned. The use of irrigation water, however, should be controlled in order to bring about not only an adequate but also an even supply of water. Good diking of fields, proper planting of crops, and the control of the velocity of the flow of irrigation water should at all times be observed. Wasted irrigation water cause soil erosion, alkali accumulation, leaching, or waterlogging. Some of the lowland soils need ditching and subsoiling.

The control of runoff and erosion are major problems in Albay considering that about 210,080 hectares or 81.6 per

cent of the total area of the province are open and cultivated lands. Logging operations should be strictly supervised by the government. Reforestation should be undertaken vigorously and *kaingin* farming should be eradicated once and for all.

PRODUCTIVITY RATINGS OF THE SOILS OF ALBAY PROVINCE

The productivity of a soil is its capability to produce a specified crop or sequence of crops under a specified system of management. In this report soil productivity rating is based on the average crop yield of a soil type in relation to national standards established, the yield being obtained without the use of fertilizer or soil amendments. Yield predictions are arrived at in two principal ways; namely, (1) through judgments based upon evidence afforded by actual yield data from sample areas of the soil mapping units, and (2) through judgments based on comparisons of the characteristics of soils and basic knowledge of plant requirements.

Table 14 indicates the productivity ratings of the soils of Albay for the major crops grown in the province. The productivity ratings were developed mainly from estimates based upon observations and interviews supplemented by a few records and census data, thus their reliability may be only considered fair. The soil productivity rating or index for a given crop is expressed in terms of a standard index of 100.

Thus, a productivity rating of 75 for a certain crop means that a soil is about three-fourths as productive relative to the national standard, or in terms of production the soil could produce 45 cavans of palay of lowland rice wherein the national standard is 60 cavans of palay.

Enumerated hereunder are the standard yields of some Philippine crops that are also grown in Albay:

Crop	Index 100: yield per hectare
Lowland rice	60 cavans of palay
Upland rice	20 cavans of palay
Coconut	3,750 nuts
Tobacco	1,475 kilograms
Corn	17 cavans of shelled corn
Abaca	15 piculs
Cassava	15 tons
Camote	8 tons
Mungo	7 cavans

TABLE 14.—*Productivity ratings of the soils of Albay*

Soil types	Crop productivity index [1]								
	Rice		Coco-nut	To-bacco	Corn	Abaca	Cas-sava	Ca-mote	Mun-go
	Low-land	Up-land							
Bascaran clay	100	------	------	------	80	------	85	85	100
Libon silty clay	65	------	65	50	75	------	80	85	100
Umingan fine sandy loam	65	------	------	60	85	------	100	90	100
Legaspi sandy clay loam	50	------	50	40	70	65	85	80	100
Legaspi fine sandy loam	50	------	50	------	60	70	85	80	90
Legaspi fine sandy loam, stony phase	45	------	70	------	70	70	90	70	80
Malinao fine sandy loam	35	------	60	50	80	70	85	85	100
Ligao loam	25	------	50	50	60	------	60	60	16
Faraon clay	------	------	70	------	80	------	80	80	80
Annam clay loam	------	90	70	40	70	------	85	80	80
Tigaon clay	------	80	70	40	75	75	85	80	80
Luisiana clay	------	75	70	40	70	------	80	80	70
Sevilla clay	------	70	70	------	70	------	90	90	70
Mayon gravelly sandy loam	------	------	45	------	60	25	65	70	70
Guinobatan sandy loam	------	------	40	------	60	30	80	90	100
Mauraro gravelly sandy loam	------	------	70	60	70	25	------	80	90
Macolod-Pili complex	------	70	70	------	70	70	75	75	80

[1] Indexes give the approximate average production of each crop in per cent as the standard of reference. The standard represents the approximate yield obtained without the use of fertilizers or amendments on the extensive and better soil types of the regions of the Philippines in which the crop is most widely grown.

TEXTURAL CLASSES OF THE SOILS OF ALBAY

FIELD DETERMINATION OF SOIL TEXTURAL CLASS

The determination of the soil textural class is 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 his field textural classification against laboratory results.

Hereunder are definitions and descriptions of the basic soil textural classes in terms of field determination.

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

Sandy loam.—Sandy loam contains 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, the soil particles will form a cast which readily fall apart, but if squeezed when moist, a cast can be formed which will bear careful handling without breaking.

Loam.—Loam consists of 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, the soil particles 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.—Silt loam contains a moderate amount of the fine grade of sand and only a small amount of clay, over half of the particles being of the soil separate 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, the soil particles will form into a cast which can be freely handled without breaking. When moistened and squeezed between the fingers, it will not "ribbon" but will give a broken appearance.

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

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

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

MECHANICAL ANALYSIS

Accuracy in the determination of textural classes of soils delineated during the soil survey is attained through mechanical analyses. However, there are instances when field classification and laboratory classification vary. Some soils exhibit clayey textures in the field. They are sticky and plastic when wet, hard or brittle when dry, but actually when analyzed their clay contents are low. Under these circumstances, the field classifications are maintained except when their clay contents are so low that their final textural classifications are those established by the laboratory.

The soil separates are sand, silt, and clay. Sand includes particles from 2.0 to 0.05 millimeter in diameter; silt from 0.05 to 0.002 millimeter; and clay, particles smaller than 0.002 millimeter in diameter.[1] Particles larger than 2.0 millimeter such as gravels, pebbles, and cobbles are considered coarse skeleton. Class names such as sand, silt, silt loam, clay loam, clay, sandy loam, etc., are determined by the proportionate amount of the different separates present in the soil. A soil analyzing 30 per cent or more clay fraction is considered a clay soil. Lately, however, this percentage was changed to 40, so that all soils containing 40 per cent or more of clay are classified as clay soils.

The modified Bouyoucus method was employed in the mechanical analysis wherein the conventional jar, hydrometer, and thermometer were used. Analysis was made without removing the organic matter from the soil.

TABLE 15.—*Average mechanical analyses of the soils of Albay*

Soil sample No. (field)	Soil type (Field)	Percentage				Laboratory textural grade
		Sand	Silt	Clay	Total cds.	
A-1	Tigaon clay	59.2	8.0	32.8	36.8	Sandy clay loam
2	Tigaon clay	58.2	10.2	31.6	35.6	Sandy clay loam
4	Legaspi silt loam	58.4	28.0	13.6	17.6	Sandy loam
28	Legaspi silt loam	80.4	8.0	11.6	15.6	Loamy sand
3	Legaspi silt loam, stony phase	79.6	14.0	6.4	10.4	Sandy loam
9	Legaspi silt loam, stony phase	65.6	24.4	10.0	16.4	Sandy loam
7	Legaspi clay	50.8	22.0	27.2	35.2	Sandy clay loam
62	Legaspi clay	48.4	24.8	26.8	37.6	Sandy clay loam
6	Mauraro gr. sandy loam	63.2	22.4	14.4	20.4	Sandy loam
3	Mauraro gr. sandy loam	69.2	20.0	10.8	14.8	Sandy loam
10	Luisiana clay	44.8	10.4	44.8	49.2	Clay
11	Sevilla clay	50.8	14.8	34.4	40.8	Sandy clay loam
40	Sevilla clay	51.2	16.0	32.8	38.8	Sandy clay loam
14	Annam clay loam	61.2	20.0	18.8	24.8	Sandy loam
63	Annam clay loam	53.2	19.0	28.8	34.8	Sandy clay loam
26	Mayon gravelly sandy loam	73.2	16.0	10.8	14.8	Sandy loam
27	Mayon gravelly sandy loam	65.2	26.0	8.8	16.8	Sandy loam
31	Malinao fine sandy loam	67.2	18.0	14.8	18.8	Sandy loam
32	Malinao fine sandy loam	66.4	12.4	21.2	27.6	Sandy clay loam
33	Umingan fine sandy loam	58.4	26.0	15.6	21.6	Sandy loam
34	Umingan fine sandy loam	73.0	15.8	11.2	15.2	Sandy loam
37	Faraon clay	40.4	14.4	45.2	57.6	Clay
38	Panganiran clay	50.4	16.0	33.6	59.6	Sandy clay loam
45	Guinobatan sandy loam	80.4	10.4	9.2	11.6	Sandy loam
56	Guinobatan sandy loam	70.8	20.0	9.2	13.2	Sandy loam
47	Libon silty clay	60.4	16.4	23.2	29.6	Sandy clay loam
60	Libon silty clay	61.0	22.0	17.0	23.0	Sandy loam
57	Ligao loam	65.0	22.0	13.0	19.0	Sandy loam
59	Ligao loam	73.2	14.4	12.4	14.8	Sandy loam
64	Bascaran gravelly clay	55.2	16.4	28.4	32.8	Sandy clay loam
65	Bascaran gravelly clay	59.2	20.0	20.8	26.8	Sandy clay loam

[1] Previous to 1938, the United States Department of Agriculture used the 0.05 to 0.005 millimeter for the size of silt and smaller than 0.005 millimeter for clay.

LAND CAPABILITY CLASSIFICATION AND CONSERVATION GUIDES FOR THE SOILS OF ALBAY

The seventeen soil types, one soil complex, and four miscellaneous land types found in the province are grouped into their respective land capability classes. A land capability class is a unit of classification to which a soil type belongs from the standpoint of its apparent and potential agricultural or economic capabilities. It is, therefore, a necessity for one to know the physical as well as the chemical characteristics of each soil type to enable one to judge correctly the capability of any soil type. The three major factors to consider in land capability classification are (1) the soil type, (2) the slope of the land, and (3) the degree of erosion. In the Philippines the three major problems on soils are (1) erosion and runoff, (2) wetness and drainage, and (3) root zone and tillage limitations, such as shallowness, stoniness, droughtiness, and salinity. The aforementioned problems further divides each class into subclasses for the soil type and are indicated by "e" for erosion and runoff; "w" for wetness and drainage; and, "s" for root zone and tillage limitations.

The different land capabilities are as follows:

CLASS A—Very good land that can be cultivated safely and extensively to crops with ordinary good farming practices.

CLASS B—Good land that can be cultivated safely using easily applied conservation practices.

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

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

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

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

CLASS N—The land is very steep, eroded, rough, shallow, or dry. It is good only for forestry or grazing if handled with great care.

CLASS X—This land is level but wet most of the time and cannot be economically drained. It can be used for farm ponds or recreational purposes.

LAND CAPABILITY CLASS A

Soil type: Umingan fine sandy loam
Legaspi fine sandy loam
Legaspi sandy clay loam
Malinao fine sandy loam
Libon silty clay

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. Soils under this class do not need drainage or other special practices. The land is rarely flooded. It is 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 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 a 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 young green plants such as any legume crop or any farm manure or compost 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 type: Panganiran clay
Ligao loam
Bascaran clay

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 subsoil 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 for runoff coming from adjoining uplands. Protection from occasional overflow 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 recommended kinds and quantities, soil improving crops, farm manure, and compost are needed to maintain the productive capacity of this class of land.

LAND CAPABILITY CLASS Be

Soil type: Faraon clay
Tigaon clay

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 standpoint 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 in any place 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 to 4 years should be observed. For all legume, the soil should be well supplied with lime and phosphate-carrying fertilizer and if the soil does not contain the right kind of bacteria inoculation should be done. The use of farm manure or compost is recommended.

LAND CAPABILITY CLASS Ce

Soil type: Annam clay loam	Luisiana clay
Sevilla clay	Mauraro gravelly sandy loam
Tigaon clay	Mayon gravelly sandy loam
Macolod-Pili complex	Guinobatan sandy loam

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 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 should 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 also be planted on the contours and a leguminous cover crop should be maintained to protect the soil from erosion.

LAND CAPABILITY CLASS De

Soil type: Annam clay loam	Luisiana clay
Sevilla clay	Mauraro gravelly sandy loam
Tigaon clay	Mayon gravelly sandy loam
Macolod-Pili complex	Guinobatan sandy loam

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 establish, reseeding and fertilizing is necessary.

Plowing and other farm operations must be done on the contour. Planting of row crops is not advisable. 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 severe, gullies should 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 with a deep soil although the topsoil is thin and light and a very rapidly permeable subsoil which is low in available moisture. Included under 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 that case artificial irrigation is necessary.

This class of land is also subject to some degree of soil erosion during those sporadic periods of heavy rainfall or due to excessive supply 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.

Increasing the organic matter content of the soil is recommended in order to increase its water holding capacity. This can be done by the application of animal manures.

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

LAND CAPABILITY CLASS Ls

Soil type: Legaspi fine sandy loam, stony phase
Land that is level or nearly so which is too stony to make cultivation not practical.

Class Ls is level or nearly level land but it could not be cultivated with ordinary farm machinery because it is too stony. Stones are present in such quantities and sizes that their removal is not practical. The soils under this class are fairly fertile, deep and are recommended only for grazing or for forestry.

Good management is also needed for the satisfactory growth of either grass or tree. This will mean proper fertilization and liming.

LAND CAPABILITY CLASS M

Soil type: Annam clay loam, Luisiana clay, Sevilla clay, Mauraro gravelly sandy loam, Tigaon clay, Mayon gravelly sandy loam, Macolod-Pili complex, Guinobatan sandy 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 with careful management. In order to grow good legumes 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. Newly developed pastures should not be grazed severely. On well established pasture grazing should be well controlled and rotated. Wherever possible, stock ponds should be constructed to supply water for 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 purposes, native trees should be protected from fires, or *kaingin* and the bare spaces planted to wood trees like *ipil-ipil*.

LAND CAPABILITY CLASS N

Soil type: Mountain soils undifferentiated
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 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 and 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, 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 fires 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 or forest. This land type is termed 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 pond. When the site is made into fish ponds or salt beds the trees or palms may be disposed off but a wide strip should be left standing along the outer borders of the shore line to protect the site from the scouring effect of waves.

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

LAND CAPABILITY CLASS Y

Soil type: Lava flow
Land suited only for wildlife and recreation

This class is extremely arid. There is insufficient grass for grazing; or is very steep, rough, and stony with very little or no soil cover at all. It also includes the rocky foothills, rough mountainous land, large areas of bare rock outcrops, and land that is very extremely eroded.

This kind of land, therefore, is not suitable for cultivation or for grazing purposes. The area should be forested and *kaiñgin* should be prevented. This kind of land is recommended for game and wildlife preserve.

TABLE 16.—*Land capability classification of the different soil types in Albay*

Soil type No.	Soil type	Possible soil Unit [1] Slope-erosion	Land capability class
122 227 231 232 233	Umingan fine sandy loam Legaspi fine sandy loam Legaspi sandy clay loam Malinao fine sandy loam Libon silty clay	a–0	A
465 234 235	Panganiran clay Ligao loam Bascaran clay	a–0	Bw
137	Faraon clay	b–1	Be
186	Tigaon clay	b–0	Be
230	Legaspi fine sandy loam stony phase	a–0	Ls
98 174 186 187 239 241 242 243	Annam clay loam Sevilla clay Tigaon clay Macolod–Pili complex Luisiana clay Mauraro gravelly sandy loam Mayon gravelly sandy loam Guinobatan sandy loam	c–1 d–1 c–2	Ce De M
118	Beach sand	a–0	Ds
1	Hydrosol		X
45	Mountain soils undifferentiated		N
341	Lava flow		Y

[1] The slope-erosion units are the possible conditions that may exist in each soil type. Any other unit with an erosion class more than the one specified above will be classed under the next capability class. Thus, Annam clay loam with a c–1 slope-erosion class has a Ce land capability class; the same soil type with a d–1 slope-erosion class has a De land capability class.

SOIL FERTILITY CHARACTERISTICS OF THE SURFACE SOILS OF THE DIFFERENT SOIL TYPES OF ALBAY PROVINCE

By

IGNACIO E. VILLANUEVA and GLORIA C. BANDONG-QUERIJERO [1]

Albay Province was surveyed by fieldmen of the former Bureau of Soil Conservation (now Bureau of Soils) to classify the various soil types in the province and to carry out effectively the provisions of CA 418 (Agronomic Survey). Soil samples were collected and morphologic studies were made in the field. These soil samples were brought to the laboratory for chemical analysis. The studies on the chemical characteristics include (*a*) the soil reaction (degree of acidity or alkalinity) which is a guide to crop adaptability of the soil type, (*b*) the presence of toxic substances and their concentrations, (*c*) the inadequacy, sufficiency or excess of nutrient elements required by the plants for their growth, and (*d*) the lime and fertilizer requirements of the soil type in relation to the crop.

Plants need food nutrients for their growth. These are supplied by the soil. The other requisites for plant growth are oxygen, carbon dioxide, water, sunshine or artificial light. The nutrient elements necessary for plant life may be divided into two classes, namely: (1) the fertilizer elements, and (2) the trace elements. The former include nitrogen, phosphorus, potassium, calcium, magnesium and sulfur while the latter include iron, manganese, boron, copper, zinc and molybdenum. The fertilizer elements must be present in abundant and balanced proportions while the trace elements must be only in very low concentrations. If plants do not get adequate amounts of these essential food nutrient elements, they become undernourished and exhibit various deficiency symptoms. Cropping, leaching, and erosion deplete the natural supply of the essential nutrient elements of the soil. These nutrient deficiencies may be corrected by the application of lime, wood ashes, green manuring, addition of organic matter, and the application of commercial fertilizers.

[1] Soil chemist and Assistant Soil Technologist (Chemist) respectively; now Regional Director, Soils Region No. 1 and Supervising Analytical Chemist, respectively.

METHODS OF CHEMICAL ANALYSIS

The crop response to the application of fertilizers is better correlated with the results obtained from the determination of the readily available nutrient elements than those obtained from the total analysis of the given soil type. The rapid microchemical tests for determining the available nutrients were employed. The total nitrogen content was determined because this element in the presence of proper microorganisms and under favorable conditions is easily converted into ammonia or nitrate forms which are available for plant assimilation.

The soil samples for chemical analysis were air dried, pulverized with a wooden mallet, passed through a 2-mm. sieve, thoroughly mixed and quartered.

The soil reaction or the hydrogen-ion concentration was determined with a Beckman H–2 pH meter fitted with a glass electrode.

The total nitrogen content of the soil was determined by the methods of analysis of the Association of Official Agricultural Chemists of the United States. The method of Spurway [2] was followed for the determination of ammonia and nitrates. Readily available phosphorus was determined by following the Truog method,[3] and available potassium, calcium, magnesium, iron and manganese were determined using the methods of Peech and English.[4] A Leitz photoelectric colorimeter with suitable light filters was used in the colorimetric determinations of available constituents.

INTERPRETATION OF CHEMICAL TESTS

Soil reaction or pH value.—A very important factor affecting plant growth and production is soil reaction.[5] It affects the behavior of plants and availability of plant nutrient elements as well as those of toxic substances in the soil. In very acid soils with low pH values, aluminum, iron and manganese become so soluble which cause injury to plants, while calcium, nitrogen

[2] C. H. Spurway, Michigan Agricultural Expt. Sta. Tech. Bull., 132 (1938).

[3] Emil Truog, Jour. Amer. Soc. Agron. 22, 874–882 (1930).

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

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

and phosphorus become less available. The poor growth of plants in very acid soil is often attributed to the toxic effects of excessive concentration of aluminum in the soil solution. Likewise, in very alkaline soil, iron, manganese and phosphorus become so insoluble that plant growth is often limited by deficiencies of one or more of these elements. The best soil pH for most crops ranges between pH 5.5 and 7.0 [6]

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

Plant	Strongly acid pH 4.2–5.4	Medium acid pH 5.5–6.1	Lightly 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, *Musa textiles* Nee [7]	Y	X	X	X	Y	O
Caimito, *Chrysophyllum caimito* Linn [7]	Y	X	X	Y	O	O
Coffee, *Coffea arabica* Linn [7]	Y	X	X	Y	O	O
Cowpea, *Vigna sinensis* (Linn.) Savi [8]	Y	Y	X	Y	Y	----------
Corn, *Zea mays* Linn. [8]	Y	Y	X	X	Y	Y
Durian, *Durio zibethinus* Linn [7]	Y	X	X	Y	O	O
Peanut, *Arachis hypogaea* Linn [8]	Y	Y	X	X	Y	----------
Petsai[10], *Brassica pekinensis* Rupr [10]	Y	Y	X	X	X	X
Rice, *Oryza sativa* Linn [7]	Y	X	X	Y	Y	O
Sugar cane, *Saccharum officinarum* Linn [7]	O	Y	X	X	X	Y
Tobacco, *Nicotiana tabacum* Linn. [7]	Y	X	Y	O	O	O
Sweet potato, *Ipomoea batatas* (Linn.) Poir [7]	Y	X	X	Y	O	O
Cassava, *Manihot esculenta* Crantz	Y	X	X	X	Y	Y
Pineapple, *Anonas comosus* (Linn.) Merr [7]	Y	X	Y	O	O	O
Banana, *Musa sapientum* Linn [8]	Y	X	X	X	Y	O
Tomato, *Lycopersicum esculentum* Mill [8]	Y	Y	X	X	Y	Y
Onion, *Allium cepa* Linn [9]	O	Y	X	Y	Y	Y
Soybean, *Glycine max* (Linn.) Merr [8]	Y	X	X	X	Y	Y
Orange, *Citrus aurentium* Linn. [9]	----------	Y	X	X	X	Y

[7] 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. "Effects of soil reaction on the growth of upland rice and on its nitrogen, calcium, phosphorus and iron content." Philippine agriculturist 33: 120–125, 1949.

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

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

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

X—Most favorable reaction

Y—Reaction at which plants grow fairly well or normally

O—Unfavorable reaction

[6] C. H. Spurway, "Soil Reaction (pH) Preference of Plants," Michigan Agr. Expt. Sta. Bull. 306 (1941).

A modified version of Pettinger's chart was published by Truog.[11] It shows the general trend of the relation of soil reaction to the availability of plant nutrient elements. The chart is reproduced here with Truog's accompanying explanation.

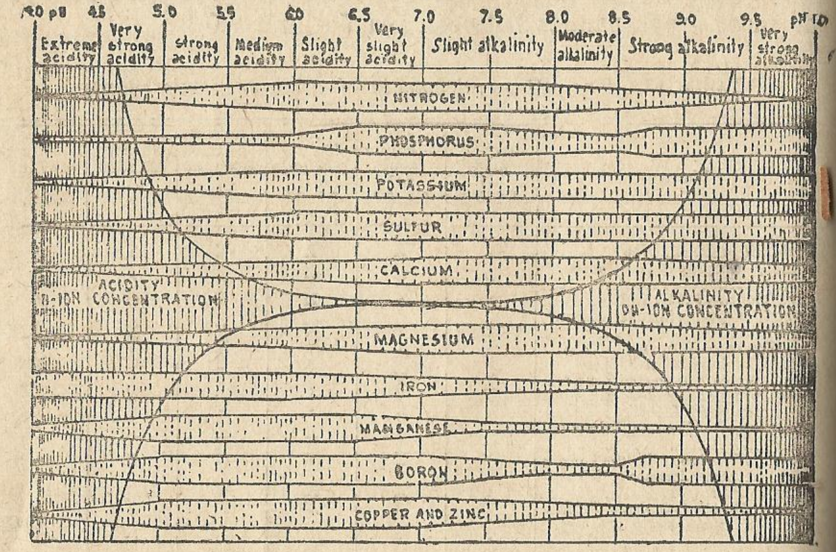

Figure 24. Chart showing general trend of relation of reaction to availability of plant nutrients.

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

"The influence of reaction on availability of each nutrient element is expressed by the width of the band (the wider the band, the more favorable the influence) carrying the names of the respective element.

"Thus, for the maintenance of a satisfactory supply of available nitrogen, for example, a reaction or pH range of 6 to 8 is the most favorable. This does not mean that if the reaction of a soil falls on this range a satisfactory supply of available nitrogen is assured. All it means is that so far as reaction is concerned, the conditions are favorable for a satisfactory supply of this element in available form. Also, the

[11] Emil Truog, "Lime in Relation to Availability of Plant Nutrients." *Soil Science*, 65, 1-7 (1948).

narrowed band for nitrogen at pH 5 does not necessarily mean that a deficiency of this element will prevail at that pH; it means that so far as reaction is concerned, the conditions are not favorable for an abundant supply in available form. Other factors than reaction may promote the presence of an abundant supply; moreover, certain crops having a low requirement may be fully satisfied with a low supply."

The economic plants grown in Albay have different specific optimum soil reaction requirements or pH preferences and tolerance limits. Table 17 shows the minimum, optimum and maximum pH requirements. The pH value of the soil types of the province varies from pH 4.60 to pH 7.05. Iron and aluminum fixation tends to increase as the pH drops especially below pH 5.5 to 6, while calcium and magnesium fixation in various forms increases as pH rises above this point. Soil acidity has been found to be associated with phosphorus and calcium deficiency. In acid soils the content of phosphates of iron and aluminum are relatively high. The unavailability of phosphorus under acid condition is due to the formation of iron and aluminum phosphates and to the accumulation of organic phosphorus; and under alkaline condition it is due to the formation of insoluble apatites and to the slow decomposition of organic phosphorus compounds. Some species of plants like rice, pineapple and tobacco grow most favorably under slightly acid soil conditions, pH 5.5 to 6.1, while other crops like alfalfa, sugar cane and orange prefer less acid and even slightly alkaline soil conditions, pH 6.2 to 7.8. The pH tolerance limits of the first group of plants just mentioned have been reported at pH 4.8 to 6.9, while those of the second group at pH 5.5 to 8.5. Some plants, however, like corn and tomato can tolerate a wider range (pH 4.8 to 8.5), although the best growth of these plants had been observed between pH 6.2 and 7.0.

Of the seventeen soil types classified and identified in the province of Albay as presented in table 18, twelve need liming to correct their pH. The soil reactions range from pH 4.6 to pH 7.5 with an average of pH 6.0. Soils become acid as the amount of available calcium on the colloidal complex is gradually depleted and replaced by exchangeable hydrogen; continuous leaching also makes the soil more acid. The ionization of carbonic acid in the soil solution supplies the hydrogen ions that replaces the calcium and other basic ions in the colloidal complex and when these basic ions are in the soil solution, they are susceptible to losses due to leaching.

Nitrogen.—Nitrogen is a necessary constituent of animal and plant proteins. It is one of the three major plant foods. Nitrogen is necessary for the production of proteins, the materials which compose the protoplasms. Nitrogen makes the stalk and the leaves dark green. The healthy appearance of a plant is due to the abundant supply of nitrogen. From the early stage of growth to the middle life of the plant its nitrogenous matter is found principally in its foliage and stalk. Excessive amounts of this element, however, produce excessive vegetative growth which in turn reduce crop yields as well as the plant's resistance to pests and diseases. Excessive nitrogen causes the lodging of rice, wheat and other small grain crops, lowers the purity of the sugar cane juice, decreases the tensile strength of fibrous plants. On the other hand, if plants are chiefly grown for foliage as in the case of leafy vegetables and forage, there must be an abundant supply of nitrogen in the soil.

The total nitrogen content of the different soil types of the province of Albay is shown in table 18. It varies from 0.15 per cent of the Macolod-Pili complex to 0.42 per cent of the Bascaran clay. The average total nitrogen content for the province is 0.26 per cent. This is quite high as compared to the average total nitrogen content (.14 per cent) found in other provinces so far surveyed. According to Spurway, 2–5 parts per million (p.p.m.) of ammonia and nitrates are considered low, 10–25 p.p.m. as medium or normal and 100 p.p.m. or more as very high or excessive.[12] The low values for ammonia with a normal supply of nitrates are normal for many soils where nitrification proceeds to completion, or where the ammonia is converted into nitrite and to nitrate at once.

The low values mean that the ammonia is used up by the plants as fast as it is formed, or is fixed in the soil complex. High values for ammonia may mean that the soil has a high organic matter content or has been recently fertilized with ammonical compounds.

The available nitrogen contents obtained by these tests may vary considerably during the growing period of the plant. To

[12] C. H. Spurway, A Practical System of Soil Diagnosis, *Michigan Agr. Expt. Sta. Tech. Bull.* 132 (1938).

be of value, therefore, it is necessary that the result of the three nitrogen tests be interpreted together. The low results of the three tests mean nitrogen deficiency, and low results accompanied with chlorotic and stunted plants are positive indications of deficiency in available nitrogen. High ammonia accompanied with a low result for nitrates indicate some unfavorable soil conditions that are interfering with nitrification. Low results for nitrates may also mean that the nitrate is absorbed by the plants as rapidly as produced or lost from the soil through leaching.

The sugar cane experiments for fertilizer constituents tests conducted by Locsin in Victorias, showed that the soil with only 0.13 per cent total nitrogen and only 11 p.p.m. of available nitrogen responded well to nitrogeneous fertilization.[13]

In another well controlled fertilizer experiment on sugar cane grown on Silay sandy loam, Richardson found that 750 kg. of ammonium sulfate per hectare lowered the value of the juice slightly but gave highly significant gains in yields of cane and sugar.[14] The soil on which the experiment was conducted contained 2 p.p.m. of available ammonical nitrogen and 5 p.p.m. of available nitrates. Superphosphate and muriate of potash were added in sufficient quantities to correct the deficiencies and the same rates were added to all plots leaving only amounts of ammonium sulfate as the variable. The highest application which was 750 kilograms per hectare gave the highest average yield of 213.46 piculs of sugar per hectare.

Phosphorus.—Phosphorus is an essential constituent of every living cell. Cell division can not take place and therefore growth is suspended if phosphorus is absent. The average phosphorus content found in soils is quite small in quantity. This element is removed from the farms in the form of cereals, grains and in the bones of animals. It promotes and stimulates healthy root growth and hastens the ripening process. It is an important constituent of protein needed in the production of nucleo-proteids, fats and albumin, as well as the conversion of starch into sugar.

Plants grown on phosphorus deficient soils have inferior feeding quality because of their low phosphorus contents. This

[13] Carlos L. Locsin, "Experimental Work on Sugarcane in Victorias 1948–1949 Season Including Part of 1950," *Sugar News* 26, 338–363 (1950).

[14] G. G. Richardson, "Amounts of Nitrogen." *Sugar News*, 25, 590–591 (1949).

fact is significant specially in animal nutrition because phosphorus is needed for teeth and bone formation. The plant takes phosphorus from the soil as phosphates and an abundant supply of it stimulates extensive root development. Phosphorus starved plants have stunted root systems and therefore less feeding zones. During the growing period of the plant, this element is found in its leaves and upper portions. It does not remain fixed in any one portion but moves about continuously. However, near seeding time, large amounts of phosphorus migrate to the seeds and become concentrated there.

Because phosphorus as found in agricultural soils is very small in quantity as compared to silica and it being a major plant nutrient, its depletion or exhaustion from the soil should be minimized. Besides stunted growth and delayed ripening, the leaves of many plants deficient in phosphorus show a purplish tinge, especially on their margins. The plants usually appear dark green, but corn and some of the small grains sometimes show purplish tinge on their leaves and stems when grown on phosphorus deficient soils. The legumes show a bluish green color on their leaves and appear stunted. Tobacco plants manifest a dark green color and a delay in their maturity ensues for as much as two months.

The available phosphorus content necessary to maintain a normal plant growth varies according to climate and soil. Under Wisconsin, U.S.A. conditions, Truog using his method of analysis set a minimum limit of readily available phosphorus at 37.5 p.p.m. for good heavy or clay soils and 25 p.p.m. for lighter and sandy soils. He further suggested that for certain sections in the southern United States, 10–15 p.p.m. of readily available phosphorus might maintain a good crop of corn.[15] In the Philippines, Marfori found that there was a little response to phosphatic fertilization of Philippine rice soils having 37.3 p.p.m. of available phosphorus following the Truog method.[16] There are indications, however, that 30 to 40 p.p.m. of available phosphorus might be a reasonable minimum requirement for a good crop of rice.

In table 18, the analysis for available phosphorus of the seventeen different soil types identified are shown. The available phosphorus content of these soils varied from 2 p.p.m.

[15] Emil, Truog, "The Determination of the Readily Available Phosphorus of Soils," *Journ. Amer. Soc. Agron.* 22, 874–882 (1930).

[16] R. T. Marfori, "Phosphorus Studies on the Philippine Soils," *The Phil. Jour. of Sc.*, 70, 133–142 (1939).

represented by the Tigaon clay to 170 p.p.m. represented by the Sevilla clay with an average of 36 p.p.m.. Eleven of these soil types are very deficient in phosphorus and six with barely enough to sufficient of this nutrient element. Marfori estimated as a reasonable minimum for a good crop of rice at 30–40 p.p.m. of available phosphorus.[17] Sevilla clay gives the maximum of 170 p.p.m. and according to the crop productivity rating (see table 14) it is not the best soil for upland rice but good for root crops such as cassava and camote.

Apparently, the first 3 best soil types mentioned in the table according to their crop productivity ratings for corn, lowland rice and mungo and their chemical analysis shown in table 18 appear to be deficient in either of the nitrogen, phosphorus, potassium and calcium. Umingan fine sandy loam has the highest productivity rating for corn but is deficient in nitrogen, phosphorus and available calcium. Bascaran clay is the next best soil for corn. It appears to be the best soil for rice although quite deficient in phosphorus and potash. Malinao fine sandy loam ranks also second for corn but poor for lowland rice. However, it is very deficient for all the elements such as nitrogen, phosphorus, potassium and even magnesium. It is therefore necessary that the deficient elements be supplied in the forms of commercial fertilizers; animal or green manures are also necessary to raise these soils to their minimum fertility levels for better crop yields. For coconuts, the highest productivity rating obtained is 70 per cent and represented by Legaspi fine sandy loam (stony phase), Faraon clay, Mauraro gravelly clay, Sevilla clay, Annam clay, Tigaon clay, Luisiana clay and Macolod-Pili complex.

Potassium.—Plants contain and require more potassium than the other essential nutrient elements drawn from the soil. This element is not localized at definite portions of the plant, but in some crops it tends to accumulate in the leaves and stems rather than in the grains. Potassium is also necessary in the production of carbohydrates and proteins. It is essential for the development of chlorophyll, production of starch and sugar, and in the synthesis of fats and albuminoids. It also improves the vigor of the plants and increases their resistance to pests and diseases. Potassium increases plumpness in grains

[17] R. T. Marfori, "Phosphorus Studies on Philippine Soils," *The Phil. Jour. of Sc.*, 70, 133–142 (1939).

and makes the stalk or stems of plants more rigid, thus minimizing lodging.[18]

The deficiency of potassium in the soil causes marked effects on plants which are striking characteristics of plant growth. The leaves generally become yellowish or dark colored at their tips and margins and finally become brown spreading upward

TABLE 18.—*Soil fertility characteristics of the soils of Albay Province*

Soil types	pH value	Total N %	Available constituents in parts per million (p.p.m.)								
			NH_3	NO_3	P	K	Ca	Mg	Mn	Fe	Al
Tigaon clay	5.90	.20	25	trace	2	86	700	150	58	1	10
Legaspi fine sandy loam	6.20	.41	25	5	43	42	1,700	470	5	3	46
Legaspi fine sandy loam stony phase	6.00	.36	25	10	19	31	800	470	5	1	51
Legaspi sandy clay loam	7.05	.31	10	25	96	358	3,200	470	11	3	[illegible]
Mauraro gravelly clay loam	6.50	.21	25	5	53	440	1,300	870	9	1	[illegible]
Luisiana clay	4.90	.17	10	2	3	139	400	480	13	2	63
Sevilla clay	6.30	.24	25	25	170	97	3,300	480	139	trace	25
Annam clay loam	5.40	.18	25	5	5	77	1,900	210	207	3	6
Mayon gravelly sandy loam	6.20	.22	10	2	2	21	400	330	6	5	7
Malinao fine sandy loam	4.60	.17	10	2	7	88	800	210	34	11	21
Umingan fine sandy loam	5.70	.38	25	5	17	214	1,600	470	58	8	2
Faraon clay	6.90	.26	25	50	13	123	20,000	1,710	57	trace	51
Guinobatan gravelly loam	5.90	.23	10	2	6	30	300	200	9	2	35
Macolod-Pili complex	6.10	.15	10	25	36	408	1,600	870	31	trace	11
Libon silty clay	6.00	.29	25	10	101	205	3,000	1,200	27	3	13
Ligao loam	6.20	.18	25	25	29	131	1,700	870	9	1	16
Bascaran clay	6.20	.42	25	100	4	91	3,900	1,680	46	38	66

and inward toward the center. This deficiency may cause the formation of shrunken or mishaped leaves, flowers, pods, fruits, tubers and roots. In corn, potassium deficiency is shown by a yellowish green streaking, stalks are short and roots are usually poor. The legumes show different chlorotic and necrotic pattern. There may be chlorosis and yellowing with small necrotic areas at first which later enlarge and coalesce to form rim-burn areas on older leaves. It has been observed that mottling in tobacco takes place during the later growth of the plant. The upper leaves may show the first symptoms of potassium deficiency. Mottling is followed by necrotic spotting at the leaf tips and margins. The shortage of this element gives a favorable development of bacterial leaf spot in tobacco and rust in cotton. Deciduous fruits show intervein chlorosis, necrosis and marginal scorch.

Potassium is found in both organic and mineral matters of the soil in hardly available or replaceable form. Most soils

[18] C. E. Millar and L. M. Turk, *Fundamentals of Soil Science* (New York: John Wiley & Sons, Inc., 1943) pp. 318–319.

contain relatively large amounts of total potassium, but the amount available to plants is generally small. These available potassium become gradually available to plants however through weathering, base-exchange and through solution in the soil water.

The major portion of the soil potassium exists in the difficultly available form, principally in primary minerals such as feldspars and micas which are constituents of igneous rocks, while the minor portion or available form of the total potassium is only about one per cent in clay minerals as kaolinite, montmorillonite, beidelite, halloysite, etc. The water soluble potassium is much smaller than the available and is the one easily lost through drainage and leaching.

Where the base-exchange capacity of the soil is large and the total exchangeable base content is low, part or all of the potassium added as fertilizers become fixed in the clay minerals and are considered fixed or stored for future use by the plants.

Marfori, *et al* in a study of the fertilizer requirements for lowland rice soils found that where the soil is highly deficient in available potassium, small applications of potassium fertilizer generally will not give immediate significant increases in crop yields because of the fixation of the added potassium in the base exchange complex. However, large initial applications of potassic fertilizers on such a soil will satisfy or saturate its potassium fixing capacity and will leave enough available potassium for immediate use by plants, thereby increasing crop yields. With larger application on the Buenavista silt loam and Maligaya clay loam containing 9 p.p.m. and 50 p.p.m. available potassium, respectively, it was found that large application gave a significant increase in crop yield with Guinangang rice variety as the plant indicator. Of the Marikina clay loam and San Manuel silt loam containing 132 p.p.m. and 161 p.p.m. of available potassium, respectively, repeated large applications of potassic fertilizer did not give any significant increase in yields also using Guinangang rice variety.[19]

Locsin in his experiments on potash fertilization of sugar cane in various haciendas at Victorias, Occidental Negros, reported that soils containing 85 p.p.m. or less of available

[19] R. T. Marfori and others, "A Critical Study of the Fertilizer Requirements of Lowland Rice on Some Philippine Soil Types," *Jour. Soil Sc. Soc. Phil.*, 2, 155–172 (1950).

potassium determined by the Peech and English method gave positive crop response to potassium applications while soils containing 151 p.p.m. or more gave no response.[20] It must also be expected that rice and sugar cane will have greatly varying minimum available potassium requirements when one considers that the amount of potash removed from the soil by a good crop of sugar cane has been estimated to be about 480 kg. of K_2O per hectare, while that removed by rice has been estimated to be about 98 kg. K_2O per hectare.[21]

According to Bray for most Illinois or corn belt soils, corn or clover will not respond to potassium fertilization when the available potassium is 150 p.p.m. or more (350 lbs. per acre). The minimum requirement of available potassium for soybeans was estimated at 100 p.p.m.[22] However, Linsley reported that Bray recommends 100 p.p.m. as the minimum available potassium requirement for the principal crops in Illinois.[23] Also, Murphy reported that Oklahoma soils containing less than 60 p.p.m. of replaceable potassium generally respond to potash application, when other factors are favorable for plant growth. He observed that the soils in Oklahoma containing 100 to 124 p.p.m. of available potassium have doubtful crop responses and no crop response with soils of 155 p.p.m. or over.[24]

From the results obtained from abroad and in the Island it may be assumed tentatively that 100–150 p.p.m. is the average minimum available potassium requirement of most Philippine crops. In table 18, it is shown that the available potassium contents of the various soil types in Albay Province range from 30 p.p.m. in the Guinobatan gravelly sandy loam to 440 p.p.m. in the Mauraro gravelly clay loam. Nine of these soils are below 100 p.p.m. while eight have barely enough to sufficient supply of this nutrient-element. The use or application of potassic fertilizers to increase the available potash is necessary to

[20] Carlos L. Locsin, "Potash Fertilization on Sugar Cane at Victorias, Neg Occ." *Jour. Soil Sc. Soc. Phil.*, *2*, 105–108 (1950).

[21] U.P., *Philippine Agriculture, Vol I, Field Crops* (Laguna, College of Agr., 1949).

[22] R. H. Bray, "Soil Test Interpretation and Fertilizer Use." *Univ. of Illinois Dept. of Agron. Ag.* 1222, (1944).

[23] C. M. Linsley, "Methods of Getting the Job Done on Soil Testing," *Jour. Am. Soc. Agron.*, 39, 249–299 (1947).

[24] H. F. Murphy, "The Replaceable Potassium Content Compared with Field Response to Potash Fertilization of Some Oklahoma Soils," *Jour. Am. Soc.* Agron, 26 84–87 (1934).

correct its deficiency. The soil types which have available potassium above 100 p.p.m. may or may not require any more potassium depending on the crop to be grown. To counteract the excessive application of nitrogenous fertilizer, the soil must have sufficient potash.

Calcium.—Calcium is one of the essential plant nutrients that affects the soil physically, chemically and biologically. This element is required in the translocation of carbohydrates and certain mineral elements. It stimulates root growth and adds strength to cell walls. It helps in regulating acid-base exchange within the plants. It also remains in the leaves and stalks as the plant matures. The calcium content of the plant is an index of its feed value because calcium is important in the development of bones and teeth of animals. Sherman states that calcium is the outstanding element of the mineral matter which gives shape and permanence to the body's framework and endows bones with strength, teeth with hardness.[25] Thatcher in his experiments with algae, have shown that in the absence of calcium salts, the mitotic the cell division takes place showing that the nucleus functions properly, but the formation of the new transverse cell wall is retarded, evidencing therefore that calcium is needed for cell wall formation.[26]

The physical structure of soil is affected by the amount of calcium it contains. Soils of high calcium content usually have better tilth and are granular, porous and easy to work. Calcium causes flocculation of the soil colloids and liming the soil neutralizes the acidity of acid soils and corrects the toxic effects to plants caused by such acidity. Lime when added to the soil tends to increase the available phosphorus. It helps in neutralizing organic acids or regulates the acid-base balance within the plant. How this element affects the availability of soil mineral elements was discussed under the topic of soil reaction. The calcium content of soils at below pH 6.5 affects the availability of phosphates. Thus in calcium-deficient soils, phosphorus is comparatively unavailable to plant although the total phosphorus content is relatively high. Below pH 6.0 the tendency to form calcium phosphate soluble in carbonic acid

[25] Henry C. Sherman, "Calcium and Phosphorus Requirements of Human Nutrition," *Yearbook of Agriculture:* 1939 (Washington: Gov't Printing Office, n. d.), 187–197.

[26] Roscoe W. Thatcher, *The Chemistry of Plant Life*, (New York: McGraw Hill Book Co., Inc.; 1921).

which is readily available to plants decreases, and increasing amounts of phosphate combine with hydrated oxides of iron and aluminum forming compounds with very low phosphate availability. Liming, therefore, does not only increase the pH value of the soil but also increases the availability of phosphorus through the formation of calcium phosphate which has greater availability than the phosphates of iron and aluminum.

The beneficial organisms found in the soil thrive best in neutral to slightly alkaline soils. Thus, acid soils are limed to adjust them to the most suitable and favorable conditions in which plants and microorganisms can thrive best symbiotically. Lime promotes decomposition of organic matter, which under favorable conditions nitrification and sulfofication take place, in addition to furnishing the microorganisms the nutrients required by them in their metabolism. In nitrification, the oxidation of ammonia to nitrous acid by Nitrosomonas and other related species and of nitrite into nitric acid by Nitrobacter are markedly retarded by soil acidity. Therefore, lime should be applied to distinctly acid soils to stimulate nitrification, according to Truog.[27]

Some of the effects of liming the soil on plant composition are, namely: (*a*) increased the calcium content of cabbage leaves from 4.42 per cent to 7.53 per cent, (*b*) more than doubly increased the yield of tomatoes as well as an increase of their vitamin C or ascorbic contents from 96 p.p.m. to 170 p.p.m. and (*c*) 40 per cent increase of the protein content of corn grain.[28]

Calcium deficient soils results in the death of the terminal buds.

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

From the published results on the effect of lime and ammophos fertilizer experiments conducted by Madamba and

[27] Emil, Truog, "Lime in Relation to Availability of Plant Nutrients," *Soil Science*, 65, 1–7 (1948).

[28] G. E. Smith and J. B. Hester, "Calcium Content of Soils and Fertilizers Relation to Composition and Nutritive Value of Plant." *Soil Science*, 65, 117–128 (1948).

Hernandez in San Ildefonso, Bulacan for upland rice[29] and the unpublished data of about 2 cavans yield in the unlimed control (no ammophos also), it was estimated that the increase in yield of upland rice due to the 6 tons of lime applied per hectare was about 20 cavans. Even without statistical treatment, an increase in yield of about 20 cavans over the control that gave about 2 cavans only was significant. The pH of the soil where the experiment was conducted was 4.80 and the available calcium content was 617.5 p.p.m.

The results (unpublished) on the liming experiments on two other soil types conducted in the greenhouse showed that with the same variety of upland rice, *Dumali*, not one of the several liming treatments (even up to an application of 240 tons per hectare) gave statistically significant increase in yield. This may be explained by the fact that both soils used in the experiments had rather high available calcium contents to start with. These soils were the Buenavista clay having a pH of 6.17 with available calcium content of 3,800 p.p.m. and Carmona clay having pH of 5.39 with an available calcium content of 3,600 p.p.m.

Table 18 shows the results for available calcium content of the different soil types in Albay Province. It ranges from 300 p.p.m. in Guinobatan gravelly sandy clay to 20,000 p.p.m. in Faraon clay and with an average of 2,741 p.p.m. Also, eleven of these soil types need liming to raise their available calcium to over 2,000 p.p.m. while the six soil types having 2,000 p.p.m. or over may not require any further addition of agricultural lime. Only one soil type, Legaspi clay, has a pH value of 7.05 with available calcium of only 3,200 p.p.m. This soil type was found excellent for mungo with a productivity rating of 100 per cent.

Magnesium.—The other essential nutrient element for plant growth is magnesium which is a constituent of chlorophyll and of most seeds. It seems needed in the translocation of starch and the formation of fats and oils and it aids in the transportation of phosphorus from the older leaves to the younger portions of the plant. The characteristic discoloration of the leaves, purplish-red leaves with green veins in cotton, chlorotic leaves in corn with the veins remaining green and the other portions becoming yellow are all symptoms of magnesium deficiency.

[29] A. L. Madamba and C. C. Hernandez, "The Effect of Ammophos and Lime on the Yield of Upland Rice (*DUMALI*) Grown on Buenavista Silt Loam." *Soil Sc. Soc. Phil.*, *I*, 204–209 (1949).

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The symptoms of magnesium deficiency occur on mature leaves of citrus at any season of the year. The irregular yellow blotches start along the midrib of the leaves near the fruits and eventually coalesce to form an irregular yellow band on each side of the midrib. This area rapidly enlarges until only the tip and the base of the leaf are green, the base showing a more or less V–shape area pointed on the midrib. In more advanced stages the entire leaf may become yellow. Other findings at the Citrus Expt. Station in Florida, U.S.A., have shown that magnesium deficiency causes a reduction in the total crop, size of fruit and in the sugar, acid and vitamin C content of the citrus juice.[30]

The addition of magnesium–bearing fertilizers principally of dolomitic limestone and magnesium sulfate to the magnesium-deficient soils in Florida, U.S.A., has become common practice. The increase in yield of the crop is due to magnesium. Standard fertilizers in Florida has included or incorporated a certain percentage of magnesium.[31] A state survey of the fertilizer practice in Florida in 1944 revealed that in 41 cases or estimates, proper fertilization increased the average yield of citrus more than fourteen times that of the control with an estimated yield of citrus fruit without fertilizer to be 24.4 boxes per acre, while that with the fertilizer, 358.5 boxes.[32]

The table of chemical analysis shows the available magnesium contents of the various soil types of Albay Province. It has been found that this nutrient element varies from 150 p.p.m. in Tigaon clay to 1,710 p.p.m. in Panganiran clay with an average of 655 p.p.m. From the data gathered in the laboratory, the soil types that have been rated high in crop productivity has about 600 to 1,700 p.p.m. of available magnesium. However, for certain species of citrus (pomelo or *Citrus maxima* (Brun. Merr.) symptoms of magnesium deficiency had been observed on soils that contained even as much as 950 p.p.m. of available magnesium. Only three types in Albay Province have over 1,000 p.p.m. of this nutrient element. Those soil types that are

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[30] A. F. Camp and others, "Symptoms of Citrus Malnutrition," Hunger Signs in Crops, (Washington: Am. Soc. Agron. and National Fertilizer Assn., 1941).

[31] National Fertilizer Assn., "Scientists Meet the Challenge of Florida's Varied Soils," *Fertilizer Review, Vol. XXII, No. 3,* 17–18 (1947).

[32] National Fertilizer Assn., "The Third National Fertilizer Practice Survey." *Fertilizer Review, Vol. XXI, No. 1,* 7–10 (1946).

very deficient in their available magnesium require applications of magnesium–bearing fertilizer.

Manganese.—Manganese is one of the trace elements needed by plants. As total manganese, it is present in very small amounts in agricultural soils, usually less than 0.1 per cent or 1,000 p.p.m. However, the requirements of plants are very small so that their manganese requirements are usually satisfied. Trace elements in quantities larger than the needs of plants are likely to be toxic or poisonous to the plant although the actual quantity may be small. Their deficiency or excess in the soil will produce certain characteristic symptoms.

Calcareous or heavy-limed soils usually lack manganese, iron and boron. This is so because of the formation of their insoluble carbonates. As a result, such crops as tomato, bean, oat, tobacco and various other leafy crops planted on such soils are dwarfed, have chlorotic upper leaves and are spotted. The presence of "gray speck" on the roots has been attributed to a shortage of manganese. The onion leaves and bulbs remain immature at harvest time. Celery becomes yellow; and spinach, lettuce, and potatoes are chlorotic.

Soil types from various parts of the Philippines which were rated high or at least medium in crop productivity contain from about 15 to 250 p.p.m. available manganese. Table 18 shows that the available manganese content of soils from Albay contain from 5 to 207 p.p.m. Soils containing less than 15 p.p.m. available manganese would therefore require manganese application. Such soils are Legaspi fine sandy loam, Legaspi fine sandy loam (stony phase), Legaspi sandy clay loam, Mauraro gravelly clay loam, Luisiana clay, Mayon gravelly sandy loam, Guinobatan gravelly sandy loam and Ligao loam. Since the rest of the soil types contain from 27 to 207 p.p.m. of available manganese they therefore do not need manganese application.

Iron.—Iron although needed in very small amounts is also one of the essential elements. It is usually available to all plants in acid soils. In neutral and alkaline soils, it is very insoluble so that plants have difficulty in absorbing enough for their requirements. In medium acid to extremely acid soils, it combines with soluble phosphates forming insoluble iron phosphate which is a form unavailable to plants. Iron phosphates occur both in acid and alkaline soils and are more likely found in sandy than in clay soils because of the former's greater power to fix or "lock up" excess soluble phosphates.

The availability of iron also varies widely with the degree of soil aeration, being higher under anaerobic condition. Investigations indicate a relationship between the solubility of iron and the supply of manganese. There are some reasons for thinking that deficiency of manganese in the soil leads up to an iron toxicity.

Several representative soil types from various parts of Luzon which were rated high or at least medium in crop productivity had been analyzed for available iron using the Peech and English method.

The results obtained ranged from 2 to 30 p.p.m. Using these figures as basis, seven (7) soil types of Albay Province are quite deficient in available iron. They are Tigaon clay, Legaspi fine sandy loam (stony phase), Mauraro gravelly clay loam, Sevilla clay, Faraon clay, Macolod-Pili complex and Ligao loam. However, the deficiency can be corrected by the application of iron-bearing fertilizers as ferrous sulfate. The rest of the soil types do not need correction for iron.

Aluminum.—Little is known of the extent to which the presence of aluminum in soils can modify the growth of crops. Acid soils yield appreciable amounts of soluble iron and aluminum and the toxicity of these elements as the possible cause of poor growth of plants has long been recognized. Aluminum behaves in acid soils, very much like iron, Pettinger's chart (Fig. 24) of nutrient elements. Since iron and aluminum behave similarly in acid soils when present in large amounts, there is a tendency for these elements to become toxic to certain plants since appreciable amounts of these constituents are soluble. However, by increasing the pH, precipitation of these ions takes place and their amounts in solution become less and less. At a soil pH range of 6.0 or 7.0, the toxicity of the aluminum, iron and manganese are suppressed.

The soils of Albay Province were found to contain from 5 to 63 p.p.m. of available aluminum.

FERTILIZER AND LIME REQUIREMENTS

The use of fertilizers and lime is becoming popular as a part of good soil management. Broadly speaking, the term fertilizers include all materials that are added to soils to increase the growth, yield, quality or nutritive value of crops. Fertilizers affect the soil and plant growth in a number of different ways but their primary uses are to increase the supply of available plant nutrients in the soil and to balance the plant

nutrient ratio. Commercial fertilizers are classified as nitrogenous, phosphatic, and potassic fertilizers depending on what nutrient element is contained in them. These chemical fertilizers especially the complete mixtures contain high and balanced nutrient elements which are readily available for immediate plant needs.

Nitrogenous fertilizers have their nitrogen either in the ammonium or nitrate forms. The ammonium forms are ammonium sulfate, ammonium phosphate, and urea. Potassium nitrate and sodium nitrate represent the nitrate form.

Phosphatic fertilizers are either water soluble or water insoluble. Those that are water soluble are the superphosphates and the ammonium phosphates. Ordinary double and triple superphosphates have their phosphates in the monocalcium forms which are very highly soluble in water. Ordinary superphosphate also contains calcium sulfate thereby supplying the soil with calcium and sulfur in adequate quantities for plant nutrition. Double and triple superphosphates contain negligible amount of sulfur but they have sufficient calcium to meet the calcium demands of most crops. These ordinary and double superphosphates are non-acid forming. The water insoluble compounds are the rock phosphates, basic slag, and guano. They are used preferably in acid soils where they are soluble. Rock phosphate and basic slag are alkaline in reaction and when used on acid soils they correct the unfavorable acidity of such soils.

Muriate of potash and potassium sulfate are potassic fertilizers. Muriate of potash usually contains 60 per cent (K_2O) and 50 per cent sulfate of potash. Both of these salts are highly water soluble and acid forming.

The fertilizer and lime requirements (see table 19) of the different soil types of Albay for lowland rice, corn, mungo and abaca were based from their chemical analysis.

For lowland rice, Libon silty clay and Legaspi sandy clay loam do not need fertilizer and lime applications. Basing on the available calcium content, only five soil types do not need lime application. They are Bascaran clay, Faraon clay, Libon silty clay, Legaspi sandy clay loam, and Sevilla clay. All the other soil types require lime treatment varying from 0.25 to 4.25 tons of agricultural lime per hectare. For nitrogen requirement, only Malinao fine sandy loam, Luisiana clay, Guinobatan gravelly sandy loam, and Mayon gravelly sandy loam require ammonium sulfate. Libon silty clay, Legaspi sandy clay loam, Sevilla clay, Mauraro gravelly clay loam, and Macolod-Pili complex do not also require potassic fertilizers.

TABLE 19.—*Fertilizer and lime requirements of soils from Albay*

Soil types	Agricultural lime [a] Tons/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Superphosphate (20% P_2O_5) Kg./Ha.	Muriate of potash (60% K_2O) Kg./Ha.	Agricultural lime [a] 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				For Corn			
Umingan fine sandy loam	1.00	-------	200	-------	2.00	100	200	-------
Bascaran clay	-------	-------	300	100	-------	-------	300	150
Malinao fine sandy loam	3.00	200	300	100	6.00	300	300	150
Faraon clay	-------	-------	200	50	-------	-------	200	100
Libon silty clay	-------	-------	-------	-------	-------	-------	-------	-------
Tigaon clay	3.25	-------	350	150	6.50	-------	350	200
Annam clay loam	0.25	-------	300	150	0.50	-------	300	200
Legaspi sandy clay loam	-------	-------	-------	-------	-------	-------	-------	-------
Legaspi fine sandy loam, stony phase	3.00	-------	150	250	6.00	-------	150	350
Sevilla clay	-------	-------	-------	100	-------	-------	-------	150
Luisiana clay	4.00	200	300	50	8.00	300	300	50
Mauraro gravelly clay loam	1.75	-------	-------	-------	3.50	100	-------	-------
Macolod-Pili complex	1.00	-------	50	-------	2.00	-------	50	-------
Guinobatan gravelly sandy loam	4.25	200	300	250	8.50	300	300	350
Legaspi fine sandy loam	0.75	-------	-------	200	1.50	100	-------	250
Mayon gravelly sandy loam	4.00	200	350	250	8.00	300	350	350
Ligao loam	0.75	-------	50	50	1.50	-------	50	100

Soil types	Agricultural lime [a] Tons/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Superphosphate (20% P_2O_5) Kg./Ha.	Muriate of potash (60% K_2O) Kg./Ha.	Agricultural lime [a] Tons/Ha.	Ammonium sulfate (20% N) Kg./Ha.	Superphosphate (20% P_2O_5) Kg./Ha.	Muriate of potash (60% K_2O) Kg./Ha.
	For Mungo				For Abaca			
Umingan fine sandy loam	2.00	-------	200	-------	1.00	250	200	-------
Bascaran clay	-------	-------	300	100	-------	-------	300	200
Malinao fine sandy loam	6.00	100	300	100	3.00	500	300	200
Faraon clay	-------	-------	200	50	-------	-------	200	100
Libon silty clay	-------	-------	-------	-------	-------	-------	-------	-------
Tigaon clay	6.50	-------	350	150	3.25	100	350	300
Annam clay loam	0.50	-------	300	150	0.50	100	300	300
Legaspi sandy clay loam	-------	-------	-------	-------	-------	-------	-------	-------
Legaspi fine sandy loam, stony phase	6.00	-------	150	250	3.00	-------	150	500
Sevilla clay	-------	-------	-------	100	-------	-------	-------	200
Luisiana clay	8.00	100	300	50	4.00	500	300	50
Mauraro gravelly clay loam	3.50	-------	-------	-------	1.75	100	-------	-------
Macolod-Pili complex	2.00	-------	50	-------	1.00	-------	50	-------
Guinobatan gravelly sandy loam	8.50	100	300	250	4.25	500	300	500
Legaspi fine sandy loam	1.50	-------	-------	200	0.75	100	-------	400
Mayon gravelly sandy loam	8.00	100	350	250	4.00	500	350	500
Ligao loam	1.50	-------	50	50	0.75	-------	50	100

[a] Limestone ($CaCO_3$) pulverized for all particles to pass through 20-mesh screen with 50 per cent to pass 100-mesh.

For corn, mungo, and abaca, the same soil types as for lowland rice that do not require fertilizer and lime application hold true. The lime requirements for those soil types that need lime which are planted to corn and mungo are however doubled that of lowland rice. Likewise, their nitrogen requirements vary. For phosphorus needs of corn, mungo and abaca

their superphosphate applications are the same as for lowland rice. The amount of potassic fertilizer applications also vary from 50 to 250 kg. per hectare of muriate of potash (60% K_2O) for lowland rice, 50 to 350 kg. per hectare for corn, 50 to 250 kg. per hectare for mungo, and 50 to 500 kg. per hectare for abaca for those soil types that need correction of potash content.

It must be remembered, however, that the time and method of application determine the value of the fertilizers mentioned above. When applied at the right time and in the proper manner, they stimulate the growth of the crop and produce satisfactory returns. For better results of fertilizers, they should be applied annually or even twice a year, rather than in large applications at long intervals.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN ALBAY

Common name	Scientific name	Family name
Abaca	*Musa textilis* Nee	Musaceæ
Achuete	*Bixa orellana* Linn.	Bixaceæ
Agiñgay	*Rottboellia exalta* Linn.	Gramineæ
Alibangbang	*Bauhinia malabrica* Roxb	Leguminosæ
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceæ
Anonas	*Anona reticulata* Linn.	Anonaceæ
Api-api	*Avicennia officinalis* Linn.	Verbenaceæ
Apitong	*Dipterocarpus grandiflorus* Blanco	Dipterocarpaceæ
Arrowroot	*Maranta arudinacea* Linn.	Marantaceæ
Atis	*Anona squamosa* Linn.	Anonaceæ
Avocado	*Persea americana* Mill.	Lauraceæ
Bakauan	*Rhizophora mucronata* Lam.	Rhizophoraceæ
Balanggot	*Typha capensis* Rohrb.	Typhaceæ
Bamboo	*Bambusa spinosa* Roxb.	Gramineæ
Banana	*Musa sapientum* Linn.	Musaceæ
Bangkal	*Nauclea orientalis* Linn.	Rubiaceæ
Batao	*Dolichos lablab* Linn.	Leguminosæ
Batino	*Alstonia macrophylla Wall*	Apocynaceæ
Bermuda grass	*Cynodon dactylon* (Linn.) Pers	Gramineæ
Binayoyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceæ
Breadfruit	*Artocarpus communis* Forst	Moraceæ
Buri	*Corypa elata* Roxb.	Palmæ
Cabbage	*Brassica oleracea* Linn.	Cruciferæ
Cacao	*Theobroma cacao* Linn.	Sterculiaceæ
Cadios	*Cajanus cajan* (Linn.) Millsp.	Leguminosæ
Caimito	*Chrysophyllum cainito* Linn.	Sapotaceæ
Cantaloupe	*Cucumis melo* Linn.	Cucurbitaceæ
Cashew	*Anacardium occidentale* Linn.	Anacardiaceæ
Cassava	*Manihot esculenta* Grantz	Euphorbiaceæ
Castor oil bean	*Ricinus communis* Linn.	Euphorbiaceæ
Cauliflower	*Brassica oleracea* var. Botrytis Linn.	Cruciferæ
Chico	*Achras sapota* Linn.	Sapotaceæ
Coconut	*Cocos nucifera* Linn.	Palmæ
Coffee	*Coffea arabica* Linn.	Rubiaceæ
Cogon	*Imperata cylindrica* (Linn.) Beauv.	Gramineæ
Corn	*Zea mays* Linn.	Gramineæ
Cowpeas	*Vigna sinensis* (Linn.) Savi.	Leguminosæ
Cucumber	*Cucumis sativus* Linn.	Cucurbitaceæ
Dayap	*Citrus aurantifolia* (Christm.)	Rutaceæ
Duhat	*Eugenia cumini* (Linn.) Druce	Myrtaceæ
Dungon-late	*Heritiera litterales* Dryand	Sterculiaceæ

Common name	Scientific name	Family name
Dao	*Drocontomelum dao* (Blanco) Merr. & Rolfe	Anacardiaceæ
Derris	*Derris elliptica* (Roxb.) Benth	Leguminosæ
Eggplant	*Solanum melongena* Linn.	Solanaceæ
Gabi	*Colocasia esculenta* (Linn.) Schott.	Araceæ
Garlic	*Allium sativum* Linn.	Liliaceæ
Ginger	*Zingiber officinale* Rosc.	Zingiberaceæ
Guava	*Psidium guajava* Linn.	Myrtaceæ
Guayabano	*Anona muricata* Linn.	Anonaceæ
Ipil	*Instia biyuga (Colebr.)* O. Kuntse	Leguminosæ
Ipil-ipil	*Leucaena glauca* (Linn.) Benth.	Leguminosæ
Kalumpit	*Terminalia edulis* Blanco	Combretaceæ
Kamachile	*Pithecolobium dulce* (Roxb.) Benth.	Leguminosæ
Kapok	*Ceiba pentandra* (Linn.) Gaertn	Bombacaceæ
Katmon	*Dillenia philippinensis* Rolfe	Diliniaceæ
Kondol	*Benincasa hispida* (Thumb.) Cogn.	Cucurbitaceæ
Langarai	*Bruguiera parviflora* (Roxb.) W. & A.	Rhizophoraceæ
Lanzones	*Lansium domesticum Correa*	Meliaceæ
Lemon	*Citrus limon* Burn.	Rutaceæ
Lettuce	*Lactuca sativa* Linn.	Compositæ
Mandarin	*Citrus nobilis Lour.*	Rutaceæ
Madre de cacao	*Gliricidia sepium (Jacq.)*	Leguminosæ
Macopa	*Eugenia malaccensis*	Myrtaceæ
Mango	*Mangifera indica* Linn.	Anacardiaceæ
Molave	*Vitex parviflora* Juss.	Verbenaceæ
Mungo	*Phaseolus aureus* Roxb.	Leguminosæ
Mustard	*Brassica integrifolia* (West) Schultz	Cruciferæ
Nangka	*Artocarpus heterophyllus* Lam.	Moraceæ
Nipa	*Nypa fruticans* Wurmb.	Palmæ
Onion	*Allium cepa* Linn.	Liliaceæ
Orange	*Citrus aurantium* Linn.	Rutaceæ
Pandan	*Pandanus tectorius* Sol.	Pandanaceæ
Papaya	*Carica papaya* Linn.	Caricaceæ
Patola	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceæ
Patani	*Phaseolus lunatus* Linn.	Leguminosæ
Peanut	*Arachis hypogaea* Linn.	Leguminosæ
Pechay	*Brassica chinensis* Linn.	Cruciferæ
Pepper	*Capsicum annuum* Linn.	Solanaceæ
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceæ
Pili nut	*Canarium luzonicum* (Blume) A. Gray	Burseraceæ
Pummelo	*Citrus maxima* (Burm) Merr.	Rutaceæ
Pumpkin	*Cucurbita pepo* Linn.	Cucurbitaceæ
Radish	*Raphanus sativus* Linn.	Cruciferæ
Ramie	*Boehmeria nivea* (Linn.) Gaudich.	Urticaceæ
Rice or palay	*Oryza sativa* Linn.	Gramineæ
Santol	*Sandoricum koetjape* (Burm. F.) Merr.	Meliaceæ

Common name	Scientific name	Family name
Sincamas	*Pachyrrhizus erosus* (Linn.) Urb.	Leguminosæ
Sineguelas	*Spondias purpurea* Linn.	Anacardiaceæ
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosæ
Soybean	*Glycine max* (Linn.) Merr.	Leguminosæ
Squash	*Cucurbita maxima* (Duch.)	Cucurbitaceæ
Sugar cane	*Saccharum officinarum* Linn.	Gramineæ
Sweet potato	*Ipomea batatas* (Linn.) Poir	Convolvulaceæ
Tabigi	*Xylocarpus granatum* Koenig	Meliaceæ
Talahib	*Saccharum spontaneum* Linn.	Gramineæ
Tobacco	*Nicotiana tabacum* Linn.	Solanaceæ
Tomatoes	*Lycopersicum esculentum* Mill.	Solanaceæ
Tugui	*Dioscorea esculenta* (Lour.) Burkill	Dioscoreaceæ
Ubi	*Dioscorea alata* Linn.	Dioscoreaceæ
Upo	*Lagenaria leucantha* (Duch.) Rusby	Cucurbitaceæ
Vetiver grass	*Andropogon zizanioides* (Linn.) Urban	Gramineæ
Watermelon	*Citrullus vulgaris* Schrad.	Cucurbitaceæ
Yakal	*Shorea gisok* Foxw.	Dipterocarpaceæ

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