REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
MANILA

Soil Report No. 19

SOIL SURVEY OF ILOCOS SUR PROVINCE, PHILIPPINES

BY

JUAN A. MARIANO
Chief of Party

ISIDORO A. ROMERO and JORGE A. TINGZON
Members

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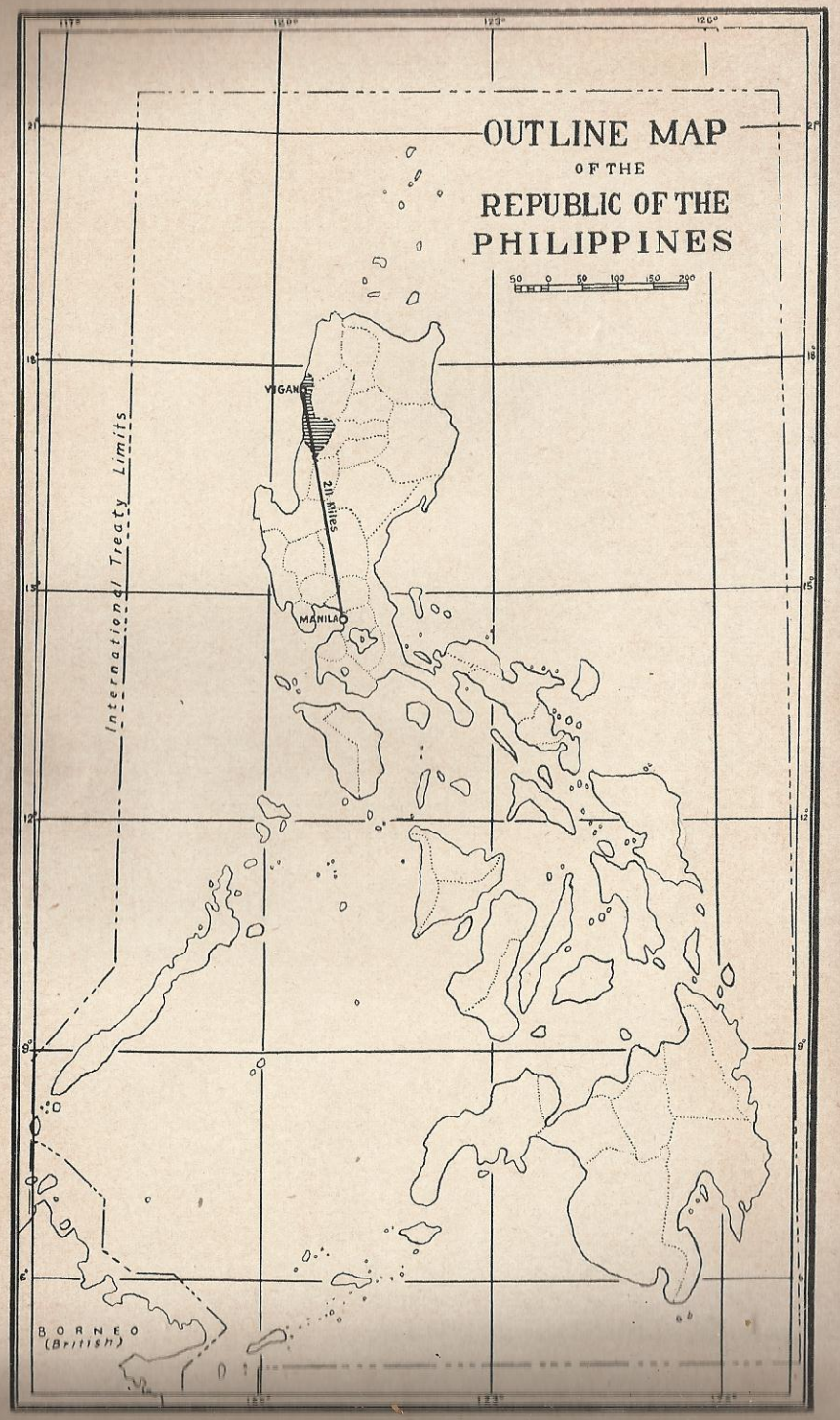

FIG. 1. Sketch map of the Philippines showing the location of Ilocos Sur Province.

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HOW TO USE THE SOIL SURVEY REPORT

SOIL SURVEYS provide basic data for the formulation of land-use programs. This report and the accompanying map present information both general and specific about the soils, the crops, and the agriculture of the area surveyed. The individual reader may be interested in the whole report or only in some particular part thereof. Ordinarily he will be able to obtain the information he needs without reading the whole report. Prepared for both general and detailed use, the report is designed to meet the needs of a wide variety of readers under three general groups: (1) Those interested in the area as a whole; (2) those interested in specific parts of it; and (3) students and teachers of soil science and related agricultural subjects. An attempt has been made to meet the needs of all three groups by making the report comprehensive for purposes of reference.

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

Readers interested chiefly in specific areas, such as a particular locality, farm, or field, include farmers, agricultural technicians interested in planning operations in communities or on individual farms, and real estate agents, land appraisers, prospective purchasers and tenants, and farm-loan agencies.

SOIL SURVEY OF ILOCOS SUR PROVINCE, PHILIPPINES

By JUAN A. MARIANO, ISIDORO A. ROMERO, and JORGE A. TINGZON
Soil Technologists

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

SUMMARY

Ilocos Sur Province is in the central part of the Ilocos region in the northwestern part of Luzon. Vigan, the capital of the province, is 211 air miles (408 kilometers by road) north of Manila. The total land area is 268,540 hectares or approximately 2,685.4 square kilometers. The population in 1938 was 270,597 and 276,278 in 1948.

The predominant relief is hilly and mountainous, although it ranges from nearly level to mountainous. The elevation ranges from a few meters above sea level to 2,352 meters. The narrow coastal plain is of recent alluvium; the hills are sedimentaries, mostly shales and sandstones; and the mountains are of igneous rocks, generally andesites.

The province is generally well drained by many rivers, the three largest of which are the Abra, Amburayan and Chico Rivers. Most of the bottom lands are subject to floods which sometimes become destructive.

The coastal plain is all cultivated to lowland rice as the main crop and corn, sugar cane, sweet potatoes, tobacco, mongo, peanuts, and vegetables as secondary crops. The hills and upland areas are under second-growth forest and grassland, while the mountains are mostly under second-growth forest and partly under primary forest.

The province was created in 1818 from the old province of Ilocos. Some of the oldest towns in the Philippines are in the province, such as Vigan, Santa, Narvacan, Bantay, Candon, and Sinait. Civil government was established in 1901. The population has increased steadily from 189,572 in 1903 to 276,278 in 1948. During World War II the Japanese forces occupied the province until its liberation in 1945 when the old Commonwealth Government was reestablished.

Transportation within the province and with other provinces is adequate with the exception of the interior towns in the hilly and mountainous areas on the eastern part. There are five ports for small vessels—at Salomague, Pandan, Solvec in Narvacan, San Esteban, and Santiago. Churches and schools are located in the towns and other convenient places in the barrios.

Agriculture is the major industry of the people. Lowland rice is the principal crop. Corn, tobacco, sugar cane, and sweet potatoes are the more important secondary crops. Due to the small area of arable lands other industries are well developed. Among the more important ones are weaving, salt making, wooden furniture manufacture, leather goods manufacture (saddles, harness, slippers, and shoes), and cigar making.

Ilocos Sur is under the first type of rainfall, i.e., a distinct dry and wet season: dry in winter and spring and wet in summer and autumn. Generally the rainy season commences at the middle of May and ends in November. The mean annual rainfall at Vigan, the capital, is 2,366.2 millimeters. The province is one of the typhoon-swept regions of the Philippines.

The soils of the province were classified into three main groups, depending upon their topographic position, namely, soils of the plain, soils of the intermediate uplands, and soils of the mountains. The soils of the plain are represented by the Bantog clay loam, San Manuel silt loam, Umiñgan sandy loam and two miscellaneous land types, the beach sand and riverwash. The soils of the intermediate uplands are the Bauang clay loam, Bantay loam, and Cervantes loam. Those of the mountain soils are represented by two miscellaneous land types, the mountain soils, undifferentiated and rough stony land.

The Bantog clay loam and San Manuel silt loam are the most important agricultural soils of the province. Both are used mainly for the growing of lowland rice, the primary crop of the province. The soils of the intermediate upland are of minor importance for agricultural purposes because of their unfavorable topography. The mountain soils are suited for forestry purposes.

The chemical analyses of the soils of Ilocos Sur Province indicate that generally they are low in nitrogen, phosphorus, and potassium. The use of commercial fertilizers and the adoption of suitable soil-conservation practices is necessary, if their present productivity is to be maintained or increased.

The San Manuel silt loam needs complete fertilizer relatively high in phosphorus and the same is true of the Bantog clay loam with still higher phosphorus requirements. The Umiñgan sandy loam, on the other hand, is quite deficient in nitrogen, hence, ammonium sulfate or ammo-phos (fertilizers) should be applied at the rate of 150 to 200 kilograms per hectare for rice. The organic matter content of the soil should be increased in order to raise its fertility.

The Bauang clay loam, Bantay loam, and Cervantes loam are not considered important agricultural soils. If possible, these soils should be utilized for pasture, forestry or wildlife refuge. If they have to be cultivated to seasonal crops, however, the adoption of erosion control measures is imperative.

GENERAL DESCRIPTION OF THE AREA

Location and extent.—Ilocos Sur Province occupies the central part of the Ilocos region in Northwestern Luzon. It is bounded on the north by Ilocos Norte Province; on the east by Abra and the Mountain Province; on the south by La Union Province; and on the west by the China Sea. Vigan, the capital, is 408 kilometers by road north from Manila and 128 kilometers from San Fernando, La Union. It has a total area of 2,685.40 square kilometers, or 268,540 hectares.

Physiography, relief, and drainage.—Ilocos Sur comprises the middle portion of a distinct physiographic unit known as the Ilocos Coast strip, which extends along the western side of Luzon (9).[1] It is very irregular with the widest portion hardly exceeding 20 kilometers.

The province is relatively uneven in physical features. The relief ranges from level to hilly and mountainous. The narrow coastal plain is level to undulating with several low hills scattered at random all throughout the entire length of the province. The eastern portion, which borders Abra and the Mountain Province, is hilly to mountainous. The highest mountains in the province are the peaks of the Malaya Range southwest of the town of Cervantes, the two highest peaks of which are the Malaya Mountains (2352 meters high) and Mt. Libo (1771 meters).[2]

Geologically, the province is largely an elevated coastal tract, in some places of raised coral, and in others of alluvium overlying

[1] Numbers in parenthesis refer to Bibliography.

[2] Elevations were obtained from Coast and Geodetic Survey topographic maps.

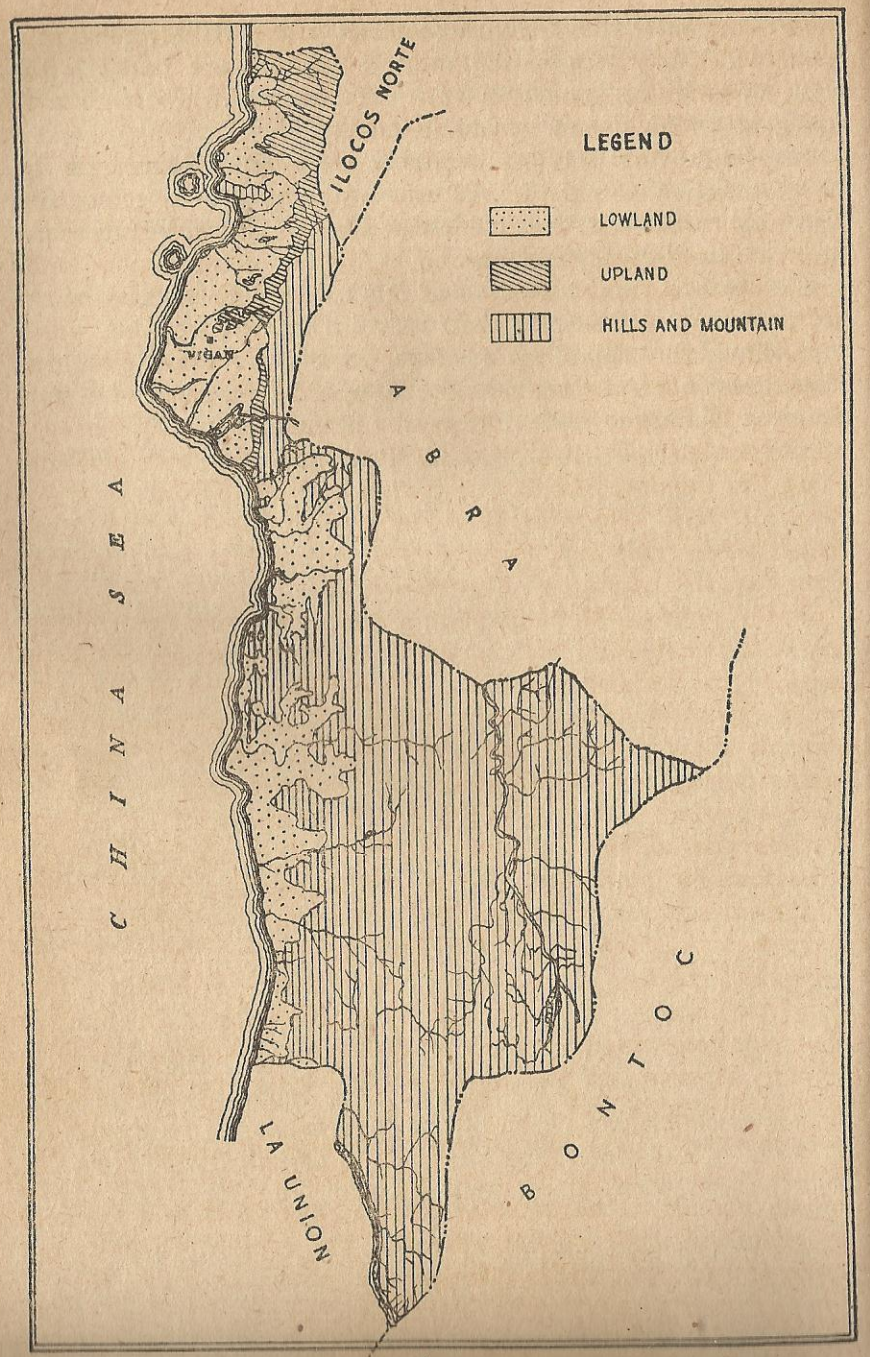

FIG. 2. Sketch map of Ilocos Sur Province showing general topography and natural drainage system.

older sediments. The eastern boundary of the plain is an escarpment which has been caused partly by a fault and partly is the edge of andesitic extrusives (2). The hills and low mountains are gently folded sandstones and shales.

In general, the province drains to the west. Because of the narrowness of the plain and the nearness of the mountains and hills to the sea, the rivers and streams are generally short and rapid with few or no meanders. Most of the bottom lands are subject to annual floods, and due to the high velocity of the streams they are usually destructive. The Abra River, which rises from the slopes of Mt. Data in the Mountain Province, debouches onto the plain near the town of Santa, south of Vigan. Some of the larger rivers in the province are the Chico, a branch of the Amburayan River, Buaya River near the town of Santa Cruz, the Candon, Sta. Maria, Narvacan, Parsua, Cabugao, and Sinait Rivers. None of these is navigable except the Abra River, where raft and dugouts could be used as far inland as Bangued, the capital of Abra Province.

Water supply.—Municipal water supply systems for drinking and domestic use are few and the most common sources of water used by the greater number of people are native shallow-dug wells, especially around lowland villages, and a few perennial streams and springs. Surface water is abundant in most places during the rainy reason, but water nearly everywhere at this period is turbid and polluted. Almost all, if not all, surface and shallow ground waters are unsafe and require treatment for potability. When the dry season sets in, some of the streams are dried up and the water level of the wells become low. Municipal water supply systems exist in the provincial capital, Vigan, and in the towns of Cabugao, Sta. Catalina, Bantay, Santa, Narvacan, and Cervantes. The number of population served varies from 800 in Cervantes to 10,000 in Vigan. In some of the towns drilled wells are some of the sources available.

Vegetation.—Originally the greater part of Ilocos Sur was under primary forest, but the usual practice of *caingin* agriculture has led to the supplanting of a large portion of the area by grassland and secondary forest. The area of the different types of soil cover in the province are shown in Table 1.

TABLE 1.—*Classification of the soil cover of Ilocos Sur.*[1]

Kind of land	Area in hectares	Per cent
Commercial forest	6,089	2.26
Non-commercial forest	32,201	11.99
Cultivated and open land	230,250	85.75
Fresh and salt marsh and swamp		
Total	268,540	100.00

[1] Data obtained from Yearbook of Philippine Statistics, 1946, Bureau of Printing, Manila. (1947)

The mountainous southeastern portion is under primary forests; the hills and foothills along the eastern part are under either secondary forest or grassland; and the plain portion is under cultivated crops. There are no swamps or marshes.

The primary forest consists of several groups of trees with many big trees successfully towering over smaller ones. The forest canopy shuts out sunlight almost entirely. Undergrowth is usually dense with plenty of climbing and clinging vines, creepers and some epiphytes. Some of the species in this type of vegetation are:

Scientific name	Common name
Anisoptera thurifera (Blanco) Blume.	Palosapis
Artocarpus cumingiana Trec.	Ubien
Dipterocarpus grandiflorus Blanco.	Apitong
Pahudia rhomboidea (Blanco) Prain.	Tindalo
Pentacme contorta (Vidal) Merr & Rolfe	White lauan
Shorea guiso (Blanco) Blume.	Pisek
Shorea polysperma (Blanco) Merr.	Tangile
Tarrietia sylvatica (Vidal) Merr.	Dungon
Vitex parviflora Juss.	Molave

The secondary forests, which usually cover the hills and foothills, consist of relatively short-lived, mostly soft-wooded trees. Young forests are composed of dense growth of scrubby trees, shrubs, and vines. Such thickets are common at the edges of the primary forests. In some places there is an intergrowth of spiny, tough, climbing bamboo which makes such forests

Fig. 1. The largest part of Ilocos Sur is under grassland. Note the undulating to rolling topography.

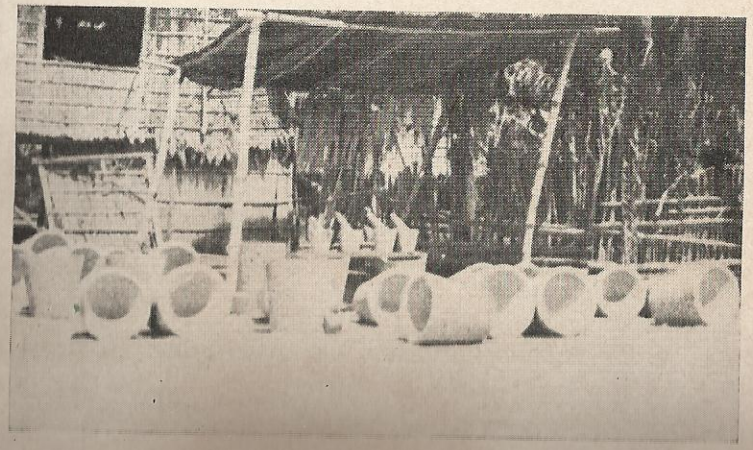

Fig. 2. Stone mortar manufacture is the main household industry in the town of San Esteban.

extremely dense. The cleared hilly areas have moderately dense growth of trees along the streams. The following are a few of the common species in this type of vegetation:

Scientific name	Common name
Albizzia procera (Roxb.) Benth.	Akleng parang
Antidesma bunius (Linn.) Spreng.	Bignay
Antidesma ghaesembilla Gaertn.	Binayuyu
Bambusa spinosa Roxb.	Bamboo (most common species)
Gliricidia sepium (Jacq.) Steud.	Madre cacao
Leucaena glauca (Linn.) Benth.	Ipil-ipil
Macaranga tanarius var. Tomentosa (Blume) Muell.-Arg.	Binunga
Schizostachyum lumampao (Blanco) Merr.	Boho

Grasslands occupy the largest area in the province. They comprise burned-over and abandoned areas commonly known as *cogonales* where the coarse grass, cogon, predominates. It forms a thick mantle that burns readily when dry. The grass grows back rapidly after having been burned off. Due to the yearly burning of the grasslands, secondary forests could not invade or expand.

Organization and population.—The two provinces of Ilocos Sur and Ilocos Norte were created in 1818 from the old province of the Ilocos which included all of the Ilocos and part of the mountain country. Included in the newly created province was the northern part of what is now La Union as far as the town of Luna and approximates what is now Abra Province. But these southern and eastern portions were separated later.

Some of the oldest towns in the Philippines may be found in Ilocos Sur, among which are Vigan, Santa, Narvacan, Bantay, Candon, and Sinait. The population has steadily increased as shown by census figures for different years as follows: in 1903, 189,572 people; in 1918, 217,410; in 1938, 271,532; and in 1948, 276,278 people.

Transportation and market facilities.—Transportation facilities from the surrounding provinces as well as within the province are adequate, with the exception of the interior towns in the mountainous and hilly regions in the southern and southeastern parts of the province. The towns inaccessible except by pack are Alilem, Sugpon, Sigay, Concepcion, Angaki, San Emilio, Tiempo, Tubo, and Lidlidda. There are 226.80 kilometers of first class road; second class, 103.40 kilometers; and third class, 78.20 kilometers. Few large companies operate

several passenger busses and freight trucks and several small operators as well serve as arteries for travel and commerce from Vigan to the different towns and to the neighboring provinces and Manila. A few among them are the Sambrano Transportation Company, Roxas Express Company, and the Northern Luzon Transportation Company. A small portion of the trade between Ilocos Sur and other provinces and Manila is promoted through the medium of motor vessels and sailboats. The few ports of call are at Salomague, Pandan, Solvec in Narvacan, San Esteban, and Santiago. The boats calling at these ports usually come from Manila, Dagupan, Aparri, Currimao, and Gabu in Laoag.

Dagupan in Pangasinan Province, Manila, San Fernando in La Union Province, and Laoag in Ilocos Norte are the most common markets for exports of the province, such as maguey, furniture, native cigars, slippers, coconuts, and salt.

Cultural development and improvement.—The Bureau of Education operates primary and elementary schools, a public high school in Vigan with branches in Candon and Narvacan and a provincial trade school in Vigan. Besides these public schools there are private high schools in Magsingal, Vigan, Narvacan, and Tagudin. Two private colleges, the St. Williams College and Colegio de Immaculada Concepcion, both located in Vigan, are junior colleges. Every town has a Roman Catholic church and a few Protestant churches in some of the towns.

The health and welfare of the inhabitants are taken care of by the Bureau of Health which operates a provincial hospital in Vigan and public dispensaries, puericulture centers and charity clinics in almost all the towns of the province. In addition to these there are dentists, teacher nurses, and doctors employed by the government to look after the health of the pupils, students, and teachers. There are several private practitioners besides.

Industries.—Agriculture is the major industry in Ilocos Sur. Due to the insufficiency of arable land to support the dense population, home industries are well developed. Wooden furniture such as beds, tables, and chairs, and carved images make the town of San Vicente famous. Tables, dressing cabinets, and chairs are manufactured in Vigan. Saddles, harnesses, slippers, shoes, and ornamental articles of gold and silver are made in Bantay; cigars are exported, usually to Dagupan, from Sta. Catalina; pottery is well developed in Vigan.

Bolos and knives are manufactured in Santa; bricks are made in Sto. Domingo and earthen stoves in Cabugao. Stone mortars are exported from San Esteban. Salt is extracted from sea water along the shore and sold in the interior towns of the province and also in Ilocos Norte. Small trading or barter system is also resorted to by some of the people. During the dry season one often sees along the roads caravans of traders with coconuts, pottery, furniture, salt or other goods bound for the adjoining province of Ilocos Norte. These traders almost invariably barter their goods or wares with rice or palay. Blankets, towels, and cotton cloths are woven in several towns of the province. Fishing is not an important industry in any of the towns.

CLIMATE [1]

The climate of Ilocos Sur Province is characterized by two distinct seasons: a wet season from May to October and a dry season from November to April.

The normal monthly temperature during the year varies within a narrow range from 25.4°C. in January to 28.°C. in May at Vigan. The normal annual temperature, however, is 27°C. When compared with the other provinces in the western part of Luzon, the normal annual temperature at Vigan is a little lower than that of Laoag, which is 27.2°C. or that of San Fernando, La Union which is 27.1°C. The mean of the maximum temperatures recorded from 1903 to 1918 at Vigan is 35.8°C. and the mean of the minimum temperatures for the same period is 17.6°C. Such extremes of temperature are infrequent, however, occuring only at intervals of ten or fifteen years.

Ilocos Sur belongs to the first type of rainfall distribution. Out of a normal annual rainfall of 2,451.5 mm., 2,366.2 mm. or 96 per cent falls during the wet season from May to October. During the sixth-month dry season from November to April only 85.3 mm. or 4 per cent of the annual rainfall falls, and the average number of rainy days during the period is 8.4 days as against 89.4 days for the wet season. Like other provinces of Western Luzon, which fall under the first type of rainfall, the rainfall during the wet season falls in torrents and is very much in excess of the needs of the crops. Most of this excess water is wasted and it also accelerates soil erosion besides.

[1] Data in this section are taken from Census of the Philippines, 1918.

In November, which is the heading period and most critical period in the life of the regular rice crop, the rainfall is sometimes insufficient to mature the crop and as a result in such years the crop is cut for livestock feed. Few secondary crops are grown during the dry season, the most common of which are corn, tobacco, sweet potatoes, mungo, peanuts, onions and vegetables such as tomatoes, eggplants, and beans. Such crops are usually planted during October to December, when there is still enough moisture in the soil thus giving the crops enough time to mature before the onset of the peak of the dry season. The farmers usually resort to manufacture and trade during the dry season when there is little or nothing to do on the farm.

The soil as well as the climate is especially adapted to the growth of maguey, a fiber crop, which formerly constituted the principal export. The growing of indigo was once a thriving industry but it is now non-existent because of the manufacture of cheap dyes which are imported into the Philippines.

The relative humidity is usually high with the highest of 85.3 per cent in August and the lowest of 71.4 per cent in February. The province of Ilocos Sur is one of the typhoon-swept regions of the Philippines, and sometimes the damage is great on the crops.

Table 2 shows the mean monthly and annual rainfall and average monthly and annual number of rainy days of four towns of Ilocos Sur Province.

TABLE 2.—*Mean monthly and annual rainfall and average monthly and annual number of rainy days of four towns of Ilocos Sur Province* [a]

Month	Tagudin		Candon		Vigan		Sinait	
	Rainfall (mm.)	Number of rainy days	Rainfall (mm.)	Number of rainy days	Rainfall (mm.)	Number of rainy days	Rainfall (mm.)	Number of rainy days
January	3.5	0.7	4.3	0.8	4.1	0.6	6.7	0.8
February	2.5	0.5	6.5	0.9	6.4	1.0	4.7	0.6
March	6.8	1.1	9.0	1.2	8.7	0.8	7.8	0.5
April	11.2	1.2	13.8	1.6	18.6	1.8	12.6	1.0
May	125.6	9.5	196.8	9.8	210.4	10.0	232.5	10.3
June	358.6	17.3	360.8	16.7	373.5	18.2	366.0	15.8
July	588.9	19.8	705.5	20.6	718.4	21.5	664.7	19.3
August	596.1	19.8	727.1	20.7	764.3	21.6	615.3	19.0
September	266.1	12.8	380.4	16.3	437.5	17.2	228.4	11.4
October	123.1	8.0	169.2	8.1	158.1	8.5	107.9	5.2
November	46.1	4.2	51.3	4.0	29.6	3.0	36.4	2.0
December	6.9	1.7	7.9	1.3	10.7	1.5	15.5	0.9
Total	2,135.4	96.6	2,632.6	102.0	2,739.8	105.7	2,298.5	86.8

[a] Data obtained from Census of the Philippines, 1918. Bureau of Printing, Manila.

TABLE 3.—*Mean monthly extreme and normal temperature for Vigan, Ilocos Sur.* [a]

Month	Maximum temperature	Average temperature	Minimum temperature
	°C	°C	°C
January	32.7	25.4	18.5
February	32.9	25.6	18.6
March	34.2	26.9	19.8
April	34.9	28.1	22.0
May	35.2	28.6	22.5
June	34.3	28.1	22.2
July	33.3	27.2	22.1
August	32.7	26.8	22.1
September	32.8	27.0	22.6
October	34.0	27.2	21.9
November	34.4	26.9	20.6
December	32.9	26.1	19.5
Monthly average	33.7	27.0	21.0

[a] Data obtained from Census of the Philippines, 1918.

AGRICULTURE

Agriculture has been and still is the chief industry of the people. It furnishes nearly all of the food of the people and feed for livestock. The intensive development of agriculture began, however, toward the first half of the nineteenth century when the planting of cotton, tobacco, and indigo was greatly encouraged. Much of the indigo was exported to other provinces at so high prices that many of the people became prosperous. The importation of cheaper dyes from Germany however, later ended the development of this once flourishing industry.

The people have to depend a great deal on diversified farming as a means of livelihood because of the limited agricultural area. The principal crops are rice, corn, cotton, maguey, tobacco, and sugar cane. Various kinds of vegetables and fruit trees, beans, sweet potatoes, peanuts, yam beans, and onions constitute the secondary crops. In 1948, the province had under cultivation 32,163.12 hectares, or 11.97 per cent of the total area of the province. The areas planted to the ten leading crops are shown in table 4.

Rice, or palay, is grown throughout the province, but the greater bulk of the supply is produced in the coastal towns. The area devoted to this crop in 1939 was 25,945.27 hectares with a production of 469,553 cavans valued at 1,453,110 pesos. The five leading rice-growing towns are Narvacan, Cabugao, Candon, Magsingal, and Sinait.

The standard varieties of lowland rice grown in the province are Raminad, Elon-elon, Wagwag, Seraup Keehil, Apostol,

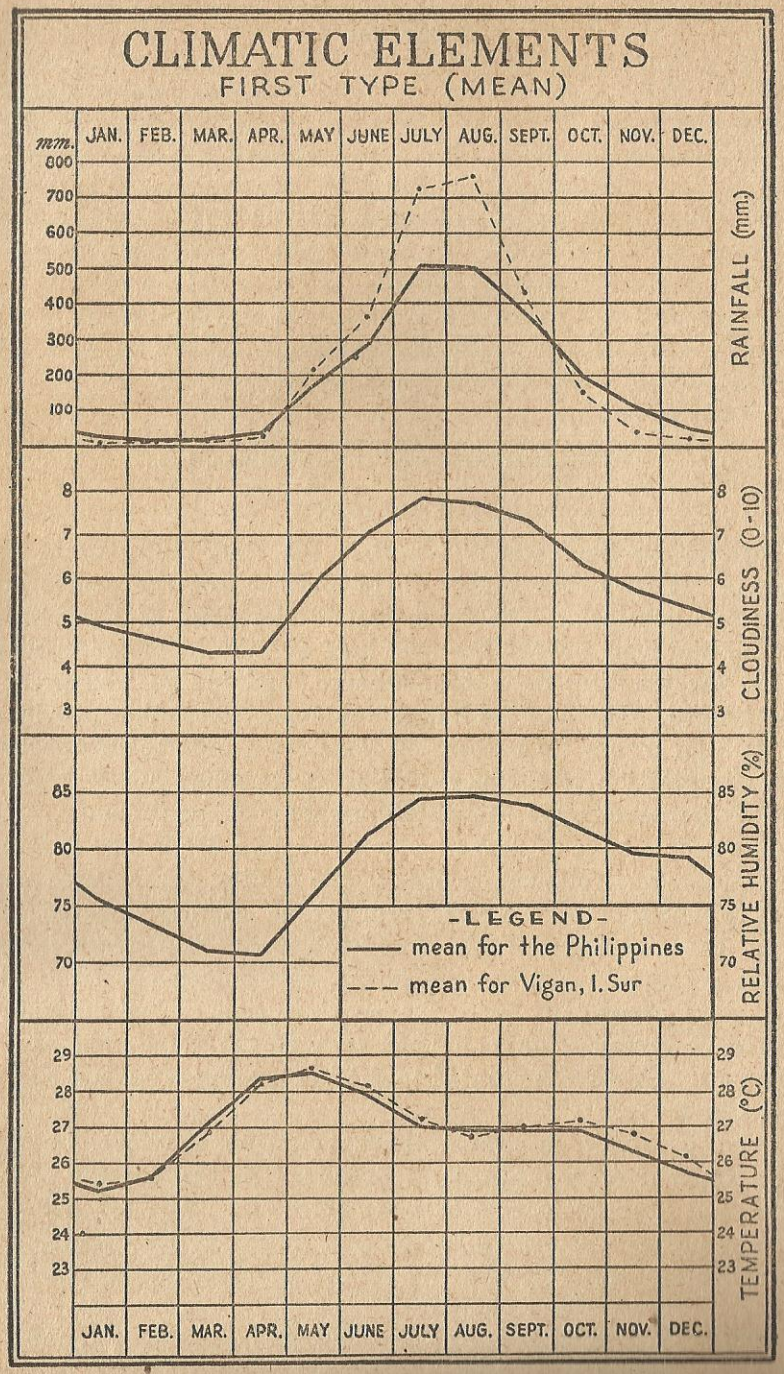

FIG. 3. Graph of the First Type of Climate in the Philippines and of Vigan, Ilocos Sur.

TABLE 4.—*Area planted, total production, average production per hectare, and value of produce of the leading crops grown in Ilocos Sur.*[a]

Crop	Area planted in hectares	Total production	Average production per hectare
Rice	26,995.87	406,005 cavans [b]	15.0 cavans
Corn	5,299.61	60,671 cavans [c]	11.45 cavans
Sugar cane	2,303.02	48,486 tons [d]	21.05 tons
Sweet potato	1,258.01	1,365,875 kilos	1,086.00 kilos
Tobacco	868.48	271,820 kilos	313.15 kilos
Maguey	731.32	694,712 kilos	949.94 kilos
Coconut	897.62	454,384 nuts	602.00 nuts

[a] Data obtained from Summary Report on the 1948 Census of Agriculture 1948. Bureau of Printing, Manila. (1952)
[b] One cavan of palay weighs 44 kilos.
[c] One cavan of shelled corn weighs 58.5 kilos.
[d] Tons of sugar; one ton weighs 1,000 kilos. Figure was furnished by the Elizalde Sugar Central at Candon, Ilocos Sur.

Fortuna, Guinangang, and Khao-Bai-Sri. The yields range from 25 to 45 cavans of palay per hectare. The local varieties commonly grown are Capigued, Namluan, Binerong, Mestizo, and Viray, with yields ranging from 23.5 to 44 cavans per hectare. Most of these local varieties are bearded.

Several communal irrigation systems exist irrigating around 7,896 hectares. The Tagudin Irrigation System, which is government-owned and operated, irrigates about 900 hectares.

The *palagad* system, or the growing of rice during the dry season, is practiced in Tagudin where irrigation water is available during the dry season. The *palagad* rice varieties commonly planted are Guinangang, Malapay, Pinas, Gonogong, and Bontayog. The average yields range from 20.5 to 35 cavans per hectare.[a] This crop is usually planted in February and March after the harvest of the first crop.

Upland rice is grown in the rolling and elevated areas, in caingins. The varieties commonly grown are Saigorot, Tui, San Fabian, Macaraniag, and Malapay, and the yield ranges from 11 to 24 cavans per hectare. The towns leading in the production of this crop are Suyo, Sta. Catalina, Sta. Cruz, San Vicente, Tagudin, Vigan, San Ildefonso, and Magsingal.

Harvesting is invariably done by hand, panicle by panicle, with the use of the *yatab*. The varieties are mostly bearded, which stand rough handling, and hence are stored in bundles in granaries. The province is not self-sufficient in this cereal and has to import some of her needs from Ilocos Norte and Pangasinan.

[a] Data furnished by the Office of the Provincial Agricultural Supervisor, Vigan, Ilocos Sur.

Corn is second to rice in importance as the staple crop of the people. It is grown throughout the province in lowland as well as in upland areas. Usually two crops are grown in a year. In 1948, the area devoted to the crop was 5,299.61 hectares, yielding 60,671 cavans. The rainy season crop is harvested as grain, but the greater part of the dry season crop is usually fed to livestock. This latter crop is planted close together and cut at the flowering stage for soilage. The towns leading in the production of corn are Sta. Cruz, Narvacan, Tagudin, Sta. Maria, and Lapog.

Sugar cane is the third most important crop of the province from the standpoint of area planted and second to rice in value of produce. In 1948, the area planted to the crop was 2,303.02 hectares. Most of the farmers grow sugar cane which they mill with the native wooden crushers. The Elizalde Sugar Central at Candon, the only one of its kind in the province, mills canes for planters in the towns of Santiago, Candon, Sta. Lucia, and Sta. Cruz. It has a daily capacity of 300 tons of cane. The centrifugal sugar produced by the central is all exported. The panocha and molasses, which are made locally, are often bartered with palay in the neighboring province of Ilocos Norte. The most common varieties planted are the POJ 2878 and PSA 14. Fertilization is practically unknown, hence the yield per hectare is very low.

Sweet potato, or camote, grows best on the San Manuel silt loam. In the lowland areas the crop is usually planted as a secondary crop after the regular rice crop is harvested. The towns that produce the greater part of the crop, however, are the upland towns of Cervantes, Suyo, Sugpon, and Sigay. In those places, it makes up an important supplement to the food of the people due to the insufficiency of the rice supply. The varieties planted are Inube and some local varieties named Borsosanna, Carodicod, and Cadaoyan.

Tobacco is a crop that is commonly grown in home gardens for home consumption, but is also planted in the fields for commercial purposes. It usually follows the rice crop and is commonly planted on the San Manuel silt loam and partly on the Bantog clay loam. The towns of Cabugao, Sinait, Sta. Cruz, and Lapog are the largest producers of tobacco. A large portion of the crop is sold in the towns of Sta. Catalina and San Vicente where it is manufactured into cigars.

Maguey is the most important fiber crop grown in the province. It is suitably grown on the hilly and upland areas of the

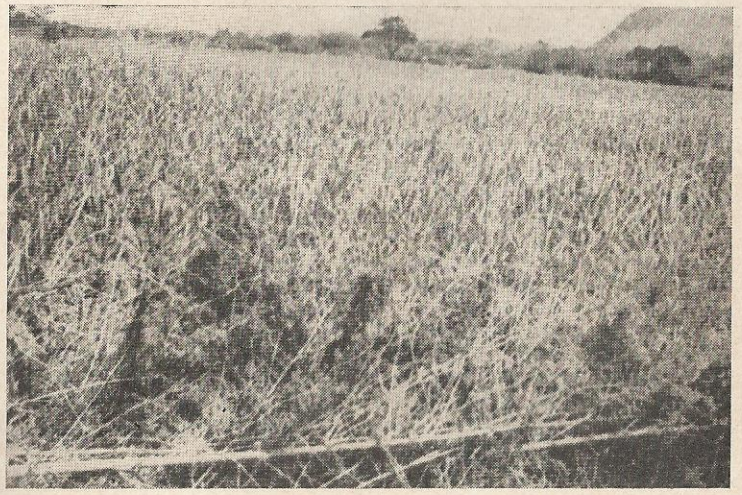

Fig. 1. Sugar cane is the third most important crop of the province. The towns of Santiago, Candon, Sta. Lucia, and Sta. Cruz are the large producers of the crop.

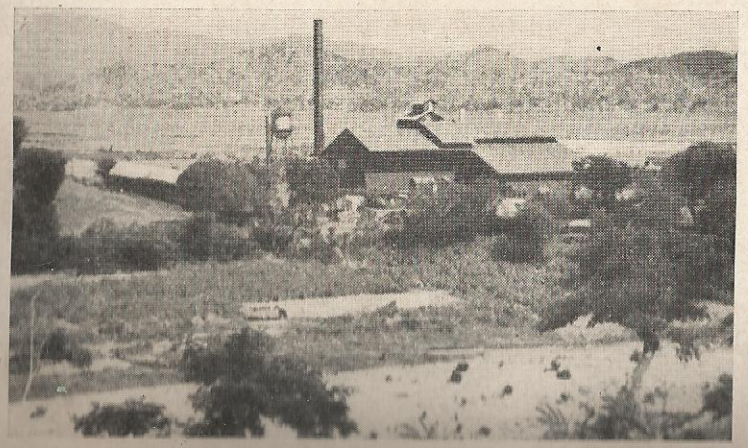

Fig. 2. The Elizalde Sugar Central at Candon. It has a daily capacity of 300 tons of cane.

Bauang and Bantay series. The fiber is made into ropes and it provides a home industry for the people during the dry season after the yearly rice harvest. The ropes are usually sent to Pangasinan and Manila. In 1939, the area planted to the crop was 731.32 hectares, yielding 694,712 kilos of fiber valued at 51,437 pesos. The five towns leading in the production of the fiber are Magsingal, Sinait, Sto. Domingo, Narvacan, and San Esteban.

Coconuts are grown along the coastal towns, but the greatest number is found in the towns of Candon, Sta. Cruz, Sta. Lucia, San Esteban, and Santiago in the order named. The greater portion of the nuts is sent to Ilocos Norte and the rest is for home consumption.

The vegetable crops of the province include eggplants, radishes, cabbage, squash, upo, patola, ampalaya, kondol, and tomatoes. They are mostly grown in home gardens, but when prices are high field plantings are also made.

The principal root raised in the province are cassava, gabi, tugui, ubi, arrowroot, potato, and ginger. The total area planted to these crops in 1939 was only 98.59 hectares, with a total value of produce of 19,242 pesos.

The important fruit trees grown in the province are breadfruit, jackfruit, bananas, mangoes, chico, oranges, pummelo, papaya, soursop, atis, santol, avocado, caimito, and pineapple. Coffee and cacao and a few other fruit trees are grown on a small scale.

AGRICULTURAL PRACTICES

Throughout Ilocos Sur Province the farmers still practice the centuries-old method of farming wherein the native plow and harrow are the principal implements of tillage and the carabao the main source of "power". The use of farm machinery and commercial fertilizers is practically unknown. Because of these and some other reasons the production in the different crops is slowly but surely diminishing year after year. The farmers, however, are now aware of the decreasing productivity of their soils and are confronted with the problem of maintaining or increasing the present level of production or face starvation.

The farmers have learned and are practicing simulated crop rotation, intercropping, application of animal manure, and the

planting of soil-building crops like indigo. After the regular rice crop, which is harvested from November to January, secondary crops such as corn, sweet potatoes, peanuts, beans, tobacco, cotton and vegetables are planted. Indigo, a legume, is commonly planted in between rows of corn, beans or tobacco and plowed under before the rainy season sets in. In lieu of commercial fertilizers the farmers apply carabao and cow manures during the dry season.

All the farmers in the province use the dry seedbed for their seedlings of lowland rise in contrast with the ordinary wet seedbed commonly used in other regions of the Philippines. The seeds are sown in hills close together, usually four to five inches apart each way.

The planting of rice in paddies in the lowland areas has incidentally reduced soil erosion to the minimum. Irrigation of the rice crop is practiced wherever water is available, and this has resulted in the formation of several communal irrigation systems. The lone government-owned irrigation system at Tagudin irrigates around 900 hectares. This system is also used to irrigate the *palagad* rice grown in this municipality.

In the upland and hilly areas where the lands have been denuded of their forest cover, the use of soil-conserving practices is imperative if the soils are to be saved from further erosion. Partly to remedy this ill, the government operates the Caniao Forestry Station for the purpose of reforesting the once forested hills of the province.

LIVESTOCK AND LIVESTOCK PRODUCTS

The livestock industry is not well developed due to the limited area of pasture land and the little amount of livestock feed and forage crops grown. The long dry season limits the planting of secondary crops which could be used to feed poultry and hogs raised on a large scale. Carabaos, cattle, and horses are the most important animals raised. The carabao is the chief work animal on the farm and is often a good source of milk. Most of the farmers have bulls (cattle) which they usually use for pulling carts when they travel to neighboring towns or provinces to trade. The horses are used mostly for pulling the native *calesas* or *caretelas* used in transportation both within and outside of the province. Many goats are raised in comparison with the number of other livestock. Hogs and poultry are raised both on the farms and in backyards, the largest producers being the towns growing the most corn or palay.

The livestock and poultry population of Ilocos Sur in 1939 is given in table 5. Like other provinces, the livestock industry of the province suffered much during the Japanese occupation.

TABLE 5.—*Kinds, number, and value of livestock and poultry in Ilocos Sur Province in 1948.*[a]

Kind of livestock and poultry	Number
Carabao	33,267
Cattle	20,280
Horses	2,238
Hogs	41,222
Chickens	243,955
Ducks	2,566

[a] Data from Census of the Philippines: 1948, Agriculture.

FARM TENURE

Around 16 per cent of the area of the province is in farm land. In 1948, according to the Philippine census, there were 25,882 farms in the province. Of the total number of farms, 9,391, or 36 per cent, were less than 1 hectare in size, and 15,629, or 60 per cent, were from 1 hectare to less than 5 hectares, making a total of 25,020 farms, or 96 per cent, which were less than 5 hectares in size. The average size of the farms was 1.63 hectares. The average farmer has to diversify and intensively cultivate his land in order to eke out a living.

In 1940, 34.4 per cent of all the farms were operated by owners; 31.7 per cent by part owners; 26.7 per cent by share-tenants; 0.03 per cent by share-cash tenants; and 0.08 per cent by cash-tenants. Most of the rentals are on a share-crop basis, which is usually one-half of the total yield.

The investment on the average farm consists ordinarily of farm implements, such as plows, harrows, carts, and sleds and work animals like carabaos or bulls. No farm machinery is used in the province. The plow commonly used is the old-type native plow made of wood with iron plowshare and moldboard. The farmers use spike-toothed harrows made of either wood or bamboo. Table 6 shows the number and value of farm equipment and work animals in the province.

TABLE 6.—*Number and value of farm equipment and work animals in Ilocos Sur.*[a]

Kind of equipment	Number	Value in pesos
Plows	34,521	491,661
Harrows	27,074	
Carts	9,862	
Sleds	18,592	
Work animals[b]	32,881	[c] 1,085,073

[a] Data obtained from Census of the Philippines: 1939.
[b] Carabaos only and does not include bulls (cattle).
[c] Value is approximate only.

The greater number of farms in the province are rice farms but other types of farms also exist. Of the 25,882 farms, 21,587, or 83.4 per cent, are rice farms; 826, or 3.1 per cent are corn farms; 434, or 1.7 per cent are sugar cane farms; 338, or 1.3 per cent, are coconut farms; 160, or 0.6 per cent, are root crop farms, and the rest are fruit, tobacco, vegetable, and other types of farms. In the above classification, a farm is classified under a certain type if the area planted to the crop was equal to 50 per cent or more of the cultivated land of the farm.

SOIL SURVEY METHODS AND DEFINITIONS

Soil survey is an institution devoted to the study of soil in its natural habitat. It consists primarily of (1) the determination of the morphological characteristics of soils, (2) grouping and classifying them into individual units according to their characteristics, (3) their delineation on the map, and (4) the description of their characteristics in reference to the growth of plants and their relationship to agriculture and other activities of man.

The soils, their landscape and underlying formations are examined systematically in as many locations as possible. Borings with the soil auger are made, test pits are dug, and exposures such as those found in roads and railroad cuts are studied. Each excavation, road or railroad cut exposes a series of layers or horizons called collectively the soil profile. These horizons of the profile as well as the parent material beneath this profile are studied in detail and the color, structure, porosity, consistency, texture, and content of organic matter, roots, gravel and stones are noted carefully. The reaction of the soil and its contents of lime and salts are determined by simple tests. The drainage, both external and internal, and many other external features such as relief of the land, climate, natural and artificial

cultures 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) phase. When two or more of these principal mapping units are in such intimate or mixed pattern that they cannot be clearly shown on a soil 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 mountainsides are called (5) miscellaneous land types. Areas that are inaccessible like mountains and great forest lands and whose classification is of no agricultural importance for the present are classified as (6) undifferentiated soils.

A *series* is a group of soils that have the same genetic horizons, similar important morphological characteristics and having similar parent material. It comprises soils having essentially the same general color, structure, consistency, range of relief, natural drainage condition and other important external and internal characteristics. In the establishment of a series, a geographic name is selected, usually that of the locality where the soil was first identified. For example, the Bantay series was first found and classified in the vicinity of Bantay, a municipality near Vigan, Ilocos Sur Province.

A soil series has one or more *soil types*, defined according to the texture of the upper part of the soil, or the surface soil. The class name sand, loamy sand, sandy loam, silt loam, silty clay loam, clay loam, or clay is added to the series name to give the complete name of the soil. For example, Bantay loam is a soil type of the Bantay 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 unit of mapping. Because of its certain specific characteristics it is usually the unit to which agronomic data are definitely related.

A phase of a soil type is a variation within the type, differing from the soil type only in some minor features, generally external, that may be of special practical significance. Differences in relief, stoniness, and extent or degree of erosion is shown as phases. A minor difference in relief may cause a change in agricultural operation or change in the kind of machinery to be used. The phase of a type with a slight degree of

accelerated erosion may present different fertilizer requirements and other cultural management from the real soil type. A phase of a type due mainly to degree of slope and amount of gravel and stones on the surface soil are usually segregated on the map if the area can be delineated.

A *soil complex* is a soil association composed of such intimate mixture of series, types, or phases that cannot be indicated separately upon a map. This is mapped as a unit and called a *complex*. If in an area there are several series, such as Sara, Sta. Rita, Alimodian and others that are mixed together, the two dominant series must bear the name of the complex, as Sara-Sta. Rita complex or Sara-Alimondian complex as the case may be. If there is only one dominant constituent, that series or type bears the name of the complex as Sara complex or Alimodian 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, usually composed of two or three soils men, maps the area and delineates the various soil types, phases, complexes, and miscellaneous land types. All natural and artificial features found in the area are indicated on the soil map. These are trails, roads, railroads, bridges, telephones and telegraph lines; barrios, towns, and cities; rivers and lakes; prominent mountains, and many others.

SOILS AND CROPS

A wide variety of metamorphic, dioritic and basic intrusive and volcanic rocks underlie the mountains in the southeastern part of the province, while gently folded sandstones, conglomerate, and shale mainly underlie the hills and foothills along the entire length from north to south. In some of the hills limestone or gravels are sometimes interbedded with the shale or sandstone, which are variable in thickness. Through the action of weathering forces, both physical and chemical, the exposed upper parts of the various rocks have broken down into soft material which in turn has been acted on by soil-forming forces and converted into soils differing in physical characteristics and chemical composition.

Due to the varying degree of resistance of the different rock formations to the forces of weathering, the lay of the land varies

from gently undulating to rugged, irregular and accentuated relief. The harder rocks such as the diorites, andesites, and some other volcanic rocks are responsible for the mountains, and the softer rocks such as the shale and sandstones give rise to the more gentle formations of the hills and foothills.

The fine material brought down from the higher lands into the lower areas by the streams and deposited along their courses have developed into the mellow, friable and fertile soils along the rivers and the clayey, deep lowland rice soils of the plain and valley.

The steeper slopes of the mountains consequently result in thinner soils; in places are outcrops of the underlying bedrock. The more gentle slopes of the hills and foothills produce the deeper soils of the Bauang and Bantay series.

Ilocos Sur has three distinct topographic units, namely: (1) the coastal plain, (2) the intermediate uplands, and (3) the mountains.

The soils of the plain are represented by the Bantog, San Manuel, and Umiñgan series and two miscellaneous land types, beach sand and riverwash. There is no marsh or swamp of any kind in the province. The soils of the intermediate uplands are represented by the Bantay, Bauang, and Cervantes series, while those of the mountains by two miscellaneous land types, the mountain soils undifferentiated and rough stony land.

In the succeeding pages the soils of Ilocos Sur are described and their agricultural relations are discussed. Their distribution and location are indicated on the accompanying soil map, and their hectarage and proportionate extent are given in table 7.

TABLE 7.—*Area, per cent and present use of the soil types in Ilocos Sur*

Type of soil	Area (Hectares)	Per cent	Present use
Beach sand	3,023.85	1.2	No crop grown on it. May be good for coconuts.
Riverwash	2,896.65	1.0	Unfit for any crop.
San Manuel silt loam	27,056.10	10.1	Good crops of lowland rice, corn, sweet potatoes, tobacco, yambean, sugarcane, mungo, and vegetable are raised on it.
Bantog clay loam	17,029.35	6.4	Excellent for lowland rice. Corn, tobacco, mungo, and few vegetables are also grown.
Umiñgan loam	1,482.25	0.6	Lowland rice is grown in the area below Cervantes town; corn and tobacco are raised in Santa.
Bantay loam	15,598.80	5.8	Maguey, cotton, tobacco, sugarcane, and upland rice are grown.
Bauang clay loam	57,486.70	21.1	Few areas are used for upland rice; some areas are planted to maguey.
Cervantes loam	37,880.62	14.1	Mostly grassland. May be good for pastures
Mountain soil, undifferentiated	97,147.60	36.3	Suited for forestry purposes.
Rough stony land	9,151.07	3.4	Should be reforested.

SOILS OF THE PLAIN

The soils of the plain are derived from alluvial materials brought down from the hills and mountains in the eastern part of the province. Like other plain soils, they constitute the most productive soils in the province, hence they support the greater part of the population.

All these soils manifest slight profile development; they are usually poorly to moderately well drained and of medium to heavy textures, ranging from fine sandy loam to light clay loam. The color ranges from light brown, brown, grayish brown to dark grayish brown.

The soils in this group belong to the Bantog, San Manuel, and Umiñgan series. Small areas of beach sand and riverwash, both of which are miscellaneous land types, are also included in this group. These two miscellaneous land types are non-agricultural.

San Manuel Series

This series comprises the most extensive and one of the best soils of the plain. The soils consist of light brown to light brownish gray surface soils 25 to 35 centimeters deep and brown to grayish brown subsoils reaching a depth of 100 to 110 centimeters from the surface. The substratum is yellowish brown to reddish brown fine to medium sand. Generally, these soils are well drained as they usually occur along rivers. They are developed from alluvial material washed down from the higher areas underlain by both igneous and sedimentary rocks.

The San Manuel soils are considered to be good for lowland rice and are highly valued by farmers. Most any crop grows on these soils so long as there is enough moisture, or otherwise provided with irrigation water. The areas covered by this series are all under cultivation with lowland rice as the main crop.

These soils total 27,056 hectares, and only one type, San Manuel silt loam, is mapped.

San Manuel silt loam.—Among the lowland soils of the province, San Manuel silt loam is the most extensive and one of the most productive.

The soil consist of light brown to grayish brown surface soil and a light brown to brownish gray subsoil. The substratum varies from yellowish brown to light reddish brown fine sandy loam to medium sand.

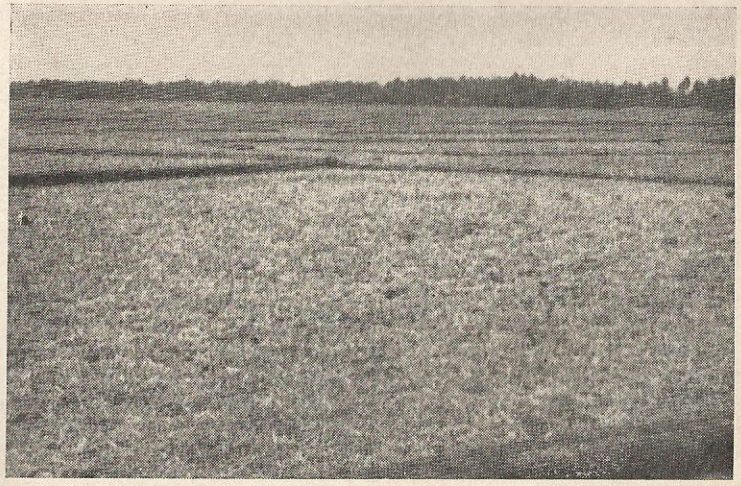

Fig. 1. The San Manuel silt loam occupies extensive areas devoted to lowland rice.

Fig. 2. Corn is widely grown as a secondary crop on the San Manuel silt loam.

The parent material is of recent alluvial deposition with the several rivers being responsible for its accumulation. The series occurs usually along rivers and streams, and some areas are subject to floods during the rainy season.

Most of the area covered by this type is planted to lowland rice as the main crop, with corn, sweet potatoes, peanuts, yam-bean, mungo, vegetables, and tobacco raised as secondary crops.

The native vegetation in the uncultivated portions usually consist of bamboo clumps and moderately dense second-growth forest along streams and rivers, and talahib and agiñgai in some places.

Only one soil type, San Manuel silt loam, is mapped under this series.

A typical profile of this type shows the following characteristics:

Depth of soil (cm.)	Characteristics
0–35	Surface soil, pale brown to brown silt loam to silty clay loam. Coarse granular and brittle when dry but slightly plastic when moist. Fields devoted to lowland rice crack during the dry season. Wavy gradual boundary into lower layer.
35–75	Upper subsoil, brown to brownish gray silt loam with mottlings of yellowish brown. Friable and fine to medium ganular structure. Wavy, clear boundary into lower layer. Roots penetrate readily.
75–100	Lower subsoil, yellowish brown fine sandy loam, slightly compact and gritty.
100–150	Yellowish brown to light reddish brown fine sandy loam to fine sand. Depth of this layer is variable.

This type occurs in widely scattered areas in the province, but the largest contiguous area occurs in the plain from Vigan northward up to midway between the towns of Lapog and Cabugao. It covers a total of 27,056 hectares, or 10 per cent of the area of the province.

San Manuel silt loam occupies nearly level to level areas with the elevation ranging from 50 feet to 100 feet above sea level. Drainage, both external and internal, is fair to good despite the nearly level topography. A few low areas, especially those devoted to lowland rice, have slow external drainage.

Lowland rice is the main crop grown on this soil, with an average yield of 35 cavans of palay per hectare more or less, depending upon the variety planted and the amount of available water during the growing season. Corn is usually planted after the rice crop, but in low places, especially along rivers, vege-

tables like eggplant, tomatoes, patola, ampalaya, and upo are grown. Sweet potatoes, yambean, onions, tobacco, and peanuts are some of the field crops raised. Some portions of this type are planted to sugar cane.

Some of the fields which are intensively cultivated, such as those devoted to vegetables, sweet potatoes, and yambeans, are fertilized with cow or carabao manure. Green manuring with indigo is also practiced. In some cases, ordinary household ash is also applied to increase or maintain productivity.

An analysis of the soils indicate that the pH of San Manuel silt loam is very mildly alkaline. From this standpoint alone, rice and tobacco cannot be expected to give maximum yields, the optimum range for these two crops being pH 5.5 to 6.1. The available nitrogen, phosphorus, and potassium contents of the soil all appear to be lower than the amounts considered ordinarily sufficient for the needs of most crops. This is especially true with respect to phosphorus. Under Philippine conditions 30 to 40 parts per million may be a reasonable minimum requirement for a good crop of rice; the San Manuel silt loam contains only 23.5 parts per million of this element. In the case of nitrogen and potassium the deficiencies are not so great.

The nearly level to level topography of this soil, together with its high water-holding capacity, renders it resistant to erosion. Incidentally, the use of levees, so necessary in lowland rice culture, materially helps in the control of erosion.

Bantog clay loam.—As mapped in Ilocos Sur, Bantog clay loam constitutes the second most extensive lowland soil. It is a dark-colored soil with flat relief. The surface soil consists of brown to dark brown or dark grayish brown clay loam to clay. It is slightly sticky and plastic when moist and forms hard clods when dry. During the dry season this soil cracks forming massive blocks with irregular cleavage. It has a medium to coarse blocky structure with a depth ranging from 25 to 30 centimeters. It merges imperceptibly into a dark brownish gray, coarse blocky, stiff clay up to a depth of 55 centimeters. The lower subsoil is light brown to yellowish brown, columnar clay loam. The substratum is yellowish brown to light reddish brown, sticky and plastic silty clay loam to clay.

This soil, like the San Manuel silt loam, is widely scattered in several parts of the plain, but the large areas of the type are in the towns of Narvacan, Cabugao, Candon, Sta. Maria, Sta. Lucia, Banayoyo, and Tagudin. It covers an area of 17,029

Fig. 1. Profile of Bantog clay loam. Note its depth and massive structure.

Fig. 2. A field of tobacco on Bantog clay loam. The rolling area in the background is Bauang series.

hectares, or 6.3 per cent of the province. Generally, this soil occupies lower elevations than the San Manuel silt loam.

This soil is developed from recent alluvium brought down from the nearby hills and foothills. The dark color may be attributed to the imperfect drainage as a consequence of the flat relief and heavy subsoil. Another possible contributory cause is the presence of coralline limestone in some of the hills. Such limestone usually gives rise to dark soils in regions having a distinct wet and dry season.

Lowland rice is the principal crop raised on this soil, with an average yield ranging from 40 to 45 cavans of palay per hectare. It is the best rice land in the province. Mongo, beans, and corn are the most common secondary crops planted after the regular rice crop is harvested. In the town of Tagudin, where irrigation water is available, *palagad* rice is planted. Tobacco is planted on the slightly higher areas of this type of soil.

This soil is being used in a manner similar to the other soils of the province. After the regular rice crop is harvested in December or January, the planting of the secondary corps usually follow without any further treatment or addition of soil amendments and fertilizers. Rice being a grain crop and as such is usually sold on the farm, the continuous practice of such a system of management leads to the depletion of the soil, especially in so far as phosphorus is concerned. The return of some, if not all, of the plant nutrients removed by the crop must be done if the fertility of the soil is to be maintained. This could be achieved through the addition of barnyard manure and the use of green manures, especially legumes if possible, supplemented by the application of soil amendments and fertilizers. The kinds and amounts used will depend upon the chemical analysis of the soil. The danger from erosion is at a minimum because of the flat or nearby level topography of the soil.

Of the 17,029 hectares under this type, about 900 hectares are irrigated by the Tagudin irrigation system, and several hectares are irrigated by communal irrigation systems run by the farmers themselves. In both types of systems open ditches are used. The flow of water is continuous and is maintained at a certain depth in the rice paddies according to the desire of the individual farmers. When a farmer drains his field he just cuts off the supply of water and lets the field drain naturally.

Of all the soils of Ilocos Sur, the Bantog clay loam has the highest pH (7.38), which is just slightly on the mildly alkaline side. Like the San Manuel silt loam, considering soil reaction alone, this soil cannot be expected to give maximum yields for rice or tobacco without the pH being lowered. In spite of unfavorable reaction, this soil is still the best rice land in the province. The deleterious effects of the adverse pH must be lessened or offset by some other factor in the soil in some way. As for available nitrogen and potassium, the soil seems to contain just barely sufficient amounts of these elements for the needs of crops. In phosphorus, however, it has the lowest among all the soils of the province. This is very significant when the role of phosphorus in the formation of grains is considered, the soil being primarily devoted to the raising of rice.

As regards erosion, it is an erosion-resistant soil mainly because of its level or nearly level topography and, secondarily because of its being used for the growing of lowland rice, which makes use of levees to hold water in the paddies.

Umiñgan sandy loam.—This series was established in Pangasinan Province, but it is also found in the adjoining province of Nueva Ecija. The soils of the Umiñgan series consist of light brown, yellowish brown to brown surface soil and subsoil. The lower subsoil contains plenty of gravels and stones. Sometimes this layer reaches a thickness of around one meter in certain places. Below this gravelly layer is another zone of gravel or stone-free soil. Only one soil type is mapped under this series, the profile of which shows the following characteristics:

Depth of soil (cm.)	Characteristics
0–20	Light brown to brown structureless, loose, fine sandy loam to sandy loam. Few gravels present in this layer in eroded areas. Diffused smooth boundary into lower layer. Easy root penetration.
20–40	Friable and structureless sandy loam lighter in color than surface soil. Clear smooth boundary into lower layer.
40–100	Layer of gravels and stones. This layer is a meter or more thick in some places. Below this layer is a layer of gravel and stone-free soil.

This type occurs in the small alluvial plain below the town of Cervantes in the southeastern part of the province and also

along the highway from the town of Santa northward up to Banaoang barrio near the Abra River gap. It covers a total of 1,432 hectares, or 0.5 per cent of the province.

This soil has a nearly level to gently undulating topography. Drainage, both external and internal, is adequate, and it even tends to be so excessive that moisture retention has become the problem on this soil.

The land in Cervantes is used mainly for lowland rice, with corn and vegetables as secondary crops, but the same kind of soil found in Santa is devoted mostly to corn with sweet potatoes and vegetables as secondary crops. Compared with the Bantog clay loam and San Manuel silt loam, the Umiñgan sandy loam is an inferior soil. The gravelly layer is the undesirable feature of this soil, because it renders the soil susceptible to drought.

This soil is developed from parent materials derived from recent alluvium.

The common vegetation of uncultivated areas of this type consists of scrubby growth of second-growth forest and few clumps of bamboos.

Due to the looseness of the surface soil, this type is slightly erodible in the sloping areas. In such places the surface soil is much thinner than the normal depth and the gravelly layer gets nearer the surface. If the crop-producing power of this soil is to be maintained, the organic matter content should be built up or increased by the use of barnyard manure or green manure supplemented by the addition of fertilizers or soil amendments. Its tendency to droughtiness may be overcome through the application of irrigation water where feasible.

Among the soils of the province, this type possesses one of the most favorable reactions for most crops (pH 6.47). Corn, peanuts, soybeans, sugar cane, sweet potato, and vegetables like onions, lettuce, and tomatoes and many other crops do best around this pH. It has, however, the lowest available nitrogen content (0.06 per cent) in comparison with the other soils of the province. The organic matter content then must necessarily be low also. Relatively, it is well supplied with available potassium (144 parts per million) and has a fairly adequate supply of phosphorus (97.6 parts per million) for the needs of most crops.

This soil is slightly susceptible to erosion. Its somewhat loose surface soil and subsoil, which permits fast penetration of water, is mainly responsible for its low erodibility. On the sloping areas, however, the use of correct soil-management and erosion-control practices is essential for the prevention of accelerated erosion.

MISCELLANEOUS LAND TYPES

Beach sand.—Although the soil map is primarily concerned with soils, other areas of land that are devoid of a definite soil must also be indicated. Beach sand is one such area mapped in Ilocos Sur Province. This type occurs in different places along the coast from the southernmost tip to the northern part of the province. It is found as narrow strips along the coast between the towns of Tagudin and Sevilla; from west of Sta. Lucia poblacion northward up to Tamurong Point midway between the towns of Candon and Santiago; from Pandan barrio south of Vigan up to west of San Vicente; two small separate areas west of Magsingal; and a small area northwest of Cabugao in the northern part of the province.

This beach sand consists of gray to light gray coarse sand to fine sand. Most of this type is bare, but in some places maguey is planted. Along the coast of the northern towns, salt is made or extracted from the beach sand by leaching it with salt water from the sea.

This type has very little agricultural importance for the present.

Riverwash.—This miscellaneous land type consists of those parts of the present stream bottoms that are frequently covered with water and subject to movement. The land consists of stony, gravelly, and sandy material that is generally bare and essentially useless for plants. The lands under this type occur along the lower courses of the Amburayan River in the southernmost part of the province and the Abra River, a few kilometers south of Vigan. Although the greater part of this type is bare, *kamachile* trees make up the most common vegetation in some places and few patches of *talahib* in others.

At present, this type is not important agriculturally, but a time may come when some of these stream bottoms may be suitable for cultivation.

SOILS OF THE INTERMEDIATE UPLANDS

The soils on the lower mountainsides and hills which comprise the intermediate upland soils, are light brown clay loams to loams. They are shallow and stony in some places depending upon the slope of the land and the nature of the vegetative cover.

The similarity of the soils in some of their properties is due primarily to the lone type of climate obtaining in the province and to the similarity of material from which they were formed. All the surface soils have acidic reactions and are medium in texture—generally silt loams to loams. They range in color from light brown to brown or reddish brown.

The Bauang soils are developed from sedimentary deposits of stratified shale, sandstone and, sometimes but rarely, conglomerates. The Bantay soils are derived from material originating from a thick mantle of shale with a little admixture of coralline limestone. The Cervantes soils are developed from material originating from igneous rocks.

Because of the unfavorable topography of these soils, only small portions of the more gentle slopes are cultivated. Their low fertility, however, renders them marginal for such use. The greater part of the area of these soils is more suitable for pasture.

Bauang Series

This series was first described and established in La Union Province, and the soils of this type in Ilocos Sur are extensions of the same formation in the former. As mapped in Ilocos Sur, it occupies the second largest area, being next to the mountain soils, undifferentiated group.

The soils of this series are characterized by light brown to light reddish brown, friable, coarse granular clay loam surface soils underlain by highly weathered stratified shale rock. The substratum consists of folded stratified shale, sandstone, or conglomerate with varying degrees of inclination of the strata. The depth of the surface soil varies a great deal depending upon the slope and degree of erosion in the area.

Upland rice and maguey are the most common crops planted on this series.

Only one type, Bauang clay loam, has been mapped under this series.

Bauang clay loam.—A typical profile of this type as found in Ilocos Sur has the following characteristics:

Depth of soil (Cm.)	Characteristics
0–30	Light brown to brown, friable, coarse granular loam to clay loam. In eroded areas the soil gets shallower and tends to be sandy in texture. Plenty of roots. Gradual boundary into lower layer.
30–60	Weathered stratified shale with very distinct cubical shape of granules. Becomes floury when pulverized.
60–95	A layer similar to the 30–60 cm. layer but more highly weathered and loose. Abrupt, smooth boundary from upper layer. Few, if any, roots present.
95–150	Another layer similar to the 30–60 cm. layer. Distinct boundary from upper layer.

This soil predominates in the central part of the southern half of the province from the boundary between La Union and Ilocos Sur up to the Abra–Ilocos Sur boundary near the town of Narvacan. It covers an area of 57,438 hectares, or 21 per cent of the province.

The elevation ranges from 100 meters to 479 meters, and the relief varies from gently rolling to hilly.

The parent material of this soil originated from Tertiary sediments, usually stratified shale and sandstone and, sometimes but rarely, conglomerates.

Due to the rolling to hilly topography, external drainage is free to excessive, but internal drainage is good to fair. The several layers of shale or sandstone regulate the percolation of water.

This type is not an important agricultural soil primarily because of unfavorable topography and natural low fertility. Generally, soils developed from sandstone, shale or conglomerates do not usually possess as high a level of fertility as soils developed from basic igneous rocks. Maguey, upland rice, corn, sugar cane, and sweet potatoes are the most common crops raised on this soil. Some of the areas now under cultivation, with slopes greater than 15 per cent, should be planted to permanent crops such as fruit trees, or they may be reforested in order to prevent or minimize soil erosion and prevent further wastage of the soil.

The soil is slightly acidic (pH 6.13) in reaction. From this standpoint alone, pineapple, sweet potato, tobacco, and rice may be expected to grow well and give maximum yields on this soil. It contains the highest amount of available nitrogen (.13 per cent) among the soils of the province, although its

Fig. 1. A typical profile of Bauang clay loam. Note the stratified shale from which the parent material is derived.

Fig. 2. The Bauang series is characterized by rolling to hilly topography.

PLATE 5

nitrate content is low (2 parts per million). This should be expected because a large part of the areas under this soil type are under grass vegetation. It seems adequately supplied with available potassium (137 parts per million) but it is miserably low in phosphorus (16.5 parts per million). On the basis of the chemical analysis alone, this soil may likely respond to phosphatic fertilizers.

Principally because of its rolling to hilly topography, this soil is susceptible to erosion. The nearness of the layer of shale to the surface somewhat slows down the penetration of water and thus subjects the soil to accelerated erosion during heavy rains.

Bantay Series

This series is first described in this survey and was first observed in the vicinity of the town of Bantay near Vigan. It is less extensive than the Bauang series, but it occupies a greater area than the other series. It comprises the low hills scattered at random on the plain and foothills in the northeastern part of the province, which adjoins Ilocos Norte.

The soils of this series consist of light brown to brown, friable, fine granular loam to clay loam that grades into a light yellowish brown nutty and brittle clay loam. The lower subsoil is a zone of highly weathered shale which has a tendency to break into cubes about a centimeter in diameter, with some concretion-like pellets of grayish white lime precipitate. The substratum is a dense mass of yellowish very light brown shale of variable thickness. A few gravels and pebbles are sometimes imbedded in this layer in some places.

The topography is undulating to rolling and the elevation ranges from 100 meters to 385 meters above sea level.[a] External drainage is free to excessive, but internal drainage is poor because of the massive shale substratum.

Like the Bauang series, the soils of this series were developed from parent material that originated from Tertiary sediments of shale with some mixtures of coralline limestone.

The native vegetation consists of a variety of types, such as grassland, second-growth forest, or *parang* type of vegetation. The most common species of bamboo and boho are plentiful. Ipil-ipil is also an important component of the plant associations found on this type.

[a] Elevations were obtained by the use of an altimeter.

Only one type, Bantay loam, is classified under this series and a typical profile exhibits the following characteristics:

Depth of soil (cm.)	Characteristics
0–20	Light brown, brown or grayish brown, friable, fine granular loam. Plant roots penetrate readily. Fair amount of organic matter. Obscure boundary into lower layer.
20–35	Light yellowish brown brittle, nutty clay loam. Clear boundary into lower layer.
35–60	Layer of weathering shale that breaks into cubes of around one centimeter in diameter. Some lime precipitate present.
60–150	Massive layer of whitish yellow shale rock.

This soil is not important agriculturally and only a small portion of it is under cultivation. The few crops grown on it are sugar cane, upland rice, corn, cassava, and vegetables. Like the Bauang clay loam, to which it is closely related, this soil is susceptible to erosion because of the steep slopes and the dense layer of massive shale underlying the subsoil.

Some of the areas presently cultivated to crops have slopes greater than 15 per cent. It would be well to revert such areas under permanent crops or reforest them to ipil-ipil, madre cacao or other quick-growing trees.

The reaction of this soil (pH 6.86) is very close to precise neutrality. Most crops except the acid- and alkaline-loving ones, should do well on this soil, considering reaction alone. Its available nitrogen content (0.11 per cent) compares well with the other soils of the Philippines. In phosphorus and potassium contents, however, it appears decidedly deficient in both elements. Applications of complete fertilizer to crops growing on this soil may be expected to give response on the basis of the chemical analysis.

SOILS OF THE HILLS AND MOUNTAINS

Cervantes series

The soils of the Cervantes series belong to the group of tropical red loam soils mapped in the Philippines, where the Alaminos and Antipolo soils also belong.

The distinguishing characteristics of this series are the very friable nature of the whole soil mass and the lack of well defined horizons until the substratum. It is similar to the Alaminos series in color but differs from the latter in the nature of the substratum. It differs from the Antipolo series in the absence of concretions in the surface soil and subsoil.

The series is gently rolling to hilly and mountainous. External drainage is free to excessive and internal drainage is good. This may account for the well developed red or reddish brown color of the soils.

The native vegetation consists of scraggly second-growth forest and grassland. The cleared hilly areas have moderately dense growth of trees along the streams. Bamboos, binayuyu, duhat and other softwood trees grow in patches. Near the town of Cervantes are a few pine trees.

The more gentle slopes of this series could be planted to permanent crops like fruit trees but moisture appears to be the limiting factor for their cultivation.

Only one soil type, Cervantes loam, is mapped under this series.

Cervantes loam.—The 7 to 10-centimeter surface soil consists of reddish brown to red loam or sandy loam which is very friable with a coarse fragmental structure. This layer is underlain by a bright reddish to red clay loam to clay with a columnar structure. This layer is also friable like the surface soil and contains few gravels. The lower subsoil is slightly similar to the upper layers but is lighter in color and has a coarser texture than the upper layers with an increase in depth. At a depth of 120 centimeters commences the substratum of whitish gray to brownish gray, loose, sandy material. This layer becomes powdery when dry.

This soil covers an area of 37,830 hectares in the southeastern part of the province along Abra River from near the town of Cervantes northward until Abra Province. The lay of the land ranges from gently rolling to hilly and mountainous. Some of the peaks are 500 to 700 meters in elevation.

The Cervantes loam is a primary soil developed from a wide variety of igneous rocks. The parent material is of a sandy nature which is whitish gray to brownish gray in color.

Due to the rough topography of the series, external drainage is free to excessive. Internal drainage is good because of the friable nature and favorable structure of the soil mass. This good internal drainage gives rise to the bright reddish brown to brick red color of the solum.

This soil is not utilized for the production of crops. Because of its unfavorable topography, the soils are not considered suitable for agriculture. Permanent crops like fruit trees may, however, be planted on the gentler slopes of the region so long as cover crops are used. As it is, moisture also seems to be one of the limiting factors in the cultivation of this type. The grasslands may make good pasture lands under proper range management.

MISCELLANEOUS LAND TYPES

Although the soil map is primarily concerned only with soil, other areas of land that are without a definite soil must be indicated on the map. Two miscellaneous land types, mountain soils, undifferentiated and rough stony land, fall under this group. The soils are usually shallow and on several steep slopes, bare rocks are exposed.

Mountain soil, undifferentiated.—These soils, as mapped in Ilocos Sur, are extensions of similar soils in La Union Province. They comprise the heavily forested southeastern part of the province which adjoins the Mountain Province. This region has no agricultural importance whatsoever, and it is best that it be left in its present state so that it may furnish the province with part of her lumber needs.

Geologically, this region is under a wide variety of intrusive and volcanic rocks. Because of the inaccessibility of the region, the kind of soil material obtaining in the area could not be ascertained.

This type covers an area of 97,147 hectares, or 36.2 per cent of the area of the province. It occurs in the interior towns of Concepcion, Angaki, Sigay, Alilem, Sugpon, Cervantes, Tubo, Tiempo, and San Emilio.

Rough stony land.—This type includes land having steep relief accompanied by many outcrops of solid rock and large boulders. The land is too steep and otherwise unsuitable for either cropping or grazing of any consequence. It occupies the mountainous region in the eastern part of the province adjoining the province of Abra, a little north of the town of Narvacan extending up to the Ilocos Sur–Ilocos Norte boundary southeast of the town of Lapog.

The area covered by this type is a portion of the Malaya Range which is largely, if not entirely, under intrusive and volcanic rocks. Some metamorphic rocks may also be found in the area. Some portions are bare with solid rocks or cherty materials exposed; in other places there is but a scanty scrubby vegetation visible on the mountainsides. The greater part of the area, however, is under second-growth forest and grassland. The failure of the forest to extend itself further is attributable to the yearly burning of such areas under grass during the dry season. The Bureau of Forestry is carrying on reforestation work in this type through its nursery at Caniao, Bantay, where different forest trees are raised for reforestation.

This type occupies a total area of 9,151 hectares, or 3.4 per cent of the province.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the factors of soil development acting on the parent materials deposited or accumulated by geologic agencies. The characteristics of any given soil are determined by the five general factors of soil formation, namely: (1) parent material, (2) climate, (3) living organisms, both plants and animals, (4) relief, or lay of the land, and (5) length of time the forces of development have acted on the material (13). The state or nature of the profile of a soil is dependent on which of the above factors exert the greatest influence. If the so called active factors, the climate and living organisms, especially vegetation, have the ascendancy over the others, the soil may have reached the mature state; if the passive factors, the parent material, relief, and time, have the edge over the active factors, the soil, may still be young or semi-mature; and if neither of the factors has any marked effects on the soil, the soil is still very young and, as such, it does not manifest true profile development.

Ilocos Sur is in the central portion of the Ilocos region in Northwestern Luzon. The southeastern quarter of the province and a small portion running in a northeasterly direction between the towns of Narvacan and Santa are made up of "Pre-Tertiary basement complex" consisting of a wide variety of metamorphic, dioritic and basic intrusive, and volcanic rocks (9). The rolling areas, hills and foothills, which comprise the major portion of the province, are Tertiary sediments undifferentiated and consist of shale, sandstone, and conglomerate with a little admixture of coralline limestone in some places. The narrow coastal plain is Quaternary alluvium consisting of floodplain and littoral deposits.

Ilocos Sur falls under the first type of climate, i.e., a maximum rain period in summer and a long dry season in winter and spring. The high uniform temperatures and heavy rainfall promote chemical decomposition of the rocks. In like manner, the distribution and intensity of rainfall play an inmportant rôle in soil formation. Where rainfall is heavy and fairly uniform, as in the eastern part of Luzon, the rocks are deeply weathered, but where there is marked or long dry season, as occurs in Ilocos Sur, the rocks are less deeply weathered.

The predominance of rolling and hilly to mountainous topography and the torrential rains during the rainy season are both conducive to accelerated soil erosion. On account of this, the characteristics of the upland soils are due in larger measure to the prevailing topography, or lay of the land, and to the parent material than to the climate and biological factors. From this point of view, the upland soils of the province could be classified under the intrazonal group of soils. The soils of the plain are likewise in the intrazonal group by virtue of the nearly flat topography, which gives rise to poor external drainage with little or no erosion. Such local effects of relief also overshadow the effects of climate. As most of the lowland soils are cultivated, the effect of biotic factors is insignificant.

In a preliminary study and classification of Philippine soils patterned after the method used by Storie and Weir of California, U. S. A. (11), nine profile groups were adopted by the defunct Division of Soil Survey, of the Department of Agriculture and Commerce. Under this grouping, the Bauang and Bantay soils both fall under profile group No. VIII, which consists of soils on upland areas developed on consolidated sedimentary rocks, generally stratified, such as shale, sandstone, and limestone. While both soils belong to the same profile group, the Bauang clay loam differs from the Bantay clay loam mainly in that it has a subsoil and substratum of stratified shale, usually folded, whereas the substratum of the latter is a massive shale without any stratification but with admixtures of coralline limestone in some places. The Bauang clay loam has thicker surface soil and subsoil than the Bantay clay loam.

The Bantog clay loam belongs to profile group No. III, or soils on older alluvial fans, alluvial plains, or terraces having moderately developed profiles (moderately dense subsoils) underlain by unconsolidated material. These are generally deep soils not underlain by claypan or hardpan but subsoils are moderately dense. The most important characteristics of this type are the dark color of the surface soil and the heavy substratum and subsoil.

San Manuel silt loam falls under profile group No. II, or soils of young alluvial fans, flood plains or other secondary deposits having slightly developed profiles underlain by unconsolidated material. These have profiles with slightly compact subsoil horizons. The characteristics of this series have been discussed in a previous paper (1). As mapped in Ilocos Sur, it occupies the largest area of the plain, and plays an important part in the agriculture of the province.

AGRICULTURAL LAND CLASSIFICATION

Frequently the results of the soil survey are applied through the meduim of land classification. There are different ways of classifying lands depending upon the objective of the classification—whether it is for the planning of land utilization, rural zoning, for tax assessment or some other purpose.

The agricultural land classification or grouping of the soils in Ilocos Sur is based on the physical characteristics of the soils with economic considerations being left out. For this reason, this classification intends to portray the relative suitability of the different soils for the growing of the more common crops and therefore does not give any idea of the economic value of the soils. The grouping is based chiefly on considerations of fertility, productivity, slope, erodibility, present degree of erosion, and drainage condition. Table 8 shows the grouping of the soils of Ilocos Sur Province.

TABLE 8.—*Comparative suitability of the soils of Ilocos Sur Province, Philippines, for agricultural use*

Soil type	Suitabillty for crops	Dominant present use	General grouping
Bantog clay loam	Very good	Lowland rice, corn, sweet potatoes.	Best soils especially for the common farm crops.
San Manuel silt loam	Very good	Lowland rice, corn, tobacco, sweet potatoes yambeans, peanuts and vegetables.	Do.
Umiñgan sandy loam	Moderately good	Lowland rice, corn, sweet potatoes.	Fairly suited to general farming.
Bauang clay loam	Poor	Corn, tobacco, sugar cane, maguey.	Inferior for common cultivated crops.
Bantay loam	Poor	Corn, tobacco, sugar cane, upland rice.	Cogonals good for pasture.
Rough stony land	Very poor	Being reforested	Suited to forestry.
Mountain soils, undifferentiated.	do	Not being used except for a limited lumbering.	Do.
Beach sand	Not suited for any crop.	No crops planted	Unsuitable for cultivated crops.
Riverwash	do	do	Do.

PRODUCTIVITY RATINGS

In table 9 the soils of Ilocos Sur are listed and assigned productivity indexes.

The rating of a soil for a particular crop shows its comparative productivity compared with a standard of 100. This standard stands for a standard yield for a specified crop which is the approximate average yield obtained without the use of fertilizer or soil amendments on the more extensive and better

soils of the regions of the Philippines where the crop is most widely grown. A soil with an index of 75 shows that it is three-fourths as productive for the specified crop as the soil with an index of 100. It is possible for unusually productive soils to have ratings over 100.

The estimate of the average yield of a soil type for a particular crop is arrived at inductively using as a basis observations of the stand of the crop in the field, interviews with farmers and the provincial agricultural supervisor, and census bulletins. The lack of records of production for the different crops on different soils necessitates the use of estimates.

The factors influencing the productivity of the land are mainly soil (including relief and drainage), climate, and management. In a certain field one factor may dominate while in another the other factors may exert more influence. Crop yields for a number of years are the best indicators of productivity, and these are taken advantage of whenever they are available. Economic factors were not considered in the determination of productivity ratings in this report. For this reason the table cannot be used as a basis for the determination of land values except in a general way. Accessibility and prices of farm products have bearing on land values.

Only one general simple system of management prevails throughout the province, and the productivity ratings have been based on estimate of average yields under the system. In this system fertilizers, lime or other soil amendments are not used and no special soil-management practices are employed. Rice, upland or lowland, is usually the principal crop. In some areas sugar cane is the major crop, but such areas are only a small per cent of the area devoted to the former crop. The secondary crops such as tobacco, sweet potatoes, corn, peanuts, yambeans, and mungo or vegetables are planted soon after the primary crop is harvested.

The following yields per hectare have been used as standards in the preparation of the crop productivity indexes for the soils of Ilocos Sur Province:

Lowland rice	60 cavans of palay
Upland rice	20 cavans of palay
Corn	17 cavans of shelled corn
Sugar cane	80 piculs of sugar
Sweet potatoes	8 tons of tubers
Tobacco	1478 kilograms
Maguey	463 kilograms
Beans	600 kilograms

TABLE 9.—*Productivity ratings of the soils of Ilocos Sur Province*

Type of soil [b]	Crop productivity index for [a]							
	Lowland rice	Upland rice	Corn	Sugarcane	Sweet potato	Tobacco	Maguey	Beans
San Manuel silt loam	60	-------	85	90	60	80	-------	85
Bantog clay loam	70	-------	75	80	-------	70	-------	80
Umingan loam	40	-------	80	75	80	75	-------	65
Bantay loam	-------	70	70	70	75	70	130	70
Bauang clay loam	-------	80	65	60	60	60	120	-------
Cervantes loam	-------	-------	-------	-------	40	50	-------	-------
Mountain soils, undifferentiated	-------	-------	-------	-------	-------	-------	-------	-------
Rough stony land	-------	-------	-------	-------	-------	-------	-------	-------
Beach sand	-------	-------	-------	-------	-------	-------	-------	-------
Riverwash	-------	-------	-------	-------	-------	-------	-------	-------

[a] The soils of Ilocos Sur Province are given indexes that give the approximate average yield of each crop in per cent of the standard of reference. The standard represents the approximate yield obtained without the use of fertilizer or other amendments on the extensive and better soil types of the regions of the Philippines in which the crop is most widely grown. Most of the indexes are essentially estimates and determined inductively. Absence of an index indicates that the crop is not commonly grown on the particular soil type.

[b] The soils are listed in the approximate order of their productivity—the most productive first.

LAND USE AND SOIL MANAGEMENT

The term "land use" as used in this section refers to the broad uses of the land on the farm, such as for cropland, permanent pasture, and forestry. The term "soil management" as used in this section refers to practices, such as drainage and cultivation, liming, crop rotation, addition of organic matter, fertilization, and supporting conservation practices.

The classes of land according to use capability are determined wholly on the basis of physical characteristics of the land, including its climatic environment. At least four groups of factors must be considered: (1) Conservability, or permanence of the soil if cultivated (susceptibility to erosion); (2) productivity of the soil as conditioned by native fertility, capacity for retention and movement of water, salt content, aeration, or other factors; (3) workability (stoniness or hardpan layer); and (4) the climatic environment, particularly temperature and precipitation.

Ilocos Sur is one of the most thickly populated provinces of the Philippines with insufficient arable land to feed her population. The people are constrained to produce so many crops in a year so long as there is enough moisture to sustain the plants. The soils are made to produce all that is possible to grow on them. In short, the method of farming is one of

exploitative rather than conservative type. The use of the land has been guided more by the needs of the people rather than by the capabilities of the soils. Some soils that are not physically suitable for the production of crops have been opened and cultivated. So many of the areas suited for permanent forest have been opened and cultivated. So many of the areas suited for permanent forest have been cleared resulting in the increase of grasslands. Some areas are now more or less devoid of vegetation with the bare rocks exposed.

Ordinarily, there are five classes of land in arable regions according to use capability. The first three classes (I, II, and III) indicate land that can be recommended for cultivation. The other two, classes IV and V, indicate land that should not be recommended for cultivation. These five classes can be described as follows:

Class I.—Under this class is land that, from the standpoint of inherent soil characteristics and environmental features, can be safely and permanently cultivated with the production of moderate to high yields of the adapted farm crops without special practices or measures. Lands placed in this class must possess the following characterristics: (1) It is suitable for cultivation, that is, cultivation is not impeded by stones, a permanently high water table or any other condition that would interfere with tillage. (2) It can be cultivated safely and permanently without special practices for the control of erosion, that is, erosion-promoting crops such as corn or tobacco, can be grown without danger of appreciable accelerated erosion. (3) It retains and supplies enough moisture and contains sufficient plant nutrients for the maintenance of those physical, chemical, and biological conditions in the soil that favor continued production of moderate to high yields of farms crops.

Class II.—Under this class is land that, from the standpoint of inherent soil characteristics and environmental features, requires one or more special practices that are easily applied in order to be cultivated safely and permanently with the production of moderate to high yields of the adapted farm crops. The special practices include contour tillage, strip cropping, and terracing; the removal of stones that would interfere with cultivation; the installation of tile drains; or any other practices that need special attention. Soil-improving practices, such as rotation of crops and the use of fertilizers and lime may also be classified as special practices if they are not commonly used in the locality.

Class III.—Belonging to this class is land that, from the standpoint of inherent soil characteristics and environmental features, requires complex or intensive measures in order to be cultivated safely and permanently with the production of moderate to high yields of the adapted farm crops.

Land under Class II or III may be characterized by one or more of at least three sets of factors: (1) Susceptibility to erosion if cultivated; (2) some physical obstacles such as stoniness or poor drainage; or (3) low productivity that requires special soil-improving practices other than those common to the locality for production of at least moderate yields of crops. Any one of these factors will cause land to be classified as II (rather than I), and in general two or more coexisting factors of such a nature, as well as a single factor of sufficient degree, would cause land to be placed in class III.

Class IV.—Under this class is land that, from the standpoint of inherent soil characteristics or environmental features, is not suitable for regular or continuous cultivation with the production of moderate to high yields of the adapted crops, but with adequate protection is suitable for uses that may involve short period of cultivation. Lands in Class IV may be characterized by steep slopes, severe erosion, physical obstacles (such as stoniness or very poor drainage), low productivity, or other qualities that make it unsuitable for regular cultivation.

Class V.—Included in this class are lands that, from the standpoint of inherent soil characteristics or environmental features, are not suitable for cultivation. Lands in class V are characterized by steep, rough, or broken topography, extreme stoniness, very severe erosion, very poor drainage, or some other features that prevent even occasional cultivation. Some areas of this class that are too steep for even occasional cultivation but will support good grass may be suitable for permanent pasture. Most lands of this class in humid regions can be utilized as woodland or for wildlife purposes.

Five classes of land are also recognized in grazing regions according to use capability, but since there are few areas of suitable grazing lands to speak of in the province, these classes need not be taken up in this discussion.

The drain on the fertility of the soil through continuous intensive cropping, especially for the last forty years, is evidenced by the declining crop yields. The productivity of most of them could be restored and maintained at their for-

mer level by (*a*) the regulation of the use of each soil as determined by its physical limitations; and (*b*) the adjustment of the management to the needs of each soil under the particular land use. The different soils are found on the several individual farms operated by the owners or tenants, so any modification or revision in the use or management of the soils must of necessity be done by the operators of the farms. Whatever necessary changes are to be made, however, must be done gradually and with all the factors concerned to be taken into account.

With respect to management requirements, each soil of the province has its own particular needs, and what may be considered an ideal system for one may not be suitable for another. In spite of the seeming diversity of their specific requirements, however, some general management requirements are applicable to most of them, and on this basis the soils can be classified into broad groups.

With the chemical analysis of the soils and the crop yields on these same soils as compared to those of the soils in other provinces of the Philippines as basis, it appears that proper and adequate fertilization is one of the requirements just mentioned. All the soils are deficient in phosphorus except the Umiñgan sandy loam; all are a little low in nitrogen; and most of them are low in potassium. The soils of the intermediate upland are low in available calcium. For the efficient use of the fertilizers, the amounts to be applied must be adjusted to the demands of the crops to be grown and the degree of deficiency of each element based on the chemical analysis.

The soils can be grouped according to (1) their fertilizer requirements, (2) their need for supporting conservation practices, and (3) their need for organic matter. The groupings are here presented and general recommendations are made for each group. It must be stated that within each group one soil may differ to a slight extent from another in its fertilizer requirements under similar use and management. Mention must also be made of the paucity of information and data pertaining to the specific requirements of each soil and that subsequent investigations may indicate differences in the requirements of the soils that are now placed in the same group. Besides, it must be borne in mind that many factors other than the natural content of mineral nutrients in the

soil, determine the fertilizer requirement for the production of any specific crop in any particular season.

FERTILIZER RECOMMENDATIONS

With respect to the use of fertilizers, the soils of Ilocos Sur are placed in three groups depending upon their need for nitrogen, phosphorus, and potassium for the production of the common crops of the province. While it is true that nitrogen is unstable or transitory in the soil depending on its organic matter content, it is nevertheless considered in the formulation of the recommendations.

Group 1

Under this group are the soils of the coastal plain, the San Manuel silt loam and Bantog clay loam. These are alluvial soils. They are the most productive in the province. The chief fertilizer requirements of these soils appear to be phosphatic fertilizers. In the absence of experimental data, no specific amounts per application could be recommended. Potash and nitrogen fertilizers are also needed on these soils but to a much less extent than phosphatic fertilizers. Ammonium sulfate should be the form of nitrogenous fertilizer to be used, as this form usually leaves an acidic residual effect on soils. The pH of both soils is a little on the alkaline side, so that the use of ammonium sulfate may be expected to lower the soil reaction. This is considered important for the reason that lowland rice, the principal crop grown on these soils, require an optimum pH of 5.5 to 6.1. Another reason is that rice seem to have preference for the ammoniacal form of nitrogen over the nitrate form. The organic matter content of these soils need to be increased a little through the use of legumes or manure, if possible.

Group 2

Included in this group is only one soil type, the Umiñgan sandy loam. The greatest need of this soil seem to be nitrogen and organic matter. Among the soils of the province, it has the lowest content of available nitrogen (0.06 per cent). Its sandy nature necessitates an increase in the organic matter content, in order to increase its water-holding capacity and nitrogen content. The use of legumes as green manure or barnyard manure where available are recommended. This soil is also an alluvial soil but of lesser natural fertility than the

soils in group I. While it seems to be amply supplied with potassium, it is but fairly supplied with phosphorus and calcium. This soil may respond to a slight phosphatic fertilizer application together with a little addition of lime.

Group 3

Group 3 comprises soils of lower natural fertility than the soils in groups 1 or 2. They are underlain by sedimentary rocks such as sandstone, shale, and limestone and gravels. The Bauang clay loam, Bantay loam, and Cervantes loam are the soils in this group. Phosphatic and potash fertilizers are the primary needs of these soils and lime in addition in the case of Bantay loam. The Bauang clay loam may not respond to potash fertilizers as its chemical analysis indicates that it is amply supplied with the element (137 parts per million) for the needs of most crops. The organic matter content of all the soils should be increased through the use of manures or legumes.

EROSION CONTROL RECOMMENDATIONS

In the last few years, the menace of soil erosion in the Philippines has begun to be recognized but the general public is still unaware of the importance of the problem. While the need for the dissemination of information and instruction about the subject is felt, it is too broad a subject to be included in this brief report.

Erosion control measures for cropland can be classified into two kinds, namely, vegetative and mechanical. Under the former are such practices as contour strip cropping, contour buffer strips, grassed waterways, and the use of cover crops. Under the mechanical methods the common practices are contour tillage, terracing, gully control, and basin listing.

In all of these practices, the underlying principle is: that fast-running runoff carrying as it does more soil material, is more destructive than slow-moving runoff. The significance of this is far reaching when one bears in mind that doubling the velocity of a stream increases its transporting power sixty-four times. In short, instead of letting runoff run, it should be made to "creep" or "walk".

In regard to their need for soil conservation measures as conditioned by their characteristics (slope, soil type, extent and degree of erosion), present land use, vegetative cover, and amount and frequency of rainfall falling on them, the soils are classed into four groups.

Group 1

The coastal plain soils, which are placed in this group, are very slightly susceptible to erosion because of their level or nearly level topography and their utilization for the growing of lowland rice which incidentally helps in the control of erosion due to the presence of levees. No apparent erosion can be recognized on these soils. The San Manuel silt loam and Bantog clay loam are in this group.

Group 2

Umiñgan sandy loam is the only soil in this group. It is slightly susceptible to erosion mainly because of high dispersibility due to its very low organic matter content. The area of the type in Cervantes town is mainly devoted to the growing of lowland rice in bench terraces, hence it is only slightly subject to erosion. As the rice is grown during the rainy season the presence of the rice crop as a cover helps in the control of accelerated erosion. The organic matter content of this soil should be increased in order to increase the cohesiveness or binding material of the soil, thus lessening its dispersibility and consequently increasing its resistance to erosion. The area of the type found in the town of Santa is devoted mainly to the growing of corn, an erosion-promoting crop, and secondarily to sweet potatoes and vegetables. Besides increasing the organic matter content, particularly for this area, it is recommended that contour tillage and contour strip cropping be practiced in addition.

Group 3

The soils in this group belong to the intermediate upland soils, such as the Bauang clay loam, Bantay loam, and Cervantes loam. These soils have gently rolling to hilly topography and are commonly planted to corn, tobacco, cotton, sugar cane, and vegetables. Most of the crops are erosion-inducing crops, hence the necessity for erosion-control measures on the cultivated areas. Slopes between 2 per cent and 5 per cent should be contour cultivated and strip cropped; those between 6 per cent and 12 per cent should always be kept covered with vegetation during the rainy season in addition to strip cropping and contour cultivation; and those areas over 12 per cent slope should be retired from cultivation or planted to permanent crops like fruit trees where practicable.

OTHER RECOMMENDATIONS

Crop rotation should be practiced on all cultivated lands and this should include legumes, if possible. In the matter of cultivation, a more thorough preparation of the land preparatory to planting is one of the most important changes that should be made. This can only be achieved by the use of better implements than those in current use and by farm machinery like tractors, disc plow, and disc harrow in places where they are practicable. The old native wooden plow should be replaced with the better types of iron plow, and the native bamboo harrow should be replaced with the *suyod* for use in lowland rice fields.

With respect to erosion, both cultivated and uncultivated lands are subject to destruction. In the case of uncultivated areas, those more suited to forestry should be reforested; the grasslands that could be used for grazing should be protected from fires and overgrazing. In short, each and every area of land in the province should be put to its best use.

WATER CONTROL ON THE LAND

Water control on the land, as applied to Ilocos Sur Province, is concerned primarily with irrigation and secondarily with the protection from floods or overflow and control of run-off and erosion.

There is sufficient rainfall for the needs of the crops during the rainy season from May to the end of October, but irrigation water must be provided during the dry season from November to the end of April. There are times also when irrigation is necessary even during the rainy season when dry spells occur.

Usually there are three types of irrigation, namely, (1) irrigation to supplement the natural precipitation during dry periods, (2) irrigation to provide all the water needed for *palagad* or dry season crop of rice, and (3) irrigation to supply all the water required by secondary crops.

As often happens, towards the close of the rainy season, the rainfall is sometimes insufficient to mature the rice crop. With irrigation systems to supply water whenever needed, the production of rice could be increased through the planting of late-maturing varieties, which are usually high yielders. Some of the lowland rice fields could be planted to *palagad* rice so long as there is enough water available, thus making possible the raising of two crops a year where only one crop was raised

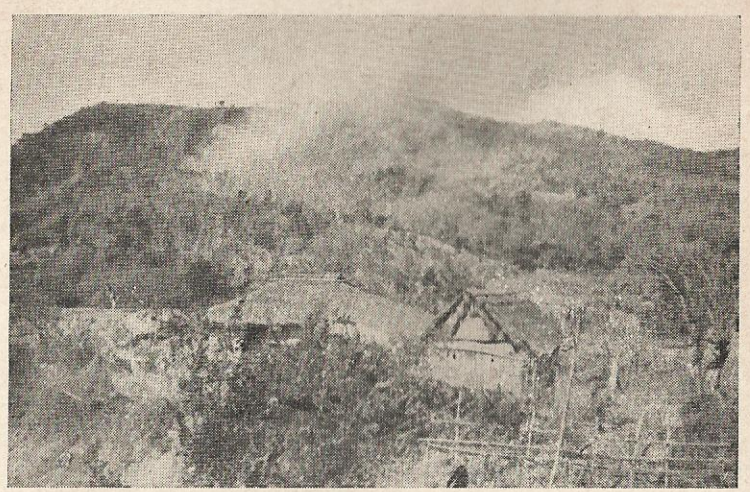

Fig. 1. Burning of the grasslands during the dry season prevents the extension of the forest cover.

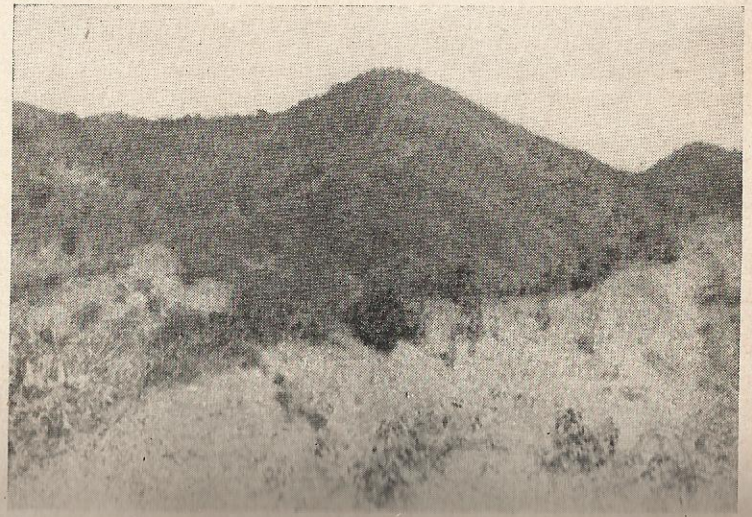

Fig. 2.-A hillside in need of reforestation at Narvacan along the road to Bangued, Abra.

before. An adequate water supply would naturally increase the planting of secondary crops, such as corn, tobacco, sweet potatoes, etc. The inadequacy of moisture in the soil after the harvest of the regular rice crop is the limiting factor in the planting of secondary crops.

Communal irrigation systems are found in Sinait, Cabugao, Santo Domingo, Narvacan, Santa Maria, and Candon. These systems are operated and maintained by the farmers themselves, and as such the structures are of the makeshift types. In Tagudin, the Tagudin Irrigation System irrigates an area of about 900 hectares. This is the only government-owned system in the province.

The lay of the land is favorable for the construction of irrigation systems and several possible sources of water are conveniently located in the different irrigable areas. The soils are mostly of the clay loam and silt loam types, both of which are moisture-retentive. It is evident that if more food crops are to be raised in the province more irrigation systems must be constructed so as to ensure enough water for the needs of the crops.

Protection from floods and overflow is a perennial problem that confronts the province every rainy season. This is intimately related with the control of run-off and erosion, so much so that if this latter problem is taken care of, the former is concomitantly brought under control.

The three types of erosion, which are sheet, rill, and gully, occur in the province at different degrees of severity in different places. Sheet erosion is "the more or less even removal of soil in thin layers from an entire segment of sloping land" (4). It escapes detection by an untrained individual, hence its insidious nature. When the run-off water concentrates in streamlets of sufficient volume and velocity to generate enough cutting power, it is called rill erosion. It is more conspicuous than sheet erosion. Gully erosion is that stage where the concentrated run-off cuts deep incisions, or gullies, on the land surface.

Very little sheet erosion, if any, occurs in the San Manuel and Bantog series due to their more or less level topography, and in the Umiñgan loam because of its looseness and permeability. Moderate degree of both rill and gully erosion occur on the Bantay and Bauang soils. Their erodibility is primarily due to the high per cent of slopes prevailing and the torrential rains during the rainy season. The somewhat heavy subsoil and substratum slows down the infiltration of water, thus

contributing to the formation of run-off. During the rainy season most of the cultivated areas of these soils are under upland rice and sugar cane. The Cervantes series does not suffer as much as the two soils (Bantay and Bauang), because of its grassland and forest cover, which act as protective cover of the soils. On the rough stony land, which is a miscellaneous land type, the three types of erosion occur simultaneously, but rill and gully erosion exact the most damage.

The extent of erosion in the province as a whole is not so severe, but the need for remedial measures is urgent in view of the effect on floods and overflow. Floods are of frequent occurrence during periods of excessive rainfall. The scanty growth of vegetation in the watersheds of the streams and rivers permits the run-off to rush down unchecked, causing floods and the overflowing of streams.

The lack of adjustment between land use and soil management on one hand and the physical capabilities and character of the soils on the other, is the main cause of the uncontrollability of water on the land and the consequent soil erosion. It is obvious that the remedy is one of correct land use and soil management.

Since the land in Ilocos Sur is subdivided into small farm units, the readjustments must be made on the individual farm. In some farms the adjustment may involve a number of problems and a compromise is not only expedient but inevitable where conflicts arise between the immediate needs of the farm and the physical use capabilities and soil-management requirements of the soils. A rational approach to the problem necessitates thorough familiarity with all the factors involved.

Some of the vegetative measures of controlling run-off and erosion in gentle slopes are contour strip cropping, contour buffer strips, cover crops for seasonal protection of fields, and grassed waterways. If steep erodible soils are to be cultivated, contour tillage and terracing are suggested as the means of control. Wherever feasible such steep lands should be put under grass and utilized for pasture or they may be reforested.

GLOSSARY OF COMMON ECONOMIC PLANTS FOUND IN ILOCOS SUR

Common name	*Scientific name*	*Family name*
Ampalaya	*Momordica charantia* Linn.	Cucurbitaceæ
Arrowroot	*Maranta arundinacea* Linn.	Marantaceæ
Atis	*Anona muricata* Linn.	Anonaceæ
Bamboo	*Bambusa spinosa* Roxb.	Gramineæ

Common name	*Scientific name*	*Family name*
Balimbing	*Averrhoa carambola* Linn.	Oxalidaceæ
Banana	*Musa sapientum* Linn.	Musaceæ
Batao	*Dolichos lablab* Linn.	Leguminosæ
Bermuda grass	*Cynodon dactylon* (Linn.) Pers.	Gramineæ
Binayuyo	*Antidesma ghaesembilla* Gaertn.	Euphorbiaceæ
Boho	*Schizostachyum lumampao* (Blanco)	Gramineæ
Cabbage	*Brassica oleracea* Linn.	Cruciferæ
Cacao	*Theobroma cacao* Linn.	Sterculiaceæ
Cadios	*Cajanus cajan* (Linn.) Millsp.	Leguminosæ
Caimito	*Chrysophyllum cainito* Linn.	Sapotaceæ
Cashew	*Anacardium occidentale* Linn.	Anacardiaceæ
Cassava	*Manihot esculenta* Crantz	Euphorbiaceæ
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
Cotton	*Gossypium hirsutum* Linn.	Malvaceæ
Cowpeas	*Vigna sinensis* (Linn.) Savi.	Leguminosæ
Cucumber	*Cucumis sativus* Linn.	Cucurbitaceæ
Derris	*Derris elliptica* (Rox.) Benth.	Leguminosæ
Duhat	*Eugenia cumini* (Linn.) Druce	Myrtaceæ
Eggplant	*Solanum melongena* Linn.	Solanaceæ
Gabi	*Colocasia esculentum* (Linn.) Schott	Araceæ
Garlic	*Allium sativum* Linn.	Liliaceæ
Ginger	*Zingiber officinale* Rosc.	Zingiberaceæ
Guayabano	*Amona muricata* Linn.	Anonaceæ
Ipil-ipil	*Leucaena glauca* (Linn.) Benth.	Leguminosæ
Jute	*Corchorus capsularis* Linn.	Tiliaceæ
Kakauati	*Gliricidia sepium* (Jacq.) Steud.	Leguminosæ
Kamanchile	*Pithecolobium dulce* (Roxb.) Benth.	Leguminosæ
Kapok	*Ceiba pentandra* (Linn.) Gaertn.	Bombacaceæ
Kamias	*Averrhoa bilimbi* Linn.	Oxalidaceæ
Kondol	*Benincasa hispida* (Thunb) Cogn.	Cucurbitaceæ
Lettuce	*Lactuca sativa* Linn.	Compositæ
Maguey	*Agave cantala* Roxb.	Amaryllidaceæ
Malungay	*Moringa oleifera* Lam.	Moringaceæ
Mango	*Mangifera indica* Linn.	Anacardiaceæ
Mungo	*Phaseolus aureaus* Roxb.	Leguminosæ
Mustard	*Brassica integrifolia* (West) Schulz	Cruciferæ
Nangka	*Artocarpus heterophyllus* Lam.	Moraceæ
Onion	*Allium cepa* Linn.	Liliaceæ
Papaya	*Carica papaya* Linn.	Caricaceæ
Patani	*Phaseolus lunatus* Linn.	Leguminosæ
Patola	*Luffa cylindrica* (Linn.) M. Roem.	Cucurbitaceæ
Peanut	*Arachis hypogaea* Linn.	Leguminosæ
Pechay	*Brassica chinensis* Linn.	Cruciferæ
Pineapple	*Ananas comosus* (Linn.) Merr.	Bromeliaceæ
Pummelo	*Citrus maxima* (Brun.) Merr.	Rutaceæ
Radish	*Raphanus sativus* Linn.	Cruciferæ
Rice	*Oryza sativa* Linn.	Gramineæ

Common name	*Scientific name*	*Family name*
Santol	*Sandoricum Koetjape* (Brun. F.) Merr.	Meliaceæ
Seguidilla	*Psophocarpus tetragonolobus* (Linn.) DC. Prodr.	Leguminosæ
Sincamas	*Pachyrrhizus erosus* (Linn.) Urb.	Leguminosæ
Sineguelas	*Spondias purpurea* Linn.	Anacardiaceæ
Sitao	*Vigna sesquipedalis* Fruw.	Leguminosæ
Squash	*Cucurbita maxima* Duchesne	Cucurbitaceæ
Sugar cane	*Saccharum officinarum* Linn.	Graminæ
Sweet potato	*Ipomoea batatas* (Linn.) Poir.	Convolvulaceæ
Tamarind	*Tamarindus indica* Linn.	Leguminosæ
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

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