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Soil Report 2

SOIL SURVEY OF RIZAL PROVINCE

PHILIPPINE ISLANDS

BY

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Map Scale - 1:100,000

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DEPARTMENT OF AGRICULTURE AND COMMERCE

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PREFACE

In the country like the Philippines, where the basic industry is agriculture, the proper conservation and ultimate utilization of the soils and its fertility are of primary importance for the perpetuation of its industries which are dependent upon the soil and the products derived therefrom. It is a recognition of this elementary principle that prompted the undersigned to create in October, 1934, a committee on soil surveys composed of the Under-Secretary of the Department and the Directors of Science, Plant Industry, Lands, Forestry, and Weather. The soil-survey project is now under the direct charge of Dr. M. M. Alicante, soil technologist, and is established in the Bureau of Science where laboratory facilities are available. In other countries where agriculture is in its advanced stage, soil investigations for a very important part of their program of agricultural development, and large sums of money are spent yearly for this work, while in the Philippines its importance is just beginning to receive attention. In order to understand more fully the benefits derived from soil survey and its necessity in this country, it would be sufficient to point out a few important considerations for which the project

has been established.

Heavy rainfalls and floods occur regularly in this country, causing soil erosion especially in hilly portions exposed to the mercy of the elements. Erosion has destroyed thousands of hectares of marginal lands and has affected wide areas of fertile lowlands. The less of soil fertility through erosion is a very serious farm problem not only here but all over the world. Information gained from soil survey is useful in the formulation of preventive measures against the destructive effects of erosion and thereby conserves the fertility of the soil.

It is to be observed that in many places of the country no particular attention is given the question of soil conservation so that many farms are fast decreasing in fertility and consequently in yield per unit area. Unless this condition is remedied, the time may come when farming in the less-enlightened regions would no longer be profitable.

Through proper soil surveys a systematic classification of Philippine soils can be made with respect to crops, forests, pastures minerals, swamps for fishing purposes, etc. This classification is important

in connection with the disposal of public lands for agricultural purposes in line with the Government's extensive program of colonization and development of the sparsely populated districts. It is a guide in selecting ideal sites for colonization work and in determining the kinds of crops that the colonizers might raise to their greatest advantages.

The present report deals with the soil conditions of Rizal Province. It covers both the physical and chemical properties of the different soil types in the province which have been thoroughly investigated and studied in relation to crops. Incidentally information regarding industries, population, transportation, education, health and sanitation in the province is also given. By taking advantage of this information through proper coordination of the different factors that contribute to the agricultural, social, and economic life of the people of the province, a more scientific expoitation of the resources could be effected for the general welfare of the community. It is, therefore, hoped that the public is general and the farmers in particular would utilize to the fullest extent such valuable information as is now made available through soil surveys.

ELUGIO RODRIGUEZ
Secretary of Agriculture and Commerce

SOIL SURVEY OF RIZAL PROVINCE PHILIPPINE ISLANDS*

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INTRODUCTION

Settlement and history.- Rizal Province, with Pasig as the capital, was created and civil government was established in June, 1901. In 1925 it was made a first-class province. There are 26 municipalities; 5 are first class, 4 second class, 5 third class, and 12 fourth class. The first-class municipalities, or towns, are Pasig, Pasay, San Juan del Monte, Malabon, and Caloocan.

The total area of the province, including the City of Manila, is 232,915 hectares. The population, excluding Manila, as of the 1918 Census, was 227,135 (non-Christian of 3,070 not included). The estimated population of July 1, 1935, was 314,458, an increase of 27.7 per cent after 17 yeqrs. According to the 1918 Census Manila had a population of 283,613. In 1935 the population of Manila was estimated to be 353,418,

*For Soil Report 1 see Department of Agriculture and Commerce Technical Bulletin 5.

mm increase f 19.7 per cent after 17 years.

Before the Spanish settlement in this province, the towns of Pasig, Parañague, Taytay, and Cainta were already thriving settlements. These towns were thickly populated, and the people were engaged in various trades and agricultural activities. It is believed that the trade relations between the natives and the Chinese of these towns had already been in existence before the Spanish occupation of the Islands,

Industries.- Because of its proximity to Manila and of the available transportation both by land and by water, Rizal Province because the best industrial region of Luzon.

There are several large factories operated in this provinces. The Rizal Cement Factory is in the town of Binañgonan where an extensive lime deposit is located. The Malabon Sugar Factory is in Navotas, the Insular Sugar Company in Mandaluyong, and the Lime Factory in Montalban.

Shoe and embroidery making are the main industries in Marikina, Parañaque, and Pateros. There are cigar and cigarette factories in Malabon, Pasay, Cainta, and Caloocan. Pottery making is practiced in Pasay,

brick manufacturing in Mandaluyong, hat weaving in Taguig and Pililla, while salt is made in Las Piñas, Caloocan, and Parañaque. Fishing in Laguna de Bay is also an industry of the towns around the lake.

Bañgos industry.- The culture of bañgos (Chanes chanos forskal) is said to have been originated by Sr. Domingo Coronel in about 1863 in barrio Concepcion, Malabon. This industry spread to the neighboring towns bordering Manila Bay. To-day it is one of the lucrative industries of Malabon, Navotas, Parañaque, and Las Piñas. The progress of the town of Malabon and Navotas is partly attributed to this industry, The mangrove and the nipa swamps along the coast were made into fishponds. The total area devoted to this industry is about 1,248.15 hectares. The types of soils or mud buttoms of these fishponds are very fine sandy mud, largely inorganic and dark-gray mud, mostly clay. The fry are brought from the coast of Bataan, Batangas, Mindoro, Tayabas, Zambales, and Ilocos. The rearing of the first requires from six to twelve months depending upon the system of management. Bañgos harvested once a year when they are large and command a high price. When the fish are

harvested twice a year, the planting is done twice a year. Fish thus caught are allowed to stay in the ponds for 10 to 12 months. The fish are caught in the evening or early in the morning. They are sold in Manila or in nearby towns. Shrimps and other kinds of fish are also caught in the ponds.

Salt manufacture.- Closely connected with the bañgos industry of Parañaque and Las Piñas is the salt industry. Salt is made by evaporating sea water is crystallizing ponds the buttoms of which are made of broken pottery cemented together. The crystallizing ponds are slightly higher than the concentrating ponds.

The reservoir where the first evaporation takes place is the ordinary fishponds. There are several rows of shallow concentrating reservoirs within the fishpond. The brime is drawn from one reservoir to another. As the concentration progresses new water is admitted. The concentrated brime is transferred to the crystallizing pond late in the afternoon and allowed to evaporate the following day. The salt is scrapes to one side of the pond and allowed to drain and then transferred to the containers

for storage. During the rainy season, when it is not practicable to make salt, the bottom of the pond is removed so as to allow the mosses to grow and the pond is again converted into a fishpond.

Shoe industry.- Almost a century ago shoe were made in the Philippines only by the Chinese. The first Filipino shoe factory was started in Marikina, and later this business spread to neighboring towns. However, the shoe industry has been developed in Marikina more than any other town in Rizal. Today Marikina is oftentimes referred to as the center of the shoe industry in the islands. Most of the locally made shoes that are sold in the Gandara and Nueva sections of Manila are made in Marikina. Of the 250 shoe shope in the Philippines a great number are found in Marikina. The materials used in the manufacture of shoe are mostly local products. For better quality shoes the leather used is imported usually from the United Stztes, though some high-grade leather is made locally.

At present Filipino capital controls about 50 per cent of the Island's shoe industry with an estimated investment of about 8 million pesos.

The tanning industry.- Closely connected with the shoe industry or Marikina is the tanning industry in Malabon and Navotas. The tanning factory at Malabon is quite modern and is done of the best in the Philippine Ceramics and Tannery Association. Most of the leather produced by this factory is used for sole leather. The improved quality of locally produced sole leather has resulted in the decline of imported sole leather.

Duck raising.- This industry is one of the most profitable industries in Rizal Province. This industry is largely carried on in Pateros and Taguig because of their favorable location on the river. Duck raising is one of the oldest industries in the Islands. It was started by the Chinese traders before the Spanish occupation of the Philippines.

The regions of Pateros and Taguig have natural streams and good drainage. The snails, or "susu" (Vivipara angulars Muller and Malania spp.), are natural food for ducks, and they are found abundantly in those streams.

The ducks are raised chiefly for their eggs. These eggs are made into "balut". This is done by

incubating the eggs from 16 to 19 days and then boiling until they are hard, The usual retail price is 5 centavos each. "Penoy" is the infertile egg that has been incubated for 13 days and boiled. Usually the price for "penoy" is less than for "balut". The "balut" is considered by some people to have a greater fpod value and palatability then the ordinary egg. The embryo in the egg is patly developed and the yolk is transformed into a more digestible form. "Balut" is a favorite food among the Tagalogs.

Transportation and cummunication.- Rizal Province has excellent transportation facilities. A railroad from Manila to Montalban passes through Mandaluyong, Fort William Mckinley, and Pasig. There is a line from Pasig to Taytay, which connects there with an autobus line to Antipolo. Caloocan is on the main north line of the Manila Dagupan Rail-road, while Muntinglupa is on the main south line. Pasig, Parañaque, and Las Piñas are on the Cavite branch line of the Manila Railroad. Pasay, San Pedro Makati, Pasig, Calooaan, San Juan del Monte, and Mandaluyong are connected with the City of Manila by electric cars and bus service of the Manila Electric Company. With the exception of Jalajala, all the towns of the province are connected with the capital by provincial roads.

Small steamers are in service between Manila and Pasig, and reach Morong, Tanay, Pililla, and Jalajala along the lake. All municipalities are connceted by telephone to the provincial building at Pasig. This system wasinaugurated in 1905. The radio stations are located in Pasay, San Juan del Monte, and Mandaluyong.

Public health.- Sanitary conditions, medical and dental inspection of school children and teachers, industrial hygiene, health centers, communicable diseases, and other public health activities are taken care by the Philippine Bureau of Health. A detailed account of this work is given in the annual report of the Bureau.

Schools and Churches.- In every town there is a public school and the large towns have private schools. The provincial high school is located at Pasig, the capital of the province. The catholic church is located in every town in the province. The Catholic church is located at Las Piñas is noted for its bamboo organ, being the only one in the world. This organ was constructed by a Spanish priest early in the Spanish regime in the Philippine.

CLIMATE

Rizal Province has two distinct seasons, dry and wet. The dry season occurs during the winter and spring months, while the wet season is during the summer and autumn months. The heaviest rainfall usually occurs the summer months. The annual rainfall reaches as high as 2,350 millimeters and the temperature is between 28° and 34°C. The rain during the autumn months is moderate and seldom results in floods. As shown in Table 1 there is always a slight rainfall during the dry months. The lowest rainfall occurs usually during February and March.

The mean monthly rainfall of the five stations of Rizal is shown in Table 1. The Alabang Stock Farm Station is located in slightly sections. The mean annual rainfall of the four stations differs very slightly from each other. The mean annual rainfall recorded at Alabang Stock Farm Station, however, is slightly lower than that recorded at the other four stations. Being protected from violent winds by the Sierra Madre Mountains on the southwest, severe typhoons seldom occur in this province. The typhoons and floods that occur in Manila and in the central plain of Luzon effect the western part of Rizal. The floods of July, 1904, and September, 1914, affected the lowlands of Rizal.

Usually the typhoon season, which causes floods in the central plain, occurs between June and November. The drought of 1903 and 1912 affected the agricultural activity of the people in Rizal and in a great part of the Archipelago. Novaliches and Antipolo, being on the high plateau, have a somewhat colder temperature. The hottest months are March, April, and May, just before the beginning of the rainy season. The mean monthly temperature is shown in Table 1.

IRRIGATION AND DRAINAGE

The principal rivers are the Pasig and the Marikina. Pasig and Manila and drains Laguna de Bay. Marikina River, which rises in the mountains of Montalban, passes through the towns of Montalban, San Mateo, Marikina, and Pasig, which empties into Manila Bay. The water supply of the City of Manila and suburbs is obtained from the Montalban and Novaliches Dams. The Novaliches watershed covers an area of abput 2,000 hectares.

PHYSIOGRAPHY AND GEOLOGY

Rizal Province is situated in the southwestern part of Luzon. It is bounded by Bulacan Province on the north, by Tayabas and Laguna Provinces on the east, and by Manila Bay and Cavite Provinces on the south, and by Manila Bay on the west. The City of

Manila, the capital of the Philippine Islands, is located on the western coast of Rizal Province along Manila Bay. The lenght of Rizal Province, north and south, is about 83.6 kilometers and the width, east and west, about 69.1 kilometers. Pasig, the capital of Rizal Province, is 12 kilometers from the City of Manila. Geogrqphically Rizal Province lies within 14° 40' north latitude and 121° east longitude.

The surface features of Rizal Province are characterized by mixed topography. The western part is low and flat. The regions bordering Laguna de Bay are either narrow coastal plains or small promontories. The rest is a region broken by spurs and ridges of the Sierra Madre Mountains. The underlying materials are chiefly Tertiary and later effusive rocks. Deposits of limestones, shales, and sandstones are found in many places. The principal mountains are Bantay Mountain in Montalban; Tayabasan, Lumutan, Pico-Susong Dalaga in Talim Island.

The largest valley in the province is Marikina valley. This extends from Pasig to Montalban, The approximate area is about 1 19,430 hectares, Marikina River is on the west side of the valley and flows throughout its length.

Teresa valley is located within the vicinity of Teresa town. The approximate area is 2,000 hectares. The area is a region of limestone.

AGRICULTURE

Agriculture has been the primary of the people of Rizal. Like the other industries the historical growth of agricultural activities is closely associated with the growth of the City of Manila. The proximity of the primary markets, available water transportation, and lately good roads connecting the different towns of the province to the City of Manila have contributed a great deal of the development of agriculture in this province.

Rizal has an approximate area of 232,915 hectares. The cultivated area is 42,528 hectares (1934), or 18.25 per cent, of open land; 8,320 hectares, or 55,52 percent, of open land; 8,320 hectares, 3.57 per cent, of timber land. The difference of 51,95 per cent in the area available for cultivation. The tillable area of Rizal province, therefore, is about 163,493 hectares, or 70.20 per cent of the total area. Most of these areas, however, are rolling lands, cogonal, and rocky regions. About 25.69 per cent of the province is covered with tropical forest, 22.4 per cent of which is

commercial forest. The kaingin system of agriculture has been partly responsible for converting the forest into open land and, consequently, into cogonal and potential critical areas. The fresh and salt-water marshes have been converted into fishponds and saltbeds.

The ten leading agricultural crops, arranged in the order of area planted, are rice, bananas, corn, mango, sugar cane, forage grass, lumbang, coconuts, tomatoes, and eggplants. The total area planted to these crops was 441,857 hectares (1934) and the value of the produce was 3,163.940 pesos. The area planted and the value of each crop are shown in Table 3.

Rice is the basic agricultural crop of Rizal Province. Rice responds well to a number of different soil types found in Rizal provided a sufficient amount of water is available during the growing period. Of the 42,528 hectares were planted to rice. The amount of production was 984,000 cavanes of palay valued at 2 2,316,550 pesos.

Practically all of the soils of Marikina Valley are planted to rice. A great portion of the Guadalupe and Bay types and the lowland phase of the Binañgonan soils are planted to rice.

The average yield of rice per hectare in the whole province is 31.2 cavanes. There is no government irrigation system maintained in the province. A small portion of the coastal plain in the town of Baras is irrigated from the small privately operated.

Banana growing occupies an important place in agriculture in Rizal Province. In July, 1934, it was estimated that there were 1,584,640 banana plants. Of these, 1,285,540 plants were bearing, with a yield of 667 bunches per hectare. The fruit are gathered when matured and taken to the Manila market. The price usually varies according to the supply and demand and according to the varieties. The varieties are latundan, bungulan, lacatan, tarnate, and saba. The commonest variety is the latundan. This fruit is in season throughout the year.

Next to bananas in area is corn. The varieties of corn cultivated are the native yellow flint and the white or more variety. Most of the corn is harvested green and sold in Manila. Corn areas are confirmed to the Quingua fine sandy loam in Marikina Valley. During the year ending July, 1934, 18,720 cavanes of corn were harvested. This excludes corn sold green.

Sugar cane is the third important crop. There is no centrifugal sugar central in Rizal Province. Sugar cane is milled in old muscovade mills, or in the sugar central at Canlubang, Laguna. In July, 1934, there were 14,860 piculs of centrifugal and muscovade sugar, 2,850 piculs of panocha, and 270,880 liters of molasses produced.

The total area planted to fruit trees of various kinds is approximately 1,119 hectares and the value of the produce (1934) was estimated to be 103,310 pesos. Of all the fruit trees planted in the province mango ranks the first with an area of 895 hectares producing fruits valued at 70,730 pesos. There are approximately 45,480 mango trees planted in Rizal, 18,320 of which are bearing trees. Most of the mango trees are located in the southwestern part of the province on the Novaliches series. There is a typical mango plantation of several thousand trees in Novaliches. The soils where these trees are grown are the typical reddish-brown loam and clay loam. Judging from the stand of those trees the mango plantation of Bulacan, a neighboring province, are located on Quingua silt loam.

The other fruit trees are pomelo, sugar apple, papaya, mandarin, chico, orange, soursop, custard apple, and lanzones. There were only 80 lanzones trees in the province. Pomelo occupies an area of 70 hectares, mandarin 38 hectares, and chico 31 hectares. In the uplands of the Antipolo and Teresa there are several cashew trees (Anacardium occidentale Linn.) and duhat (Bugenia jambolana Lam.). Judging from the luxuriant growth of these trees, the soil appears to be very appropriate for cashew and duhat trees.

Forage grass (June, 1934) occupied an area of 41, 020 pesos. This is grown side by side with lowland rice and is sold as food for horses. Because of the great number of horses used for transportation in the City of Manila, most of the grass feed is marked in Manila. In order to obtain the optimum yield of grass feed per unit area, commercial fertilizers(ammonium sulphate, 250 to 300 kilos per hectare) are applied to the soil at least once during the growing period.

There are some lumbang trees scattered thrpughout the upland regions of Rizal. The nuts are sold in Manila for oil extraction. The nut contains a high percentage of oil, which is used in the manufacture of paints.

Coconuts are also planted in small areas in some parts of Rizal/ In June, 1934, the estimated area was 153 hectares with 18,450 trees, 7,700 of which were bearing trees.

Tomatoes and eggplants are the two leading vegetable crops of Rizal. In 1934, 122 hectares were planted to tomatoes, yielding produce valued at 10,800 pesos; and the 118 hectares planted to eggplants yielded produce valued at 700 pesos. These crops are usually planted on the Quingua fine sandy loam along Marikina River and in the Bay soil type of Laguna de Bay. Other vegetable crops are beans, mongos, radishes, and cabbages. The total area planted to vegetable crops was 388 hectares, with the value of the produce amounting to 26,000 pesos. These vegetables find a ready market in the City of Manila.

A number of farm animals are raised in Rizal. Carabaos were estimated to be 34,976 heads; cattle, 8,494; horses, 4,947; hogs, 35,481; goats, 2,443; sheep, 705 and chickens, 471,782. There is no available figure for ducks. The duck-raising industry in Pateros and in Taguig was badly affected by the occurence of blue-green algae in Laguna de Bay, which in turn af-

fected the snails and other aquatic life that serve as a natural food sup ly for dusks. Part of this industry has been moved to Binañgonan; the location of this town being along the shore makes it a very good place for extensive duck raising in Rizal Province.

RIZAL SOILS

Difficulties have been encountered in the classification of soils in Rizal Province because of the existing parent materials that were found overlapping each other in a number of places. A large part of the province is underlain by tuffaceous materials. However, there are limestone deposits, volcanic tuff, and basqlts occuring in some places. Because of this complexity of parent materials influencing the soil formation a large number of soil series were established.

RIZAL SOILS

1. Hydrosol series.
   Rizal hydrosol.

2. Obando series.
   Obando fine sandy loam.

3. Quingua series.
   Quingua fine sandy loam.

4. Prensa series
   Prensa clay loam.

5. Novaliches series.
   Novaliches loam.
   Novaliches clay loam.
   Novaliches clay loam adobe.

6. Guadalupe series.
   Guadalupe clay.
   Guadalupe clay adobe.

7. Marikina series.
   Marikina silt loam.
   Marikina loam.
   Marikina clay loam.

8. Bay series.
   Bay clay loam.

9. Binañgonan series.
   Binañgonan clay.
   Binañgonan clay lowland phase.

10. Antipolo series.
    Antipolo clay.
    Antipolo clay loam.
    Antipolo soils undifferentiated.

11. Filled-up soils (City of Manila).

HYDROSOL SERIES

The hydrosol of Rizal Province is mostly utilized for fishpond and saltbeds. Because of the difficulty in delinating the soil boundary under water the hydrosol soils are classified and appear as such on the colored map. However, actual examination showed that in some places near the sea the subaqueous horizon, or mud bottoms, is a sandy loam to fine sandy loam, while in land the subaqueous horizon is clay loam to clay depending upon the soil of the immediate vicinities. The area of this hydrosol is about 1,300 hectares.

OBANDO SERIES

Obando fine sandy loam.- The Obando fine sandy loam is the result of accumulations of sandy material by the sea and the nearby river. It is characterized by a brown fine sandy loam surface soil with a depth ranging from 10 to 30 centimeters is a subsoil of brown fine sand. Beneath this subsoil is a gray sand with marine shells admixed. The area is about 1,995 hectares.

PRENSA SERIES

Prensa clay loam.- The surface soil of the Prensa clay loam is brown to dark yellowish brown or light reddish brown clay loam, loose and granular with plenty of spherical iron concretions. The depth ranges from 20 to 25 centimeters depending upon the extent of weathering of the parent material. The subsoil is gray, sometimes light yellowish gray to dull grayish brown, loose and gravelly clay grading to sandy clay with plenty of concretions. It ranges in depth from 40 to 50 centimeters. The substratum from a depth of 50 centimeters downward is gravelly clay, light grayish brown or dark brown in color. The most important characteristics feature of the area is the presence of some places of volcanic tuffaceous material which is used for building purposes. Rice is grown in some parts of this tupe of soil depending upon rainfall. To increase the rice production in this soil, manure or rich soil application on the surface has been the practice of the farmers.

NOVALICHES SERIES

The Novaliches soils are light reddish brown, reddish brown to bright reddish brown in color. The surface and subsoil friable in consistency and granular

in structure. Spherical iron concretions are present, especially in the subsoil. They are underlain by tuffaceous material of varying degrees of disintegration and weathering. This series occurs both in upland and lowland rolling and hilly topography.

In the upland area the lower subsoil has a horizon of light gray clay, which is sticky and plastic. The soil is covered by cogonal (Imperata exaltata) vegetation with occassional trees. The Alibangbang tree is very common in this area.

In the lowland area the lower subsoil is a horizon of light yellowish brown, highly weathered, tuffaceous material, and just below this is a massive and compact material. In some cases this tuffaceous material is exposed by extensive erosion. The soil is partly planted to lowland rice, which is dependent upon rain for its water, and partly covered with shrub and trees of various species. In spite of the soil conditions the land has been utilized for mango plantations. The plantations range from a few hectares to 500 or 600 hectares. In general, mangoes are not as productive in this type of soil as in other types, because the trees are easily uprooted by a strong winds. The commonest soil types found in this region are loam, clay

loam, and clay loam adobe.

Novaliches loam.- The surface soil of the Novaliches loam is reddish brown, friable and fine to coarse granular loam with the depth ranging from 20 to 40 centimeters. Concretions are present. The soil is comparatively poor in organic matter. Being friable, the soil is easily eroded. The subsoil down to a depth of 60 centimeters is brownish red, friable and ganular clay loam with concretion and gravel. As the depth increases the color changes from light brick red to rusty red. The substratum from a depth of 111 centimeters downward is tuffaceous material of varying degrees of weathering.

Novaliches clay loam adobe.- The upper surface soil ranging from 20 to 30 centimeters in brown heavy clay loam to clay with concretions. It is sticky when wet but friable when dry. The subsoil from a depth of 25 to 45 centimeters is light gray to brownish gray clay and compact. Concretions and gravel are present. Just below this is a compact volcanic tuff. The volcanic tuff in many places is exposed, or nearly so, making the surface soil very shallow. The level areas are planted to rice. This type occupies about 19,820 hectares.

Novaliches clay loam.- The upper 12 to 29 centimeters of surface soil is brownish red to light reddish brown clay loam, ganular and friable when seemingly dry and slightly stivky when wet. Reddish brown concretions are present in a considerable amount. The subsoil to a depth of from 54 to 81 centimeters is brick red clay loam to clay with gravel and reddish brown concretions. The substratum to a depth of from 100 to 150 centimeters downward is highly weathered tuffaceous material. A large portion of the area in Novaliches is planted to mango trees. The area covered by this type is about 16,940 hectares.

Novaliches clay loam adobe.

Depth of soil cm.	Characteristics.
0 to 5	Brown loose and friable loam to clay loam.
5 to 20	Dark-brown granular clay loam with gravel and concretions.
20 to 35	Adobe clay loam with concretions and gravel; highly weathered tuff.
35 to 60	Weathered adobe rock, slightly compact.
60 +	Compact and massive adobe rock.

GUADALUPE SERIES

The Guadalupe series, like the Novaliches series, is underlain by volcanic tuff of varying degrees of disintegration and weathering, but the resulting soil profile is very different from that of the Novaliches series, both in consistency and color.

The surface soil is very dark-brown to nearly black plastic clay. When dry it is coarse granular to cloddy structure. The subsoil is lighter in color than the surface soil. Spherical tuffaceous concretions are present in both the surface soil and the subsoil. Limestone concretions are also in some areas.

The series consists of lowland and upland areas. The upland area is slightly rolling topography. The lowland is devted to lowland rice. The upland area in some places is planted to upalnd rice and fruit trees.

Guadalupe clay.- The surface soil ranges in depth from 25 to 30 centimeters. It is very dark to nearly black clay, coarse granular to cloddy when dry. When wet it is very finely granular and sticky. The subsoil ranging from 50 to 80 centimeters is clay and is lighter in color than the surface soil. It is finely granular when dry and sticky when wet and contains tuffaceous spherical concretions. The lower subsoil is highly

weathered tuffaceous rock with crevices containing dark-colored soil from above. The substratum down to an indefinite depth is volcanic tuffaceous material of varying degrees of weathering. This type of soil, which is utilized mostly for rice, covers an area of about 8,885 hectares.

Guadalupe clay adobe.- Like the Guadalupe clay the surface soil is very dark to nearly black, ranging in depth 20 to 25 centimeters. When dry the soil is coarse ganular and slightly friable. The upper subsoil to a depth of from 40 to 45 centimeters is lighter in color than the surface soil. It is clay, granular and sticky. The lower subsoil is a zone of volcanic tuff material. The degree of weathering varies in many locations. The substratum is a solid volcanic tuff.

Guadalupe clay.

Depth of soil. cm.	Characteristics.
0 to 35	Very dark-brown to nearly black coarse granular clay. Cloddy when dry and sticky when wet. Plastic when seemingly dry.
35 to 50	Color is lighter than above. Spherical tuffaceous concretions present. Finely granular when dry and sticky when wet.

50 to 120	Tuffaceous rock with concretions. Black clay soil is present in the crevices of rocks.
120 to 150	Very dark to black soil leached from above.
150 +	Tuffaceous material, massive and hard.

MARIKINA SERIES

The Marikina series is a typical recent alluvial soil. The surface soil is medium or light brown to brown in color. Just below the surface soil is a horizon of very dark brown to dark gray in color, a little heavier in texture than the surface soil. This is the most distinguishing characteristics of the Marikina series. The substratum of this series is underlain by a tuffaceous material of varying degrees of weathering and disintegration. The presence of a dark-colored horizon in the subsoil is indicative of good drainage. This valley has been under rice for many years.

The Marikina soils occupy all Marikina Valley from the Montalban to Pateros. Rice is the important crop. Rain is the only source of water and consequently the time of planting depends entirely on the rainfall during the year. The soil being light in texture looses moisture easily. Soil of a heavier texture is located

on the west fault line. There are three types in this series; namely, loam, clay loam, and silt loam.

Marikina loam.- This type is found between the Marikina and Antipolo series on the San Mateo-Montalban area. The surface soil is a loam, friable, loose, and coarsely granular. Like the Marikina silt loam the upper subsoil is brown, somewhat darker in color than the surface soil; the lower subsoil is lighter in color and of clay texture. The substratum is clay loam to adobe clay loam; underlying a bed of tuffaceous material. The soil is planted to corn and vegetables. The area covered by this type is about 1,570 hectares.

Marikina clay loam.- On the western side of Marikina Valley along the fault line, is long strip of clay loam type of the Marikina series. A body of this type is also mapped on the Taytay and Paterós area, on the headwaters of the Pasig River. The surface soil is brown clay loam, almost compact but friable. The presence of some concretions on the surface soil of the area along the western side of Marikina River is due to the proximity of this type to the Novaliches series. This type is planted mostly to rice, corn, and sugar cane.

Marikina silt loam.- The principal type of soil in Marikina Valley is the Marikina silt loam. The surface soil ranges in depth from 20 to 25 centimeters and is light brown to brown silt loam with brick red streaks. The subsoil down to a depth of 35 to 40 centimeters is very dark-brown to dark-gray clay loam, granular and friable. In a natural and undisturbed condition this horizon assumes a columnar structure and is very friable, an indication of good drainage. The lower subsoil down to a depth of 80 centimeters is a brown friable and finely granular clay loam, with few spherical tuffaceous concretions. The substratum is a bed of highly weathered, disintegrated, tuffaceous material. This type occupies the middle portion of the valley from Montalban to Pasig. It is devoted entirely to rice production. It has been reported that the yield of rice in this type of soil is higher than in other rice lands in the province.

Marikina silt loam.

Depth of soil. cm.	Characteristics.
0 to 15	Medium brown silt loam with brick-red streaks. Almost compact but friable.
15 to 35	Dark brown to light gray clay loam, finely granular and very friable.
35 to 60	Light brown clay loam with light gray mixture. Almost compact but granular.
60 +	Light brown clay loam with slight motlings of light gray and brown clay loam. Almost compact and friable.

Bay Series

The soil of this series is dark brown surface soil with dark green to black sand in the substratum. This soil occurs along the Laguna de Bay shore, the fine surface materials of which very likely deposited by water from the lake. Most of the area is planted to rice, though some portions are utilized for duck raising.

Bay clay loam.- This type of soil has a brown to dark brown clay loam to clay surface soil. It is fine granular and friable when dry but sticky when wet. The depth ranges from 20 to 25 centimeters.

The depth ranges from 20 to 25 centimeters. The subsoil down to 50 centimeters is dark-green to bluish-green sticky clay. Just this horizon is dark-green sand. Rice is the principal crop for this soil.

BINAÑGONAN SERIES

The Binañgonan soil occupies an area of limstone. Like the surface soil of the Guadalupe type, the Binañgonan surface soil is very dark brown to nearly black. All the limestone regions so far investigated have this characteristic dark-colored surface soil.

The Binañgonan soil is the typical one of limestone origin. The surface soil is dark brownish gray to nearly black. The fine surface soil on drying assumes a distinct grayish brown to nearly black. The subsoil is light gray to whitish gray sticky clay. The lower subsoil is a highly weathered soft limestone material.

A large portion of this series is mountainous. Although the mountain section has only a thin layer of soil, the vegetation is quiet luxuriant.

Binañgonan clay.- The surface soil of the Binañgonan clay, ranging in depth from 20 to 25 centimeters, is dark brown to nearly black clay, coarse granular to

cloddy when dry and sticky when wet. The upper subsoil is clay, lighter in color than the surface soil. The lower subsoil ranging in depth from 40 to 55 centimeters is a calcareous horizon, light brown to nearly white. This is a highly weathered and disintegrated limstone. The substratum is a bed of stratified soft calcareous rock. This type, like the Sibul clay, is the limestone origin. The difference between the two types is that the Sibul clay is lighter in color, brown to medium brown, while the Binañgonan clay is very dark to nearly black. The subsoil of the Sibul clay has less calcareous material than the Binañgoman clay. The Binañgonan clay type follows a strip of soil from Binañgonan north to Montalban. Rice is planted to terraces. Corn is also cultivated in this region.

Binañgonan clay-lowland phase.- The lowland phase of the Binañgonan clay occupies the lacustrine valley of Teresa and the adjacent small valleys along the headwaters of Morong River. Rice is the principal crop.

Binañgonan clay.

Depth of soil. cm.	Characteristics.
0 to 20	Very dark-brown to nearly black clay, coarse granular and cloddy when dry and sticky when wet, Stiff when seemingly dry..
20 to 40	Clay lighter in color than above, granular when dry, sticky when wet.
40 to 55	Beginning of the lime accumulation. Light brown to nearly white in color, highly weathered limestone on the lower horizon.
55 to 100	Highly decomposed and weathered soft rock limestone.

ANTIPOLO SERIES

The antipolo series comprises red or reddish brown soils developed from igneous and other volcanic rocks. The soil developed around the Antipolo area is deeper than in vicinities of Morong, Tanay, Baras, Pililla. In some parts the upper subsoil is composed of highly weathered tuffaceous material. The lower part of the subsoil is lined with igneous or volcanic rocks, especially basalt of various degrees of weathering and disintegration. In some places the rocks are exposed on the surface. This series is covered partly with low-

grade forest, grass (cogon), and shrubs. It is also cultivated to some extent with upland rice and fruit trees like cashew. There are two types of soil in this series; namely, clay and clay loam.

Antipolo clay loam.- This type, as mapped, occurs in isolated areas. The surface soil is a dark reddish brown clay loam, finely granular and friable when dry, but slightly sticky when wet. The subsoil and substratum are like the clay type of this series. On sloping areas basaltic boulders are abundant. Both upland and lowland rice are planted in this type of soil.

Antipolo series undifferentiated.- The area occupies about 63,925 hectares. In some rough and mountainous and unsuited for cultivation. In some places the land has been used for grazing.

Antipolo clay.- The largest single type mapped in Rizal is the Antipolo clay. The surface soil ranging in depth from 25 to 30 centimeters is light reddish brown, very friable, and finely granular clay. Spherial tuffaceous concretions are present. The upper subsoil ranging in depth from 50 to 60 centimeters is dqrk reddish-brown, granular, and friable clay loam with fine spherical iron concretions. The lower

subsoil to a depth of from 45 to 90 centimeters is a zone of highly weathered tuffaceous material. Few concretions are present. The substratum from 120 centimeters to an indefinite depth is coarse granular, dark reddish brown clay loam with numerous iron concretions. This type is well developed in the vicinity of Antipolo and in the upland of Montalban. A large area is mapped just across the Binañgonan clay type which extends to Pililla and Jalajala. In the vicinity of Antipolo, corn and rice are planted in terraces. Cashew and duhat trees are also found growing in several places. Pineapples are grown on the lower slopes of this district.

ANTIPOLO CLAY

Depth of soil cm.	Characteristics.
0 to 27	Light reddish brown, friable, and finely granular clay. Presence of spherical tuffaceous concretions. Slightly compact.
27 to 65	Dark reddish brown, granular to friable clay. Concretions are present. Slightly compact.
65 to 85	Bright reddish brown granular and friable clay loam. The lower part of this horizon is the beginning of the adobe structure. Slightly compact.

85 to 120	Zone of highly weathered tuffaceous material hardly noticeable unless the soil material is washed exposing the skeletal tuffaceous remains. The soil is finely granular, slightly friable clay loam. Concretions are present.
120 to 150	Coarse granular, dark reddish brown clay loam and very friable. Soft concretions are present.

Filled-in soils.- The district in which the City of Manila and its suburbs are located consists of filled-up soils from different sources. Sands from the river beds, volcanic tuff and reddish brown soils from near Novaliches, silts from the esteros, and various other similar sourves constitute the soil materials used for filling-up. On the map this area is placed under one color to indicate a filled-in area.

SOIL EROSION AND WATER CONSERVATION

The problems of soil erosion and water conservation in the Philippines have not been seriously considered. Several soil types in Rizal Province are very susceptible to erosion. The Antipolo soils being very friable erode easily. The cogonal in the mountains of Pililla on the boundary of Laguna Province is exposed to erosion activity. In several areas gully

erosion has already gained headway and several hectares will soon be reduced to bad land topography.

The soils along the hillside of Marikina River are critical ares. Several hectares hawe been destroyed and converted into river beds, for the water of Marikina River has been eating into the river banks. The absence of trees and other soil-binding materials along the banks makes the soil an easy for native erosion. In some parts of the Pasig-Montalban road the river has cut its bank to the road.

Usually the river banks are hold intact when trees are grown on them. The best plants found to hold the soil ad the bank in place are the bamboos. When they are all planted in a series of rows along the river bank, the erosion of the soil is reduced to a minimum. In many parts of the province, where the soil is barren, bamboo will grow well and will hold in place the soil that would be eroded during the terrential rains.

Water conservation is a problem in any part of the World. In Rizal Province the problem of water conservation requires the forestation of the cogonal areas of the uplands. The Novaliches region would region

would make excellent reservoir if the Novaliches soil were well covered with forest. The Antipolo soils are badly deforested. Water that accumulates during the rainy season runs off easily and soon evaporates, leaving the region almost without water during the dry season. The friability and looseness of the Antipolo soils enhance evaporation, especially when the soil is almost devoid of proper plant cover.

The Guadalupe and Binañgonan soils, although sticky plastic, and heavy, cannot hold the moisture as they once could. Due to lack of adequate plant cover, the soil cracks on drying, thus making opeinings for the moisture to evaporate.

A program for water conservation and the control of soil erosion is recommended for Rizal Province. Several kinds of bamboo grow well in various types of soils. These plants are highly recommended for erosion-control work, particularly on river banks.

ANALYSIS OF RIZAL SOILS

Chemical analysis.- The Philippine practices of conducting soil surveys consists first in taking samples of major soil types. These samples are then analyzed chemically for the essential plan-food elements, such as nitrogen, phosphorus, and potassium. The analysis also includes pH value, organic carbon, calcium, and magnesium. The number of samples obtained from such soil type depends upon the extent and the agricultural importance of the soil type. The chemical analysis is confined entirely to surface-soil samples. These are taken at a depth of 16 centimeters. Subsoil samples were also taken in conjunction with the surface samples.

The data (Table 5) represent the average chemical analysis for each major soil type. The determination of the pH value was made by the electronic method, using the antimony electrode. The organic carbon content was determined in accordance with Parr's method. All the other chemical analysis consisted of total determinations.

The object of making the chemical analysis is to ascertain the chemical composition of the different soil types and thus obtain information concerning the fer

lizer requirements. The data given in Table 5 show that the soils of Rizal are slightly acidic in reaction, with the pH ranging from 5.03 to 6.95. In general these soils are low in phosphorus and potassium, but the nitrogen content is about normal.

Mechanical analysis.- The results of the mechanical analysis of the surface soils of the different soil types found in Rizal Province are recorded in Table 6. These analyses serve as a check on the field description of the soil types.

SUMMARY

Rizal Province, with Pasig as the capital, was founded in 1901, and was made a first-class province in 1925. This province has 26 municipalities; 5 first class, 4 second class, 5 third class, and 12 fourth class.

The total area, including the City of Manila, is 232,912 hectares.

The populations according to the census of 1918, excluding the population of the City of Manila (353,418), was 314,458.

The climate is tropical and generally an alternation of the wet and dry season.

Transportation and communications, electric and telephone service, are available throughout the Province.

Public schools are available in almost all towns in the province, and some of the large towns have private schools conducted by the Catholic church.

Pulic-health activities are taken care of by the Philippine Bureau of Health. The water system operated by the Metropolitan Water District supplies good drinking water to thd City of Manila and neighboring towns.

The province is drained by the Pasig and Marikina Rivers, which empty into Manila Bay. At present there is no irrigation system operated in this province.

Crops are grown is accordance with the annual precipitation.

Rizal Province is situated in the southwestern part of Luzon. It is bounded by Bulacan Province on the north, by Laguna and Tayabas Provinces on the south, and by Manila Bay on the west. Geographically Rizal Province lies within $14^{\circ}40'$ north and $121^{\circ}10'$ east longitude.

The surface feature of Rizal Province re characterized by mixed topography. The western part is low and flat. The regions bordering Laguna de Bay are

either narrow coastal plains or small promontories. The remainder is an area broken by the spurs and ridges of the Sierra Madre Mountains.

The underlying materials consisting the soils of Rizal are chiefly Tertiary and later effusive rocks. Deposits of limestones, shales and sandstones are found in many places.

Agriculture is the most important industry. The development of this industry is closely associated with the growth of the City of Manila. Manila is the market center for the products of Rizal Province. Manufacturing and fishing are also important activities.

Rice is the leading crop of this Province. The area planted to rice is about 35,200 hectares. The other crop are bananas, corn, sugar cane, fruit trees, and vegetables.

The soil of Rizal Province consists of 10 series and 19 types, including the filled-in soils covering t the area in which the City of Manila and neighboring places are located. The Antipolo and Novaliches series occupy the greater portion of the Province.

Antipolo clay is the largest soil type surveyed, followed by Novaliches clay loam adobe. Marikina silt loam may be considered as one of the best soils in Rizal.

Chemical and mechanical analyses of the surface soil of each soil type were made. In general the analyses showed that the soils are slightly acidic, with pH ranging from 5.95. The phosphorus and potash contents are low, but the nitrogen is about normal. The analytical results indicate that the average soils of Rizal Province require fertilizer treatment to remedy the deficiency in phosphorus and potash for normal crop production.

Soil surveys give basic scientific data showing the actual soil conditions in a given area. The laboratory data are supplemented with field tests as to the adaptability and treatment of soils for certain crops. The information thus obtained is applicable to other places under similar soil conditions.

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Table 1. - Temperature and rainfall of Antipolo and rainfall of other stations in Rizal from 1925 to 1935.

Month	Antipolo			Rainfall			
	Temperature						
	Maximum	Minimum	Rainfall	Bosobo-so Antipolo	Montalban	La Mesa: Novaliches	Alabang Stock Farm
	oC.	oC.	mm.	mm.	mm.	mm.	mm.
January	29.8	19.4	21.3	20.2	58.3	15.2	11.4
February	31.1	19.6	17.7	6.6	17.4	18.6	18.4
March	32.9	20.6	13.1	13.0	16.0	12.2	5.8
April	34.3	21.9	41.5	30.3	60.6	64.4	23.8
May	33.5	23.0	299.1	244.7	280.1	193.2	276.1
June	31.2	22.8	376.2	422.5	472.9	382.0	267.5
July	29.8	22.6	583.4	572.7	716.6	552.1	326.6
August	29.5	22.3	501.0	525.7	636.8	532.1	396.4
September	29.7	22.2	437.3	487.4	515.3	388.9	283.3
October	29.8	21.7	266.9	303.2	284.6	233.3	168.5
November	29.7	21.0	138.7	143.1	151.2	115.2	112.2
December	29.4	20.4	68.1	80.6	84.4	56.1	41.2
Mean Annual			2,764.3	2,850.0	3,302.2	2,563.3	1,931.2

Table 2. - Approximate area of Rizal province

Kind of Land	Area		Timberland	
	Hectares.	Per cent	Hectares	Per cent
Commercial forest	52,190	22,40	40,060	17.20
Non-Commercial forest	7,664	3,29	730	0.31
Cultivated area	42,528	18,25	_____	_____
Open land	129,285	55.52	8,320	3.57
Fresh-water marsh	413	0.18	_____	_____
Salt marsh	835	0.36	_____	_____
T O T A L * - -	132,915	100.00	49,110	21.8

a Fischer, A.F., Wealth of our forest. The Philippine Herald Yearbook 3 (1935) 41-45.

Table 3.- Ten leading crops of Rizal Province in the order of their area in July, 1934.

Crop	Area	Value
	Hectares	Pesos
Palay	35,140	2,316.550
Bananas	2,377	370.760
Corn	1,890	41,190
Mongos	846	70,380
Sugar cane	820	270.880
Forage grass	241	41,020
Lumbang nuts	153	33,030
Coconuts	150	1,560
Tomatoes	122	10,800
Eggplants	118	7,770
Total -	41,857	3,163,940

Table 4.- Hectarage and proportionate extent of soils mapped in Rizal Province.

TYPE OF SOIL	AREA	
	Hectares	Per cent
Rizal hydrosol	1,300	0.6
Obando fine sandy loam	1,995	0.9
Quingua fine sandy loam	2,220	1.0
Prensa clay loam	2,090	0.9
Novaliches loam	2,520	1.1
Novaliches clay loam	16,940	7.3
Novaliches clay loam adobe	19,820	8.5
Guadalupe clay	8,885	3.8
Guadalupe clay adobe	11,775	5.0
Marikina silt loam	11,250	4.8
Marikina loam	1,570	0.7
Marikina clay loam	4,410	1.9
Bay clay loam	2,525	1.1
Binangonan clay	12,890	5.5
Antipolo clay	51,540	22.1
Antipolo clay loam	8,680	3.7
Antipolo soil undifferentiated	63,925	27.4
Filled-in soils	3,950	1.7
Total - - - - - -	232,915	100.0

Table 6. - Mechanical analyses of the surface soil of different soil types of Rizal Province.

Type: No.:	Sand (2-0.05) mm.	Silt (0.05-0.005) mm.	Clay (0.0005-0) mm.
	Per cent	Per cent	Per cent
2 : Obando fine sandy loam	68.6	18.3	13.1
4 : Quinga fine sandy loam	66.4	25.2	8.4
6 : Prensa clay loam	47.0	24.0	29.0
11 : Novaliches loam	29.4	23.0	47.6
12 : Novaliches clay loam	31.0	28.4	40.6
17 : Novaliches clay loam adobe	48.2	19.0	32.8
18 : Guadalupe clay	33.8	11.4	54.8
19 : Guadalupe clay adobe	39.9	17.1	43.0
20 : Marikina silt loam	22.8	50.0	27.2
21 : Marikina loam	36.9	30.2	32.9
22 : Marikina clay loam	30.8	24.2	45.0
23 : Bay clay loam	29.0	23.6	46.6
24 : Binangonan clay	36.6	8.0	55.4
25 : Binangonan clay lowland phase	31.7	20.4	47.9
26 : Antipolo clay	29.4	12.0	58.6
27 : Antipolo clay loam	27.0	18.2	54.8

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