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Distribution and characteristics of the vegetation of Central Luzon, Philippines.

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Thesis

DISTRIBUTION AND CHARACTERISTICS OF THE VEGETATION
OF CENTRAL LUZON, PHILIPPINES

by

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INTRODUCTION

Agriculture is one of the oldest occupations of civilized men, and is still the most essential form of human industry; for agriculture supplies not only the food for the world's population but a considerable proportion of the raw materials for manufacturing. Agriculture is relatively more important in Central Luzon than in areas of the temperate zones, because there is little manufacturing, and the soil and climate are especially favorable to the growth of plants. Because of this advantage, agriculture will surely continue to be the chief occupation in Central Luzon, and no other subject studied will have so great an economic value as this one. This study is an attempt to present concisely the fundamental facts about the distribution and characteristics of the vegetation of Central Luzon, Philippines, and to show the relationship of these facts to the life of the Filipino.
PART I

LOCATION AND PHYSICAL SETTING
LOCATION MAP
CENTRAL LUZON
LOCATION

See: Figure 1

Central Luzon comprises the middle part of the island of Luzon, which in turn is the most significant and largest of the nearly 7,100 islands of the Philippine archipelago. The area consists of the nine Provinces of Bataan, Bulacan, Manila City, Nueva Ecija, Pampanga, Pangasinan, Rizal, Tarlac, and Zambales.

Central Luzon is strategically located, lying only 400 miles southeast of the Chinese coast and 740 miles east of French Indo-China. Manila, with its adjacent bay and lowland hinterland, is the economic hub of the Philippines; one of the major ports of the Far East, and the focus of Philippine transportation and trade.
RELIEF MAP

LOWLANDS

UPLANDS AND PLATEAUS

MOUNTAINS

Figure 2
PHYSIOGRAPHY

See: Figures 2, 3, 8.

The topography of Central Luzon is relatively simple. A central depression is bordered by two mountain masses, each of the three units forming a distinct physiographic region. From east to west they are: (1) Central Sierra Madre, (2) Central Plain, and (3) Zambales Mountains.

The Central Sierra Madre is 75 miles long and reaches a width of 30 miles. The area is characterized by densely forested, rugged mountains, with peaks reaching 4,000 feet in elevation. The mountains have steep slopes on both the east and west. Near the southern end, at Infanta, a low triangular peninsula reaching 5 miles in width juts into the sea. The southward terminus of the mountain range is Laguna de Bay, where a belt of low hills predominate.

The Central Plain lies between the Zambales Mountains to the west, the Cordillera Central to the north, and the Central Sierra Madre to the east. Northwestward it opens on Lingayen Gulf, southward on Manila Bay. The Central Plain is 100 miles in length; 30 miles wide in the north, 50 miles wide in the center, and 40 miles wide in the south. It is traversed by two major rivers, the Agno and the Pampanga. These have their sources in the Cordillera Central in the north. The Agno River crosses the Plain from northeast to southwest to the foot of the Zambales Mountains and then
meanders north into Lingayen Gulf. At Lingayen Gulf the Central Plain ends in a sand dune coast. Tidal marshes occupy a belt about 3 miles wide behind the dunes. The course of the Agno River reflects the general southwesterly slope of the northern part of the Plain. The Pampanga River flows relatively straight south to Manila Bay, through the central and southern parts of the Plain, indicating the general slope of these sections. Most of the Plain is level; floods are common. A large section of the Plain adjoining the east bank of the lower Pampanga River is permanently flooded. This is the Candaba Swamp. In the southern part of the Plain the isolated cone of Mount Arayat, an extinct volcano, rises 3,300 feet. The undulating plain at the foot of the Sierra Madre continues southward into the isthmus between Manila Bay and Laguna de Bay. Sloping gently toward Manila Bay the lowland of Manila ends to the east in a bluff about 170 feet high. The Central Plain is flanked by foothills in its central and southern part. Along the foot of the Sierra Madre the hills in the northern part are oriented parallel to the mountains, and in the southern part are low spurs trending away from the mountains. Foothills are almost entirely absent along the northern edge of the Central Plain. Instead, the level plains end suddenly against the abrupt slopes of the Cordillera Central.2

The Zambales Mountains, reaching an elevation of 7,600 feet, form a well-defined topographic unit between the Central
Relief model of the Philippine Islands. Notice the configuration of Central Luzon. The Zambales Mountains and the Central Sierra Madre are separated by the extensive and conspicuous Central Plain. The Central Plain is the largest of the lowlands. The relief of the Philippines gives an indication as to the reason for the great population density of the Central Plain. This is a United States Army photograph.

Figure 3
Plain and the China Sea. This mountainous area terminates to the north and south (Bataan proper) in large peninsulas dipping into Lingayen Gulf and Manila Bay respectively. The characteristic feature is the Zambales Range proper which forms the backbone of the area. Extending along the China Sea is a narrow coastal plain, frequently interrupted by numerous isolated low hills.
WEATHER STATIONS

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RAINFALL BY ZONES

- Two pronounced seasons; dry in winter and spring, wet in summer and autumn.
- No dry season; with a very pronounced maximum rainfall in winter.
- No very pronounced maximum rain period, with a short dry season lasting from one to three months.
- No very pronounced maximum rain period and no dry season.

Figure 4
CLIMATE

See: Figures 4, 5.

The climate of Central Luzon is tropical. Abundant precipitation, constant heat, high relative humidity, and variable but mostly gentle winds are typical. Few tropical storms occur yearly. Local topography causes variations in the weather.

The dominant winds are the northeast and southwest monsoons. Both change seasonally, each prevailing for five months. The shift from one to the other monsoon is gradual, producing a spring transition period of two months. But in autumn the southwest monsoon rapidly gives way to a strong northeasterly wind, with the transition effected within a two week period. The year is thus divisible into three seasons based on varying degrees of rainfall.

The rainy season extends from June to October (the summer and autumn months). The deflected trade winds cause a predominantly southwest circulation, and moist, unstable equatorial air overlies Central Luzon.

A prolonged or secondary rainy season occurs from November to April (the winter months) when the northeast monsoon drenches the eastern coasts and windward mountain slopes. The western or leeward mountain slopes are comparatively dry.

During the spring months (April and May) northeast trade winds are typical and tropical maritime air overlies the area;
rainfall being light. Thus there are two distinct climatic types, one in which the dry season is long and pronounced, and another in which the dry season is shorter and less pronounced. Forests in the west during the latter season shed a portion of their leaves, and some trees are even entirely defoliated for a short time; in the east, forests are generally evergreen. Though areas of grassland are found in both, they establish themselves more readily in the drier belt.

The amount of rainfall in local showers and relative humidity is less in the lowlands than in the high altitudes. Consequently the forests of the low altitudes may show a much less evergreen appearance than the forests of higher altitudes.

The rugged relief and the degree of exposure to prevailing winds cause decided place-to-place contrasts in certain climatic elements, particularly during the northeast monsoon. The eastern coast receives maximum rainfall from November to February, while the central and western regions experience relatively dry weather. In addition, slight local differences in slope or exposure frequently give nearby places dissimilar wind and rainfall regimes.

Over all of this area rainfall is heavy; most places receive an average of between 50 and 145 inches a year. Place-to-place contrasts are irregular and are controlled largely by local relief. Rainfall is much heavier on exposed mountain slopes than over the lowlands.
ANNUAL AVERAGE TEMPERATURE AND PRECIPITATION OF CENTRAL LUZON

**Figure 5**
Seasonal variation is not great. However, many places have significant seasonal variation associated with orographic exposure. Areas exposed to the northeast are generally wet in all seasons, but have the greatest rainfall in winter. Areas exposed to the southwest are relatively dry in winter and spring, with heavy rainfall in summer and fall.

Over most of the area rain falls on 125 to 220 days a year. Rainfall is usually in the form of intense showers. Rains are most intense in the wet season, when falls of more than one-half inch can be expected on about one-third of the rainy days.

In all seasons, over most of the lowland, temperatures range from about 70 degrees Fahrenheit in the early morning to 90 degrees Fahrenheit in early afternoon. Temperatures below 65 degrees or above 95 degrees Fahrenheit are infrequent. Cooler conditions prevail in the highlands. Very high relative humidity prevails in all seasons, averaging about 80% throughout the year.
Figure 6

SOILS

- Alluvial soils - Texture undifferentiated
- Medium textured soils developed from igneous and sedimentary rocks (loam soils)
- Thin stony soils and rock outcrops of mountains
- Swamp and marsh (inundated soils)
- Fine textured soils developed from sedimentary rocks (clays)
SOILS

See: Figure 6

The soils of Central Luzon are generally deep, rich, and fertile, mostly of volcanic origin. However, in most forested areas the soil varies from clay to clay loam which has a depth of about two or more feet.

Developed soils, resulting from the effect of high temperatures and abundant moisture, show lateritic weathering, but a few true laterites have been found. Large areas of undeveloped soils have been built up through recent flooding or by deposits of volcanic ash. In upland areas the soils are sometimes derived from volcanic ash and rock. Coral limestone is also an important element in the material from which some soils are derived.

The water-holding capacity of the soil is relatively high. The amount of water in the soil in the forests increases with the rising elevations, until, in the moss forests, the soil is practically saturated. In cultivated areas and grasslands water-holding capacity of the soil varies considerably.

In an area like Central Luzon, where climatic conditions bring about heavy precipitation and high temperatures, soil erosion and soil depletion are more accelerated than in semi-temperate regions. Every year thousands of tons of top soil are washed away by runoff. Consequently, many sections of the country are declining rapidly in crop productivity; floods are
gaining in frequency and seriousness; lands once productive are being abandoned due to submarginality; and diseases due to dietary deficiencies are today more prevalent than before. Soil erosion, prevention, and control deserve top priority and preferential attention.
CENTRAL LUZON

DRAINAGE

Figure 7
DRAINAGE

See: Figures 7, 8.

Numerous torrential streams in the hilly areas, together with lowland streams, wells, springs, and cisterns yield a supply of fresh water sufficient for agricultural use. The main drainage lines in the area are well defined and doubtless structural, north and south, with the usual attendant tributaries, influenced by local or minor topographic features.

The chief river systems of Central Luzon are those of the Agno and Pampanga Rivers. Both are sluggish and relatively shallow. These streams prolong the growing season by artificial irrigation and threaten the Central Plain with floods. The Agno River rises in the Cordillera Central and flows southward into the northern part of the Central Plain where it makes a sharp northwestward bend and empties into Lingayen Gulf.

The Pampanga River is the largest river flowing into Manila Bay, starting as a torrential stream in the upper part of the Cordillera Central to the north and descending in a serpentine manner through the 'heart' of the Central Plain. The principal tributaries of the Pampanga are the relatively small Angat, Maasim, and Penaranda, which flow in from the east. Among the other rivers emptying into Manila Bay, but of less significance, are the 9 mile long Pasag and Pasig Rivers south
of the Pampanga River. The Pasig River is the outlet for Laguna de Bay.

The only lake of significance is Laguna de Bay, which forms part of the Central Luzon boundary, and is over 340 square miles in area. It plays a small part in the drainage and transportation value of Central Luzon because it has no surficial outlets.

The only fresh water swamp of any size is Candaba Swamp located in eastern Pampanga Province. The largest salt water swamps border the northern shore of Manila Bay, where much of the mangrove has been cleared for firewood and reclaimed areas utilized for fish ponds and salt pans. Numerous narrow water courses meander through these salt water swamps.
SUMMARY

Major relief, drainage, and vegetation characteristics of each terrain region are as follows:

I. Central Sierra Madre
   A. Physiography
      1. Mountains. Coastal plain at Infanta.
   B. Drainage
      1. Mountain streams.
   C. Vegetation
      1. Dense forest. Secondary forest, clearings, and cogon patches along western margin. Coconuts and rice on Infanta plain.

II. Central Plain
   A. Physiography
   B. Drainage
      1. Sluggish rivers; swamps border north side of Manila Bay and behind beaches in east Pampanga Province.
   C. Vegetation
      1. Almost entirely cultivated in rice, sugar-cane. Considerable areas of grassland and second growth forest, especially near borders. Salt water swamps in mangrove or nipa palm. Candaba Swamp in marsh grass and wild cane.

III. Zambales Range
   A. Physiography
      1. Steep, rugged mountains above 5,000 feet in elevation.
   B. Drainage
      1. Swift mountain streams.
   C. Vegetation
      1. Dense forest. Some pine and mossy forests. Scattered grassy ridges at lower elevations, especially on east side.

Figure 8
PART II

NATURAL VEGETATION
Vegetation types and their distribution throughout the Philippines. Notice most of the Central Plain is cultivated land and the Zambales and Central Sierra Madre are well forested. Compare vegetation map with the relief map.

Figure 9
NATURAL VEGETATION

See: Figures 9, 12.

Most of the land area of Central Luzon was originally covered with unbroken forest growth. Where forests are located within easy reach of a large agricultural population, the forests have been drained of their more valuable species. After these species have disappeared, the edges of the forest pass through a period of heavy culling where patches of settlement occur. Shrubs, vines, and small trees gain a foothold and develop. In the more thickly settled areas, forests have disappeared almost completely, giving way to grass or dense secondary growth.

Forest vegetation of Central Luzon consists of mangrove stands along the coast, tropical rain forests in lowlands and on the lower mountain slopes, pine forests in higher elevations, and mossy forests on the slopes of some high mountains. Trees, commonly with diameters of 3 feet or even more, grow in great variety in the tropical forests. The vine-covered foliage shades the ground, and the air is usually moist and relatively cool. Where the sun shines through the trees, the ground is usually covered with tangled vegetation through which it is difficult to pass. In the high altitudes many varieties of small trees and shrubs prevail, and the ground is covered with moss.

Grasslands are called "cogonales". The grass grows from
a few feet to as much as 8 feet high and forms a very thick cover. A large part of these grasslands are man-made (result from shifting cultivation or burning). Hill tribes make patchy clearings in the virgin forests between 2,000 and 3,000 feet in elevation above sea level. The clearings thus gained are planted for one or two seasons without blowing the soil and then abandoned for a new clearing. When planted repeatedly, the fields do not revert to forest but to grassland.

Climate plays a dominant role in the distribution of forest types throughout Central Luzon. Environmental conditions in the forests are favorable for growth year round. Where there is a long dry season, the evergreen forests will be found at higher elevations, while the lowland forests will contain many deciduous trees mixed with bamboos. Humidity and soil moisture are always high in the forests; rates of evaporation low.

Most of the forests of Central Luzon, like those in other parts of the archipelago, belong to the tropical rain-forest type. A characteristic of this is the great mixture of different species of trees. However, it would seem that, in general, the area is fortunate in having heavier stands than usual of similar merchantable timber trees; consequently commercial lumbering can be carried on more profitably than in many equatorial regions. In regard to quantity per acre and usefulness, the most important group of timber trees is the
Dipterocarps, which furnish important commercial timbers. The trees of the dipterocarp types mainly utilized for lumber are lauan, hagachae, vacal, anitong, and oak. Rattans and other minor forest products are also obtained from these forests.

Where there are muddy shores, as at the head of bays and other protected places along the coasts, there are mangrove swamps. Practically all the useful tanbark has already been collected, worked up into cutch in Manila, and exported to the United States. Nipa palms, important as a thatch material, are also common in the coastal swamps.

Fresh water swamps occur along the middle reaches of the Pampanga River. In some of the fresh water swamps sago palms are common. Their starch-filled trunks are a source of food for some of the people.

On the higher mountains the botanical composition of the forests change with increasing altitude. The height of the tropical forest gradually decreases, until near the tops the trees are dwarfed and draped with moss and the soil is covered with a relatively deep, spongy mass of organic matter.
Mangrove swamp-lined tidal distributaries of the Pampanga River emptying into Manila Bay. Mangroves reach their best development on delta regions of large rivers and at the head of protected bays. Notice the settlement cluster occupying a meander of the main stream and reclaimed cultivated patches within the mangrove areas. This indicates the panaceas being employed in the population pressure problem.

Figure 10
MANGROVE SWAMP FORESTS

See: Figures 9, 10.

Distribution:

Mangrove swamp forests are scattered along protected sea-coasts on soft mud near river mouths, on river deltas, and along shallow bays and tidal river banks. They occur mostly along the coasts of Pampanga, Bulacan, and Pangasinan Provinces.

Characteristics:

Mangroves reach their best development on delta regions of large rivers and at heads of protected bays. They consist of medium-sized and even-aged trees, which may grow to 100 feet in height and 4 feet in diameter. There is usually little undergrowth. The mangrove thickets are a mass of tough branches and snarly root systems. For the greater part of the time the roots and even the lower parts of the tree trunks are submerged in from 1 to 3 feet of salt water, while at high tide the lower limbs and foliage of the trees on the edges of the swamps are submerged for short periods of time.

Trees are generally low-branched and crooked. Depending upon the species, the roots showing on or above the ground surface may take the form of erect "air" roots (resembling tent pegs and measuring up to 10 inches high and 2 inches in diameter), knee-like prop roots up to 6 feet high, or crawling roots with side branches extending along the ground.
surface. These peculiar varieties of root systems are a distinguishing characteristic of the mangrove forest. The leaves of all trees are tough and leathery.

Just inland from the mangrove swamp forests there are often small, narrow belts not flooded at any time by the tides, yet containing too much water for the growth of forest trees. These areas contain a tangle of low-growing vines, shrubs, and ferns.

Mangroves are the principal sources of tanbark (tannin), dyewood, and charcoal. Some of the woods can be used as construction timber.
NIPA PALM SWAMPS

See: Figures 9, 10.

Distribution:

Nipa palms are found in soft mud on the landward side of mangrove swamps in tidal estuaries and rivers flooded with brackish water. A swamp area about 20 miles long and 3 miles wide located just north of Manila Bay has recently been reclaimed for the cultivation of nipa palms. Like the mangroves, nipa are commonly found in Pampanga, Bulacan, and Pangasinan Provinces.

Characteristics:

Nipa are wild and semi-cultivated short-stemmed palms requiring about 4 years to mature. Each plant has 7 or 8 leaves about 15 or 20 feet in length. The plants develop underground stems which start new centers about one yard apart. Seeds carried by water and deposited on land under shade produce the most healthy plants.

In cultivated areas seeds are planted 6 feet apart during May and June. Mature palms are harvested from July to April. Sap from the flower stalks is the chief source for native alcohol and vinegar. Palm leaves provide inexpensive roofing and thatching materials.
BEACH VEGETATION

See: Figures 9, 12.

Distribution:

As the name infers this type of vegetation is found above high-tide limits on sandy beaches where the original vegetation has been left undisturbed.

Characteristics:

Narrow, discontinuous sandy beaches of varying lengths are commonly found along the coasts and at the mouths of large rivers in Central Luzon. These are usually covered with a frontal zone consisting of a tangle of vegetation made up of casuarina or screw pine trees, low-growing plants, vines, and shrubs. The canopy of dominant species is of simple composition, open, and predominantly deciduous.

Casuarina trees form a conspicuous part of beach vegetation. They attain a height of 75 feet and a diameter of 3 feet, with long, whip-like branches. Undergrowth is generally absent except for the seedlings. The wood, sometimes known as "iron-wood" (because it is very hard and heavy), is an excellent firewood and is suitable for construction purposes.

Behind the frontal zone a narra type forest is found. This forest grows on newly made and poorly drained mud flats, gradually disappearing where higher and better drained soil is reached. It is characterized by a few tall narra trees widely scattered amongst a dense undergrowth of palms and
climbing bamboos with a mixture of vines, herbs, and shrubs.
Mixed stream bank vegetation lining the Pampanga River in its upper reaches. Stream vegetation varies with the nature of the surrounding country; often dense and tangled in forested areas and grasses and shade trees with a few fruit trees in cultivated areas. Notice tall grass and shade trees predominate in this area.

Figure 11
STREAM BANK VEGETATION

See: Figure 9, 11.

Distribution:

This is a mixed growth of vegetation occurring along streams. The vegetation varies with the nature of the surrounding country.

Characteristics:

Growth as a whole has the character of secondary growth forests. In cultivated areas usually grass, fruit and shade trees predominate. In some of the farming areas streams are lined with dense thickets of bamboo, interspersed in places with papaya and jack fruit trees.

In forests a thin belt of trees and jungle growth may line streams. Where streams are large enough to move logs by water, a narrow belt of secondary growth about 200 yards wide may adjoin streams due to logging practices.
FRESH WATER SWAMP VEGETATION

See: Figure 9.

Distribution:

Fresh water swamps are very few and fluctuate seasonally in areal extent. They are found where the water table is always high, and in some areas that are always flooded.

The most important fresh water swamp is the Candaba Swamp located in the valley of the Pampanga River. It is 20 miles long, egg-like in shape, and lies near the heart of the Central Plain.

Characteristics:

These swamps are periodic in character, contracting to well-defined lakes in dry weather and flooding large areas in the wet seasons. Coarse grass and sago palms dominate the landscape and make up the major part of the vegetation.

In most of the swampland the water is covered with floating vegetation with low-growing grass at the edges. The land which is inundated only part of the year, as far west as Sexmoan, is covered with a dense blanket of tall, reed-like grass 10 feet high. Some parts have been drained and are used for rice cultivation.

Sago palms, known as "fresh water nipa palms," grow in clumps on muddy, soft ground. They grow up to 50 feet high and 15 inches in diameter. These palms are cultivated in scattered patches throughout the swampland. The leaves,
which attain 20 feet in length, are used as thatching material. Rice and vegetables are grown by native swamp dwellers on the mud flats in the dry season.
GRASSES

See: Figures 9, 11.

Distribution:

Grasses are prevalent at nearly all elevations, from sea level to the tops of mountains. Large areas in Central Luzon are covered with grass, partly as the result of shifting cultivation and frequent burning.

Characteristics:

When a forest is cleared and the soil is cultivated by crude methods, grass and weeds invade the area. In order to remove them, it is a common practice to cut and burn all vegetation. This kills the tree seedlings and shrubs, but does not harm the grass, which has sturdy underground stems. This practice leaves the land in grass.

Grasses form dense masses of roots and underground stems. Where fires are absent, grasses are associated with vines, small trees, and shrubs.

There are three principal grass species. They are: 1) cogon, 2) talahib, and 3) shorter highland grasses. The most common grass is cogon. The areas which it occupies are called cogonales. It is a rank-growing, sod-forming grass which grows to a height of 5 feet and forms a thick ground cover. It usually grows on clayey or black soils and is found from sea level to more than 5,000 feet in elevation. Cogon generally indicates dry ground.
Talahib is a taller grass than cogon, frequently reaching 10 feet high. It grows in dense bunches and usually occurs in more moist environments, often sandy or gravelly. Talahib is sometimes used to make temporary fences.

The shorter highland grasses are present due to the clearing of the natural forest. Their chief use is as fodder for the work animals.
SECONDARY GROWTH FORESTS

See: Figures 9, 12.

Distribution:

Secondary growth forests occur throughout Central Luzon. They are found at all elevations, particularly in the more thickly settled portions of the area.

Characteristics:

The growths which spring up after the original forests are destroyed by cutting or fire are called secondary growth forests. These forests, in many ways like grasslands, are mainly due to shifting cultivation and the result of logging operations.

The composition of the forests varies with different localities, with its age and with the nature of the surroundings. Generally the forests are characterized by a great variety of small trees (reaching up to 50 feet high and 2 inches in diameter), isolated clumps of climbing bamboos, low scrubs, and clinging vines grouped together in a dense heterogeneous tangle. The trees are quick-growing, soft-wooded, and short lived. At the edges of forests the vines form a compact blanket the height of the trees.

In places bordering commercial forests, trees of adjacent timber species are common. In places near grasslands and cultivated areas, cogon grass is mixed with the secondary growth.
Secondary growth forests are of little value. The wood is structurally weak, used only as firewood and light temporary construction material.

Areas of shifting cultivation are made at the edge of forests, on lower mountain slopes, and in the vicinity of villages. During the dry season natural vegetation is cut, left for a few days to dry, then burned to facilitate clearing. These agricultural clearings are planted in subsistence crops. Lack of modern cultivation "know-how" and equipment and rapid depletion of the soil nutrients finds these agricultural patches abandoned after 2 or 3 years. Natural regrowth on these clearings consists of grass, weeds, and many tree species.
BAMBOOS

See: Figures 9, 17, 22.

General:

All bamboo types play an important part in the domestic and economic life of the Filipino. Many kinds are found growing throughout Central Luzon. They occur in various vegetative types, but are considered here because certain prominent forms are found in secondary forests.

Distribution:

Numerous wild bamboos are found scattered everywhere, but wild structural bamboo in commercial quantities is confined to areas with a pronounced dry season. Extensive cut-over areas in Bataan and Zambales Provinces are occupied by this tree. In Bataan these areas are from 2 to 3 miles wide. Generally, bamboos are found between the upper limit of beach vegetation and an altitude of 600 feet.

Characteristics:

There are about thirty species of bamboos, thirteen climbing and seventeen erect. Climbing bamboos are characterized by zigzag branching. They grow to a height of about 40 feet and develop nearly solid stems 2 inches thick. These trees occur at the edge of forests, in abandoned caingins, or in cleared logging areas. Climbing bamboos form a dense, homogeneous thicket.

Erect bamboos are used for structural purposes. They are
divided into thick- and thin-walled species. The thick-walled varieties are used for framework, roofs, and floors of houses. Erect bamboos are clump-forming and cultivated in all settlements.

Thick-walled bamboos are usually known as kawavans. They attain a height of 70 feet and stem diameters up to 8 inches. These are most commonly used, having the qualities of strength and durability. They are distinguished from other bamboo types by the fact that they grow in large clumps surrounded by a densely interlaced thicket of branches.

Thin-walled bamboo are used extensively for matting. The form most widely used is bubo, which is widely scattered throughout Central Luzon. These bamboos grow to about 25 feet high and often occupy considerable areas almost to the exclusion of other vegetation.

Once established, the bamboo forests are very stable. Mixed with most bamboos are patches of secondary trees, old trees left from the original forests, and hardy shrubs.

The value of bamboos is highly respected by the Filipino. Where climatic and soil conditions are most conducive to the growth of bamboos, extensive areas are devoted to the large-scale, scientific, and commercial production of this plant.
Dense forest from coastline reaching into the low clouds above blankets the Zambales Mountains in the vicinity of Lingayen Gulf. Notice the open areas along the mountain base caused by the cutting away of easily accessible commercial timber which are conveniently floated in the adjoining waters to nearby lumber processing mills. Numerous old caingins now revert to forest on the steep slopes.

Figure 12
VIRGIN DIPTEROCARP RAIN FORESTS - LOWLAND TYPES

See: Figures 9, 12.

General:

Dipterocarp means "winged seed," and this term applies to a great many trees which characteristically have such seeds. The wood from trees of this type are known in the United States as "Philippine Mahogany." Generally these forests are uniform, but the composition of trees varies considerably, controlled principally by topography and climate.

This is the forest type in which members of the dipterocarp family form the predominating timber species, about 75% by volume. They thrive under a variety of conditions, from moist river bottoms to hilly and mountainous country, and make up the upper story in more or less pure stands. The lower stories consist largely of unmerchantable species, of shrubs and vines, including the rattans. This forest is the main source of raw materials for the lumber industry. About 70% of the entire lumber output is represented by six species.

Distribution:

In Central Luzon dipterocarps occur on almost all types of topography below 3,000 feet. Usually they grow best on well-watered plains, or on the gentle lower slopes of the main mountain masses. They have, however, been removed from considerable areas, particularly coastal.

Characteristics:
Both forests and individual trees are best developed at comparatively low altitudes and, as higher elevations are reached, the trees become smaller and less numerous. **Dipterocarp** trees are tall and dense. Large and small trees are crowded together until their leaves occupy all available space. The ground is sometimes covered with a dense undergrowth consisting largely of feathery rattans, some of which reach up among the trees. Scattered throughout these forests are tall palms, strangling figs, ferns, and large trees with large buttresses.

The tall dipterocarp-type forests present an appearance strikingly similar to the deciduous forests of the temperate zone, but differing in having the trees arranged in stories with an accompanying greater density of foliage. The dipterocarps vary from dense stands, in which the main story is composed entirely of mature trees, to more open stands, in which the main canopy may contain more individuals of other species.

In the typically developed dipterocarps the top stories form an even, full canopy; trees reaching 200 feet high with straight unbranched trunks 3 to 5 feet in diameter. Under the top stories are two other stories, each composed of distinct types of trees, and a ground covering of small bushes or herbs. The development of the lower stories is usually in inverse ratio to that of the top stories, the reason being that the better the top stories are developed the less light
passes through to the lower stories. The middle stories are composed of fair-sized trees, which spread their leaves under the branches of those of the top stories. The trees of the third or lowest stories are small, but large in number. They average 30 to 40 feet high, 3 inches in diameter, and have a small amount of foliage.

The development of these trees varies according to the topography. Large trees are noticeably scarce in ravines and narrow valleys, while on the tops of ridges the trees may have large diameters, but are shorter than on gentle slopes. In ravines the undergrowth also is more open than on the ridges.

Where the main canopy is irregular and more open, dipterocarp seedlings often form dense thickets 3 feet high over large areas. Most dipterocarps are evergreens; few partly deciduous, defoliating during the dry seasons.

Tree palms probably occur in all of the dipterocarp forests, and may form a conspicuous part of the vegetation in small pockets. Lianas (climbing vines) are a characteristic feature. Rattan palms are, however, not found near settlements. Climbing bamboos are often well developed in the drier forests of western Central Luzon.
MOLAVE TYPE SEASONAL OR DRY FORESTS

See: Figures 9, 12.

Distribution:

Molave types of forests are native to the Philippines. They grow near sea level on slight to steep slopes, on low coastal hills, and headlands whose basal rock is limestone. Molave types are also found on clay and sandy loam soils up to 2,000 feet in elevation.

Characteristics:

Molave types are more open than the dipterocarp forests and the volume of timber per unit is much less. They occur in areas where there are distinct wet and dry seasons, each of several months' duration. During the dry season, the vegetation is largely leafless, but in the wet season it grows luxuriantly. Under certain local soil conditions during the dry season, there are places approaching desert-like conditions.

Molave trees are members of the teak family, and are the best known hardwoods of the Philippines. Most of the species produce woods that are highly valued for their natural beauty and durability. Trees are large, reaching a height of from 80 to 100 feet, a diameter of 3 to 4 feet, and having widespread crowns. The wide spaces between the large trees are filled with small trees and loosely-tangled jungle growth or with small, erect bamboos mixed with shrubs.
VIRGIN MIDMOUNTAIN RAIN FORESTS

See: Figures 9, 12.

Distribution:

Midmountain rain forests are found on shallow soils on rough mountainous terrain, extending from an elevation of 2,000 feet to approximately 3,000 feet.

Characteristics:

As a rule, rainfall and humidity in these forests are high. Exposed to strong winds, the trees are mostly dwarfed and usually covered with mosses, liverworts, filmy ferns, and epiphytic orchids. These forests are much less dense than the dipterocarp. The change from the dipterocarp type to the midmountain type of forests is gradual, and begins in the upper part of the dipterocarp type.

Midmountain forests are evergreen two-story formations. The upper story is usually continuous, but fairly open. As the trees composing these forests are smaller than in the dipterocarp, they are consequently much more numerous. The largest trees attain 60 feet in height and up to 20 inches in diameter.

The lower story is well developed at lower elevations. The trees are generally short and slender, averaging 24 feet high and 8 inches in diameter.

Changes in the character of the vegetation between the upper and lower limits of the midmountain forests are largely due to the increased cloudiness upward. At lower elevations
rattans mixed with small trees are numerous. Tree ferns are characteristically found at higher elevations. Epiphytes and climbing vines increase considerably in the higher parts of the forests.
Moss Forests

See: Figures 9, 12.

Distribution:

Moss forests are found on shallow volcanic soils above 3,000 feet in elevation on very rough ground at or near tops of mountains. They appear to be confined to the cloud belt (where the atmosphere is saturated throughout the year).

Characteristics:

Moss forests consist of a single story of low trees, the branches and trunks of which are largely covered with mosses, orchids, ferns, liverworts, and moss-like plants. The trees may reach 65 feet in height, but often are not more than 16 feet in height. Trees are taller and the forests more open in ravines than on ridges. Near the tops of mountains the ravines are shallow, but the conditions in them are wetter than on the ridges, with a greater development of medium-sized filmy ferns on the ground and the lower part of the trees.

Vegetation is complex, yet as great in the midmountain forest below. The trees are dwarfed in appearance, seldom reaching a height over 60 feet. The canopy is evergreen with an irregular profile, and varies in density. Some trees develop aerial roots.

Tree ferns are the most numerous tree species in the moss forests, giving a decided character to the vegetation (especially on steep slopes). Small, erect palms are common.
Some species of vines are fairly prominent.

Ground covering usually consists of dense herbaceous growth. In open places shrubs and vine undergrowth predominate. In areas where the soil is poor or unstable, grasses and sedges occur.
PINE FORESTS

See: Figures 9, 12.

Distribution:

Pine type forests occur on the high mountainous terrain of Central Luzon, usually between 3,000 and 8,000 feet on broken hilly poor soils. Pines reach their best development on drier leeward sides of mountains and in areas having a distinct dry season. They are found to a less extent at higher altitudes in the moss forests, and occur in abandoned subsistence farms at altitudes above 5,000 feet, where they alternate with patches of grass or moss forest.

The principal species is the Benguet pine. Tapulau pine is found mixed with Benguet pine between 1,600 and 5,000 feet in elevation in the highlands of Zambales.

Characteristics:

Pines reach a height of 130 feet and a diameter of 4 feet. They are scattered as single individuals, or in open to nearly closed patches of pure pines throughout large grass areas, with broadleaved trees along the watercourses. Where there have been fires, the stand is thin and open, and the trees short. Where there have not been fires, large numbers of seedlings are conspicuous.

Benguet pine is Central Luzon's most valuable coniferous tree. It is an important source of firewood and construction timber (widely used for mine construction purposes).
species supply turpentine and rosin.
PART III

CULTIVATED VEGETATION
Major crop producing areas throughout the Philippines. Notice that Central Luzon is well represented, especially in the production of rice and sugar.

Figure 13
CULTIVATED VEGETATION

See: Figures 9, 13.

Central Luzon, with its tropical climate and fertile soils, is essentially an agricultural region, the cultivated area being concentrated on the Central Plain. Rice is the principal cultivated plant. Upland rice is cultivated in dry fields, while other varieties are grown on fields under water. Before World War II Central Luzon was definitely a surplus rice-producing area. Today, although all Provinces grow rice, 40% of all Philippine production is grown in Pangasinan and Nueva Ecija Provinces alone.

Besides rice, the principal food elements are sugar, corn, garden vegetables, fruits and nuts, and coffee. The important non-food vegetable products are coconuts and tobacco. A large part of the typical diet in the region consists of cereals, of which rice is obviously the largest item. Root crops, such as sweet potatoes (camotes), cassava, and yams form an important part of the carbohydrate foodstuffs in many Provinces.

The quantity of vegetables, other than tubers, in the average diet is not large, although this seeming lack is made up in some degree by the consumption of edible parts of numerous wild and cultivated plants. The main fruit is the banana, and fresh coconuts are eaten almost everywhere.

The economic structure is based substantially on three leading crops: 1) sugar and its by-products, molasses and al-
cohol; 2) coconuts and their related products, copra and oil; and 3) tobacco and its associated products. In 1951 all crops cultivated were produced in greater volume than during the preceding year except rice where a slight decline occurred owing to typhoon losses. The production of coconut and domestic consumption crops (vegetables, root crops, and fruits) was more than restored to prewar levels while that of tobacco is rapidly picking up. Production of the sugar industry may equal prewar levels by 1954.

The soils are capable of producing ample food supplies to support at least double the present population. All Provinces of Central Luzon contribute to the country's chief source of national wealth - agriculture. Some areas have obtained special prominence in the production of certain crops (as we shall see).
IRRIGATION

Central Luzon generally enjoys a normal rainfall, sufficient to meet the ordinary demands of agriculture, with the exception that the cultivation of rice requires systematic irrigation. All irrigation waters are obtained from surface sources (rivers, springs, and streams). The largest irrigation systems are: 1) Angat River of Bulacan and Pampanga Provinces irrigating 56,800 acres; 2) Penaranda River of Nueva Ecija Province irrigating 39,000 acres; and 3) Talavera River of Nueva Ecija Province irrigating 20,000 acres.

It took three years of teaching and encouragement by the Philippine government before the people of Central Luzon realized the importance of irrigation as indispensable in the promotion of agricultural economy. Experience has shown that irrigation alone with the customary methods of farming will rehabilitate and keep up the fertility of the land irrigated. As a matter of fact, existing government systems have maintained the productivity of the lands irrigated at an average of from 45 to 50 cavanés (cavan is a measure equal to 2 1/8 bushels) per hectare (hectare is a land measure equal to 2.4 acres) annually for the last twenty years. In Bulacan and Pampanga, where the largest irrigation systems in the Philippines exist, the yearly production of at least 50 cavanés per hectare has been maintained.
FLOOD CONTROL FOR LAND UTILIZATION

Flood control works are partly designed to realize complete utility of agricultural soils and check the removal of alluvial soils. These works consist mainly of short lengths of dikes, river walls, or cutoff channels and spurs to guide the water flow. The lengths of the dikes range from a few hundred feet to a few miles.

The largest schemes under construction are the Agno and Pampanga river projects in the Central Plain. These are comprehensive flood control schemes for protecting the entire alluvium of the river basins, and are now under construction (April, 1953). The method employed consists of continuous lengths of dikes along the rivers on the Plain, the straightening of the channels by cutoffs, and the detention of the flood flow in some large, swammy areas where the rivers debouch into the Central Plain. It is worth mentioning that the potential storage capacity of the swamp of the Pampanga River aggregates 135,000 million cubic feet, and that of the Agno River aggregates 30,000 million cubic feet.
Typical scene in Central Plain. Checkerboard pattern of extensive paddy rice fields interspersed with clusters of garden crops and mango, coconut, or fruit tree groves. Round white spots in rice fields are threshing floors. Notice scrub and grass-lined irrigation ditches and monotonously flat, uninterrupted terrain with imposing mountain ranges in the background. Mango plot in front center of photo.

Figure 14
RICE

See: Figures 14, 15, 16, 19.

The granary of the Philippines is the Central Plain of Central Luzon. It normally produced a surplus of over eleven million cavanes (about 25 million bushels) of palay (unpolished rice) before World War II. To the traveler during the monsoon season, this area — the heart of the "rice bowl" — is a sea of green; in the dry season it presents an unvarying landscape of brown-stubbed paddies; dotted by the small stacks of unthreshed palay which grow fewer and fewer as the harvest recedes.

Rice is the principal food crop of most of the people. Its cultivation occupies an area larger than that of any other crop. While grown by small farmers for domestic consumption, large commercial estates (haciendas) also exist. 30% of all Filipino paddyland occurs in Central Luzon; 2/3 of the total crop is produced here.

Altogether 1,000 distinct varieties of rice are recognized, indicating the subtle variations in local conditions. The area adapted to each variety may have been improved. If rice is planted in a Province having different climatic conditions from those of the place where it was formerly grown, results may be disappointing. In other words, yields are greatly affected by local environmental conditions.

The rice-producing areas may be divided into two main
Terraced rice fields covering the foothills of the Central Sierra Madre where the level plains of Central Luzon are met are being worked by the peasant laborers and the water buffalo. Notice coconut trees on terraced ground at left and forested mountains in background.

Figure 15
climatic groups. They are: 1) those that have pronounced wet and dry seasons, and 2) those that have no dry season but do have a pronounced maximum rainfall. In the areas with a pronounced dry season, the rains enhance the growth of the plants. One crop is usually raised, except where irrigation is provided. In areas that have no dry season, two crops are usually raised.

Distribution:

Rice is grown extensively in each of the Provinces of Central Luzon. The five Provinces of Nueva Ecija, Pampanga, Bulacan, Pangasinan, and Tarlac have the soil and climatic conditions most favorable for the cultivation of rice on a large scale. Large surpluses originate in Nueva Ecija, Tarlac, and Pangasinan. Rice grows best on a heavy clay subsoil which prevents loss of water.

Characteristics:

The two popular kinds of rice are named according to the type of terrain they are grown on, namely lowland and upland (dry). Transplanting is the usual method for lowland rice, which generally has two annual crops, as against one for upland rice, which is sown by the broadcast method.

Lowland rice is grown in lowland swamps or under irrigation. Most of these areas are in lowland rice. Of the lowland group of rices, some are capable of growing a second crop (called palagad) and cultivated on lands with irrigation faci-
lities of those with a continuous supply of water).

A good crop of lowland rice can be obtained from a land with a fairly rich loamy soil underlaid with a hardpan or substratum. This type of subsoil is important because it retains water much longer than other types.

The first crop of lowland palay is usually a wet season crop, transplanted from seedbeds to paddies during July when 6 inches high. The second lowland crop is confined entirely to irrigated areas, since the crop is usually produced during the dry season.

The season of lowland rice flooding and harvesting varies in different parts of Central Luzon. For instance, in Pangasinan Province seeds are sown in wet fields during May and June, transplanted in July, and harvested from November to December. In Pampanga Province seeds are sown in January, transplanted in February, and harvested in May.

With the beginning of the wet season, rains are captured in individual plots or paddy fields by earthen embankments about 1 foot wide and 2 feet high and spaced between 25 and 75 feet apart. After flooding, these checkerboard patterned fields are harrowed painstakingly by the Filipino laborers to the accompaniment of guitar and harmonica music.

In lowland rice fields up to 6 seedlings may be planted in each hill-row. The hill-rows are set about 15 inches apart. During growth of the rice plant, cultivation consists of re-
gulating the water level in the paddy fields and occasional
weeding.

Lowland rice harvesting makes a heavy demand on labor
because the cutting is by hand with a small sickle or a knife
(yatab) and even farmers with a few acres are obliged to use
outside labor, customarily on the basis of giving the harvest-
ters a portion of the crop (communal farming). Milling of
rice is done by modern rice mill utilization and to a lesser
extent by hand, after foot-threshing and wind-winnowing the
rice.

Dry, or upland, rice is grown mostly in small patches
in forest clearings (caingins). A small percentage of the
total rice produced in Central Luzon is of the upland variety
largely the product of shifting cultivators who are prominent
in the hilly, less accessible and developed areas (especially
in Batangas Province). Terraced fields are adapted for late
upland rice crops. The plant requires only rainfall.

Dry paddy activities are a month or two earlier than
those of the first wet paddy cropping. They are entirely
primitive in method of cultivation and harvesting. Upland
rice is grown by the hill people for local use. The patches
of rice cultivation usually are bordered by earthen terraces
of varying height to catch and hold rainwater (usually higher
than those of the lowlands). The rice is planted directly on
the field, 3 to 8 seeds being dropped in each small hole.
Weeding takes place when the plants reach about 10 inches high. Harrowing is performed by using a kalmot (bamboo harrow) or a spike-toothed harrow.

Of the percentage of total cultivated area estimated to be occupied by each of the major subsistence crops, rice ranked conspicuously high with 80.2%. Of the 1,689,500 acres of total cultivated area in Central Luzon, rice fields occupied 1,355,000 acres (1,255,700 acres in lowland rice and 99,300 acres in upland rice).
### Lowland Palay

<table>
<thead>
<tr>
<th>Province</th>
<th>Irrigated area (hectares)</th>
<th>Irrigated yield (cavanes)</th>
<th>Unirrigated area (hectares)</th>
<th>Unirrigated yield (cavanes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pangasinan</td>
<td>1,080</td>
<td>49,212</td>
<td>1,606</td>
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<tr>
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<td>3,586</td>
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<td>Tarlac</td>
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<td>Tayabas</td>
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### Upland Palay

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<th>Province</th>
<th>Upland area (hectares)</th>
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<td>Tayabas</td>
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### Distribution of Land Planted in Rice

<table>
<thead>
<tr>
<th>Province</th>
<th>Lowland (acres)</th>
<th>Upland (acres)</th>
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</thead>
<tbody>
<tr>
<td>Nueva Ecija</td>
<td>482,500</td>
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<tr>
<td>Pangasinan</td>
<td>265,300</td>
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<td>Bulacan</td>
<td>150,700</td>
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<td>Pampanga</td>
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<td>Rizal</td>
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<td>Bataan</td>
<td>20,200</td>
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Figure 16
SUGARCANE

See: Figures 13, 18.

Distribution:

Sugarcane is one of the most valuable crops produced in Central Luzon. It is cultivated in all Provinces for domestic use. Commercial cultivation, however, for export sugar is confined largely to the Provinces of Bataan, Bulacan, Nueva Ecija, Pampanga, Pangasinan, and Tarlac.

Sugarcane will actually grow in every Province, but it does not thrive well in a constantly rainy climate or in a climate with a long dry season if irrigation during that period is lacking. It thrives best on sandy loam soil (usually in a valley) which is not too saturated or submerged during rainy periods. Upland locations are favored.

Characteristics:

Sugarcane is a coarse, annual grass which is planted in close stands and attains a height of about 8 feet at maturity. It is planted chiefly between December and April, and is harvested during the same months. Sugarcane grows in conjunction with rice as a small-farm crop, half the farms averaging less than 4 acres each of sugarcane. Rows are usually 3 to 4 feet apart. There are a number of large estates growing sugarcane, but it is grown chiefly on holdings of from 10 to 50 acres.

Sugarcane is used for making centrifugal sugar, but some is manufactured into low-grade sugars, such as muscovado and
Panocha, and some is used for other products of local consumption, such as alcoholic beverages. Fresh stalks are chewed for the sweet juice.

The land must be thoroughly prepared before planting. The plant is propagated by cuttings taken from the top of stalks. Cultivation consists of furrowing between the closely knit rows.

The bulk of sugarcane is processed in sugar centrals, and long-time contracts between growers and centrals are drawn up. The centrals get about 45% of the sugar for their share, and the growers get the remainder. In addition to processing by centrals, there are many small mills in all Provinces which produce crude forms of sugar for domestic consumption.

Commercial sugar production of 134,900 short tons in Pampanga in 1939 far excelled that of any other Province. Tarlac was second with 89,000 short tons. All other Provinces combined produced an aggregate of 28,000 short tons of sugar for commercial use. Of the 149,600 acres planted in sugarcane (8.7% of total cultivated land in Central Luzon), Pampanga and Tarlac combined contained 114,000 acres.
Aerial view of intensively cultivated coconut plantations and mature bamboo patches. White spots along road are roof-tops of houses. Garden crops and tree groves are familiar sites around the houses. Linear settlement pattern hugging transportation routes is typical of the Central Plain.

Figure 17
COCONUTS

See: Figures 13, 15, 17.

Distribution:

Tayabas and Pangasinan Provinces are two of the most naturally-favored coconut-producing areas in the world. Coconut palms are grown in every Province, but on a comparatively minor basis except in the aforementioned.

Characteristics:

Coconut production ranks high in amount and importance. More than half of the farms in Central Luzon have coconut trees. The groves on which most of the coconuts are grown consist of plots of less than 10 acres. There are few large plantations. Where favorable conditions are found, the coconut palm thrives equally well on the seashore and inland, and on well-drained soil up to an elevation of about 2,500 feet.

Coconut palms thrive and are most productive where there is regular rainfall throughout the year. An annual rainfall of 60 inches or less is needed if the ground water ascends within reach of the root systems.

The seedlings of the coconut palm are planted at the age of 8 to 12 months. The palms are usually planted in rows 30 feet apart and spaced a similar distance apart. The triangular system of planting is, however, growing to be a common practice, as more trees are accommodated in a given area by this method. The holes, where the seedlings are transplanted,
are dug 2 months before planting time, and are set 25 feet each way. The transplanting is started early during the rainy season to permit the young trees to become well established before the dry season sets in.

Coconut palms on newly-opened forest land normally reach their bearing age at 5 years. If planted on cogon grassland, the first harvest takes place in 10 years. It takes up to 20 years for a coconut palm to reach its full size.

The growing of coconut palms is largely an enterprise of small units, usually operated by peasant proprietors. In some areas the groves extend in an unbroken sequence for many miles, and are well kept. The coconut palm does not grow wild in Central Luzon. Many coconut groves are found along the coasts.

Coconut products include coconut oil and copra meal. The husk is used for fuel and the shell for making charcoal. A minor percentage of the bearing coconut trees are devoted to the production of tuba, a native alcoholic beverage made from the sap of the coconut palm. Nuts are not harvested from trees tapped for the purpose.

The United States Office of Foreign Agricultural Relations reports that in 1939 Central Luzon had a total of 2,042,000 coconut palms of which 1,312,000 were bearing. Pangasinan far exceeded all other Provinces in the production of copra. From the 1,077,000 bearing trees 11,999 short tons
of coconuts were produced.

In 1939 Pangasinan marketed 23,823,000 nuts commercially or 1.1% of all Philippine production. Zambales followed with 1,546,000 nuts or .1% of all production. Commercial production of all other Provinces combined equalled 1,200,000 nuts.

Coconut trees occupy 34,500 acres or 2% of all land in Central Luzon. In Pangasinan 27,100 acres or 7.3% of the total cultivated land area is planted in coconut palms. 7,500 acres of the remaining Provinces of Central Luzon is occupied by coconut palms.
Tobacco was introduced into the Philippines by Spanish missionaries. Four distinct types of tobacco are marketed: 1) cigar-filler, 2) aromatic cigarette, 3) wrapper, and 4) chewing. The cigar-filler type, which forms the bulk of production, is grown on a large scale in Pangasinan Province where a short dry season prevails. The aromatic cigarette type is best adapted to Central Luzon west of 121 degrees East longitude, which has a distinct dry and wet season. The wrapper type is grown south of Manila City where rainfall is fairly evenly distributed. Miscellaneous tobaccos are usually over-mature leaves, strong, thick, and leathery to the touch. These are the chewing tobaccos.

The characteristics which distinguish one type from another are primarily the result of a combination of climatic and soil conditions, the variety grown, and the method of curing utilized. Good quality wrapper leaf tobacco is grown under shade provided by bamboo frame and coconut, nipa, or
abaca leaf roofs or mats.

The tobacco plant is an erect green herb reaching a height of 9 feet at maturity. It has large leaves, 7 to 15 inches in length, which vary in shape with the different varieties, and which are attached to the stalk about 2 inches apart. The plant thrives from September to March.

Cultivation minimizes weed growth, conserves soil moisture, and allows roots to develop freely. Harvesting consists of carefully picking the leaves off singly.

Where the tobacco land is not inundated, green manuring with cowpeas, or any native bean or legume, and crop rotation are practiced. In 1938 Central Luzon produced 3\frac{1}{2} short tons or 10% of the total Philippine tobacco production. Pangasinan is particularly known for its production, averaging 6.6% of the total Philippine production from 1935 to 1938.

The total area occupied by tobacco crops in Central Luzon was 13,900 acres in 1939. Of this 8,500 acres were in Pangasinan, 4,000 acres in Nueva Ecija, and the remainder spread almost equally among the remaining Provinces. Central Luzon contributed less than 1% of the country's commercial tobacco supply.
DISTRIBUTION OF VEGETATIVE TYPES

- 500 Acres Sugarcane x One Sugar Central
- 25,000 Bunches Bananas x 500 Acres Tobacco
- 2,500 Acres Coconuts x 1,000 Short Tons: Copra Processing Plants

Figure 18
CORN

See: Figure 19.

Distribution:

Corn is grown in all parts of Central Luzon, but as a secondary crop. It occupies a negligible part of the cultivated areas. An exception to this is its conspicuous growth in the Province of Pangasinan, partly as a commercial product.

Characteristics:

Corn is a coarse grass (resembling the types familiar to the American mid-western farmer). It is used as a cereal food. It is planted in furrows about 3 feet apart and attains a height of about 6 feet. When the plant grows to a height just above the ground level, the furrows are filled with earth. No further cultivation is necessary.

As the Filipino prefers rice to corn, corn is only grown as a second crop, or in hilly areas where rice will not grow easily. In the rural areas and where topography limits commercially productive land, it is a chief subsistence crop.

Planting time depends upon the rainfall. Where there is a distinct dry season, two plantings are made, one at the beginning and one at the end of the rainy season. Otherwise, planting is at any time of the year, and up to four crops a year are grown. Corn will grow on poor soils, but develops best on fairly deep, well-drained, sandy-loam or light clay-
loam soils with a good supply of lime and humus. Corn will not thrive in soils that are water-logged.

Of the percentage of total cultivated area estimated to be occupied by each of the major subsistence crops, corn occupies 74,000 acres or 4.4% of all land in Central Luzon. The principal corn growing areas are Pangasinan with 2,005 hectares and Nueva Ecija with 738 hectares. Production in the remaining Provinces averages 100 hectares each.
CAMOTE

See: Figure 19.

Distribution:

Camote is the Spanish yam or sweetpotato. It is widely cultivated as a secondary crop; grown as a staple root crop in all Filipino garden plots. It is grown principally for food, and the amount of this crop sold off the farm comprises only a small part of the total production.

Characteristics:

Camote is an annual, creeping, spreading, herbaceous vine, cultivated for its edible, fleshy, root which is rich in starch. The boiled leaves are also eaten by the natives. Camote is the most important of the root crops in Central Luzon. It can be grown at any time of the year. The short time needed for production and the ease of cultivation makes it a valuable emergency crop when other crops fail.

The vines are planted usually in furrows. To secure the best crops, the vines are planted 20 inches apart, the distance between the furrows being 3 feet. In a favorable season, the distance between the vines is increased to allow the root plants to mature freely.

Ridge planting is a less popular method employed by the natives. The process is more scientific and normally more productive, but the cost and care required are greater.

In 1939 Pangasinan Province produced 5,543 short tons of camote, followed by Tarlac and Nueva Ecija, both producing
2,620 short tons. Of the total area in Central Luzon estimated to be occupied by each of the major subsistence crops, 11,100 acres.
DISTRIBUTION OF VEGETATIVE TYPES

- 2,500 Acres Rice
- 100 Acres Beans
  x 100 Acres Cassava

- 2,500 Acres Corn
  x 500 Acres Sweetpotatoes

Figure 19
CASAVAS

See: Figure 19.

Distribution:

Cassava (manioc) is widely cultivated but usually as a secondary crop. It is grown in all kinds of soil provided with good drainage. It is best adapted to low elevations, and is grown in all Provinces of Central Luzon.

Characteristics:

Cassava is grown at any time of year, usually bordering fields planted in other crops. It is a hardy root crop, drought-resisting, and readily succeeds in growth under adverse soil and climatic conditions and little cultivation. It is a perennial plant, shrubby, erect, and grows rapidly, reaching a height of up to 7 feet. Leaves are palmlike with long, narrow-pointed leaflets.

Starch is extracted and tapioca made from the large roots of the "bitter" type of cassava. Cakes are made from the "sweet" type, and the cassava roots are boiled and eaten as food.

Best results of growth are obtained when cassava is planted at the beginning of the rainy season (June) in light, sandy, aerated loam which is well irrigated. Central Luzon produced 11,139 short tons or 6% of all Philippine cassava commercial production in 1939. Pangasinan produced 6,660 short tons, followed by Nueva Ecija and Zambales Provinces.
with 1,395 short tons.
VEGETABLES

See: Figures 19, 22.

Distribution:

Vegetables are grown locally in most native garden plots. Vegetable farms are largely concentrated in the hilly and mountainous areas, where a subsistence type of agriculture prevails.

Characteristics:

Details of each individual crop will not be given since there are so many. The relatively important crops will be mentioned.

More than 100 varieties of vegetables are grown in Central Luzon. Among the most important not already mentioned are tomatoes, beans, onions, radishes, cabbages, eggplants, lettuce, cauliflower, pechay (Chinese cabbage), peanuts, and arrowroots. The vegetables raised are those commonly used by the public. The Chinese market gardens in the city of Manila and in Rizal Province are laid out into plots, utilizing all available space.
FRUIT AND NUT TREES

See: Figure 14.

General:

Fruit and nut trees are grown throughout Central Luzon. Fruit farms are more or less evenly distributed, the largest concentrations being in Batangas Province, where there are over 2,000 such farms. The average area of cultivated land in each fruit farm is a little more than 5 acres. Most fruit and nut trees are not usually planted in commercial quantities.

The chief varieties of fruit grown (and treated here in order of volume grown) are banana, mango, jackfruit, papaya, and citrus. Coffee and cacao trees also planted extensively.

Each of the main fruits grown in Central Luzon will be treated briefly under separate headings. Distribution characteristics and soil qualifications will be indicated where conditions depart from the normal.

Banana:

The banana is the most widely grown fruit tree. About 62 varieties are cultivated in Central Luzon. The tree is actually a large herb, often reaching 23 feet in height. The leaves are long, large, and somewhat leathery to the touch.

The fruit is well known to the American, being very similar to the edible variety imported from South America. It varies in length from 3 to 11 inches. A few varieties excel
as dessert fruits; these are generally commercially cultivated. Most are fried, roasted, or cooked by the Filipino farmer before eating.

Mango:

The leading mango-producing Provinces in order are Pangasinan, Bulacan, Nueva Ecija, Rizal, and Batangas. The mango thrives best on heavy soils, and from sea-level to about 1,500 feet in elevation. It requires a distinct dry season and an annual rainfall between 60 and 100 inches of rainfall (falling mainly between July and October).

The mango tree grows up to 75 feet and lives productively for more than 150 years. The crowns are dense and readily extend outward, shading a large area. The foliage is heavy, sometimes breaking parts of the tree down because of its weight.

The fruit is about 5 inches in diameter and is favored for its sweetness, juiciness, and aromatic aroma. The leaves are long, pointed, narrow, and leathery to the touch.

Jackfruit:

The jackfruit is the largest tree-fruit known in the world. The large fruit is from 10 to 18 inches long and 6 to 9 inches in diameter (often weighing 30 pounds or more). It is one of the most widely cultivated fruits in Central Luzon. The whole fruit is eaten by the natives, the seeds being roasted.

Papaya:
The papaya (pawpaw) is a large, tree-like, herbaceous plant, with large palmate leaves. It is grown everywhere on cultivated plots, grows rapidly, and bears fruit throughout the year. It is best developed where the dry season is short and the rainfall well distributed throughout the year, as in Tayabas. The papaya grows best in a deep soil that is loose, well-drained, and rich in organic matter.

In plantations the trees are planted 10 feet apart in rows of corresponding spaces. Constant weeding is necessary. All excess water must be drained off or the growth will be unfavorable.

Papaya produces an enzyme, papain, which has become an article of commerce. Its major use is as a tenderizer of meats. It also resembles pepsin in its digestive action and is used for treatment of certain digestive ailments.

Mandarin:

Mandarin is a small tree, 12 to 23 feet in height, with several secondary trunks. It is well distributed throughout Central Luzon, and is grown commercially in Batangas Province, where mandarins are better in quality than elsewhere. Most trees are grown on palay farms, coconut plantations, and fruit orchards. The fruit is usually thin-skinned and the flesh is of excellent quality.

Orange:

Orange trees attain a height of 40 feet and are generally
thorny, with compact crowns and shiny leaves. Again, Batangas Province palay farms and coconut plantations are extensively occupied by commercial quantities of orange trees. The quality of oranges cultivated for local consumption on native plots throughout Central Luzon is usually poor.

Pummelo:

Pummelo (grapefruit) is a thorny tree reaching about 45 feet high. It is grown on all native plots, but for local consumption only. Nearly all fruit from the native trees is of poor quality. The fruit is large, about 6 inches in diameter, round, and contains a reddish, juicy flesh.

Soursop:

Soursop is a small, attractive, dark-green tree 20 feet in height. It has large, oblong, green fruits with soft spines, sometimes exceeding 10 pounds. The flesh is white, fibrous, juicy, and of sweet flavor. It is widely cultivated on native plots on all lowlands and up to 2,500 feet in elevation.

Sugar-apple:

Sugar-apple is a tall, deciduous shrub, reaching 15 feet in height. The fruit is heart-shaped, and 4 inches in diameter. It is common on all native plots and adapted to elevations up to 3,000 feet. Sugar-apple is a hardy plant in that it will stand a long dry season.

Coffee:

Coffee is grown extensively in Batangas Province, where
the abundant rainfall from May to September and the evenly distributed rainfall from October to December are conducive to maximum growth. Coffee is commonly grown elsewhere for local consumption. It is cultivated best around 1,000 feet above sea level on clay loam soil rich in humus. Very little cultivation is necessary except for weeds being cut close to the ground.

The tree is small (up to 15 feet in height), upright, and of various species. The leaves are large and of dark green color. The seedlings are planted about 10 feet apart. Other crops are usually grown with the coffee. Shade trees are used to insure the quality of the coffee.

Cacao:

The cacao (cocoa) tree grows up to 20 feet in height and is characterized by alternate, pointed, thin but full papery leaves. It is adapted to low elevations (below 2,500 feet) with rainfall of equal distribution, no strong winds, and a well-drained fertile soil.

Cacao trees are common throughout Central Luzon, but only in a few places are they grown commercially on plantations. They are mostly grown around huts and houses for local consumption. The cacao pods appear on the trunk and large branches as isolated clusters.
PART IV

SUMMARY AND CONCLUSIONS
CENTRAL LUZON

Density of Population, 1950

Persons per Square Mile

- 322-64.4
- 96.6-128.8
- 128.8-160.9
- 193.1-257.5
- 257.5 and over

Figure 20
The total population of Central Luzon is 1,318,673 according to the census of 1948. A census of the area is at present being taken and, based on the figures available, it is expected that the final figures will show a substantial population increase.

Census figures have shown that the population has had a steady upward trend. Together with the increase, there have been some major shifts in population, the principal movement being from rural to urban areas. Population is not evenly distributed and development is not uniform throughout Central Luzon.

The total area of Central Luzon is 6,770 square miles. Nueva Ecija is the largest Province with an area of 2,130 square miles and a population of 416,762. The average density of population per square mile is 119 for Central Luzon. The population, however, is unevenly distributed throughout the Provinces and ranges from a density of 562 in Rizal (excluding Manila City which has an exceptional density of 43,601) and 454 in Pampanga to 165 in the Province of Bataan and 76 in Zambales. The Filipinos of Central Luzon have settled chiefly in the fruitful Central Plain "breadbasket" as opposed to the custom throughout the remainder of the country, where settlement is concentrated along coasts.

The picture is one of congested areas separated by nearly
empty forested highlands. Only to a very small extent has this local congestion produced migrations to the emptier islands. Official encouragement to such migration have produced few permanent results.
The composition of the population is derived from stock of contrasting types. Originally Central Luzon was populated by Malayan types and for the period 1292-1478 it was under the influence of the Majapahits from Java, who drove the aboriginal tribes inland.

From 1565, Spanish influence was strong. The Spanish focus was Manila City and the cultural influences of Christianization and Hispanicization spread radially from there. Most of the Filipinos became christianized. The Spanish colonial aristocratic group, however, is rapidly diminishing.

Spanish infiltration into the stock was not the only process of mestization which has gone on in Central Luzon. Chinese were well established when the Spaniards first came and they staged at least 2 risings against the Spaniards in the Seventeenth Century. Chinese have continued to trade and to act as middlemen during the 2 successive colonization periods undergone by Filipinos, who were themselves not attracted by trading activities. For that reason, there has been a considerable cross-marrying of Chinese with Filipinos, evident in the more active personalities of Filipino public life. The cross-currents of Malay, Spanish, and Chinese stock have become confused and the distribution blurred so that Central Luzon may be described as a mestizo territory.
OVERSEAS INFLUENCE ON FARMER AND FARM TYPES

See: Figure 21.

A heritage of Spanish colonial influence is the unusually high proportion of landless farmers in Central Luzon, unequalled anywhere else in Southeast Asia territories. According to the census of 1948 less than half the farmers owned the land they worked, about 16% owned some of the land they worked, and 35% were tenants on a sharing basis. This was at the end of 30 years of effort by the United States to undo the social evils and economic paralysis left by the Spanish overlords in rural areas.

The Spanish found in Central Luzon the system of communal land holdings and communal help common to equatorial Asia. They observed that there was a leader of this local communal activity with rights to direct it, but they did not realize or acknowledge that he was a communal centerpiece rather than the proprietor of village farmlands. Spaniards treated him, however, as the local landlord and gave him additional rights in return for his aid in taxation. They grafted into this their own colonial system of land grants to individuals who had feudal rights over property and persons living on the land. Huge grants of land (encomiendas) were given to encourage settlers from Spain as well as to reward people who had been useful. The local leader thus became a cacique, as the Spanish call one of these feudal landlords, or a foreigner came to act
as one. The land became the property of one person and everyone on it lost his land rights, thereby forming a group of landless laborers. By this system the Spaniards created a landless population in a territory which had been one of subsistence farmers. *Latifundia* (large estates of absentee landlords) followed as a matter of course. The rural people were reduced to tenants or workers for wages, whereas they had been traditional partners in their community, with equal rights and obligations in the production of food. Operating to increase the concentration of property was the gradual acquisition of huge properties by the religious houses and the tendency of people newly introduced to money systems to mortgage their property.

The caciques continued through the United States colonial period and reaped most of the advantages therefrom. Land was a major social problem. There was a highly educated class of landed proprietors, who were prominent in all agitations for political power, and an illiterate, defenseless landless group of rural workers, tending to migrate to places where wages were high, but often unable to move from their districts because they had become deeply indebted to the landlord.
### AREA, POPULATION, AND POPULATION DENSITY

<table>
<thead>
<tr>
<th>Region or Province</th>
<th>Area (square miles)</th>
<th>Population (number)</th>
<th>Density (persons per square mile)</th>
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<tbody>
<tr>
<td>Bataan</td>
<td>517</td>
<td>85,538</td>
<td>165</td>
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<tr>
<td>Bulacan</td>
<td>1,021</td>
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<td>2,120</td>
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<td>827</td>
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<td>2,021</td>
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<tr>
<td>Rizal</td>
<td>791</td>
<td>44,805</td>
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<tr>
<td>Tarlac</td>
<td>1,175</td>
<td>264,379</td>
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<tr>
<td>Zambales</td>
<td>1,408</td>
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<td>CENTRAL LUZON</td>
<td>6,770</td>
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### TOTAL NUMBER AND PERCENTAGE OF FARMS UNDER DIFFERENT CATEGORIES OF TENURE

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<thead>
<tr>
<th>Region or Province</th>
<th>Number Of Farms</th>
<th>Owners %</th>
<th>Part Owners %</th>
<th>Share Tenants %</th>
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### UTILIZATION OF FARM AREA

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<tr>
<th>Region or Province</th>
<th>Total Farm Area (1,000 acres)</th>
<th>Cultivated Land Total (1,000 acres)</th>
<th>Irrigated (1,000 acres)</th>
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<td>499.5</td>
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<td>5.1</td>
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<td>275.4</td>
<td>215.6</td>
<td>64.8</td>
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<tr>
<td>Tarlac</td>
<td>91.4</td>
<td>61.2</td>
<td>13.6</td>
</tr>
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</table>

**Figure 21**
TODAY'S AGRICULTURAL FARM TYPES

See: Figure 14.

Central Luzon has several agricultural types which are less related to major climatic or environmental differences between one place and another than to differing rates of agricultural development. To these rates of development the greatest impulses have derived very largely from conditions outside the region and most of the crops concerned have been introduced from outside. Prior to the introduction of these plants, agriculture centered on root crops, sweet potatoes, or yams, which are still staples for the more isolated and primitive groups.

Law enacted recently forbids acquisition of land in excess of 250 acres by individuals or more than 2,500 acres by corporations. With comparatively few large plantations, the agricultural economy is based very largely upon small holdings of individual land owners and tenant farmers. Large estates, with the exception of the sugar-growing lands, are parceled out among farm tenants. The average farm is a small plot of 2 or 3 acres. One or more water buffaloes furnish the motive power. Many individual farmers are organized into farming communals. The result of this system is inefficient farming, the majority of farm labor proving crude and primitive.

Sugar estates and agricultural projects sponsored by the
government have encouraged scientific methods and increased the use of machinery. In recent months favorable results seem to be developing.
HACIENDAS

A good deal of land is held in large tracts, known as haciendas. The landlord divides his estate into small units and leases them to tenant farmers. Many such estates or haciendas contain from 1,000 to 5,000 acres, but few exceed 2,500 acres. Where these large tracts of land are not owned by the caciques, the secular church, or religious orders, they are the property of private corporations, such as those in control of the large sugar plantations.
SHARE TENANCY

The prevailing form of tenancy is share tenancy or kasama. Under this arrangement land is leased on shares; of the proceeds, one-third commonly goes for labor, one-third to the owner of the land, and one-third to the owner of the work animals. Under the second system of tenancy, known as the cash crop system, the renter of the land pays cash, or part of the crops, as rent.

Under share tenancy, the proportion of the crop retained by the tenant varies according to whether he merely works the land and has seeds and animals provided for him (which gives him half the crop after half costs for these items has been deducted) or whether the tenant supplies his own animals, seed, harvesting labor, and so forth (which obtains for him two-thirds of the crop). While at first glance reasonable, these terms in reality operate against the tenant, who in poor years may receive for his labor less rice than his family needs to feed it, so that he must borrow to get through the year and meet his taxes. Whatever the state of the crop, the landlord gets a clear return which is probably worth more in cash to him in a year of scarcity than in a normal year. It is a case of partial cooperation, seemingly fair, but inevitably getting tenants progressively into debt because they bear all the risks of cultivation.

A modern evil has been subleasing. Landlords lease ha-
ciendas on a cash rent basis to a few tenants, who in turn sublease on sharing terms to many smaller tenants, whose position and risk become increasingly desperate as pressure of population on the paddylands increases. Landed corporations were tending to maintain this system, which gave them returns at minimum bother to themselves.

Expropriation of large estates became part of the Filipino constitution after 1936 and the laws prohibiting new large estates operated to divert United States plantation interest away from Central Luzon to other parts of Southeast Asia.

In Mindanao there are still empty spaces, but it is doubtful whether these can absorb the excess of specialized farmers from Central Luzon without tremendous preliminary developments. It is as difficult in Central Luzon as, for example, in Java to cause relief of rural populations by migration to virgin territories. An adequate incentive has not yet been found and it is clearly not enough to have population pressure in the home districts.

In 1933 the Rice Share Tenancy Act was passed in order to promote the well-being of tenants on agricultural lands devoted to the production of rice and to regulate the relations between them and the landlords. Much of the benefits of this law was lost when the landlords attached vitiating amendments.
SHIFTING CULTIVATION

Of the agricultural types particular interest attaches to shifting cultivation because it represents a special stage in the evolution from hunting and food gathering to sedentary farming. Within this style considerable variations exist, from the clearings used for cultivating yams and bananas for the family's food requirements to the shifting cultivation of tobacco and coffee by farmers intending to sell these crops.

Some shifting cultivators are true wanderers. The whole group, family or tribe, moves on to a new location when it abandons one clearing in favor of another. Others are sedentary farmers, staying in one village all their lives, but varying the piece of ground they cultivate from time to time, relinquishing the old patch to secondary forest growth, which can be thought of as fallow.

In the Philippine vernacular caingin is the clearing, caingining is the process of growing crops, and cainginero is the one who produces crops in this way. The forest trees and brush are cut early in the dry season. Then, as soon as it is dry, the slash is burned. Thus there are suddenly liberated in the form of wood ashes at the surface of the ground most of the plant food materials that have been moving, perhaps for many centuries, in the forest cycle. At the same time the soil is suddenly exposed to the sun and rain. The crop is planted as soon as the first showers have thoroughly mois-
tened the soil, but before weeds get well started or the stumps of the forest growth have sprouted. The seeds are planted in small shallow holes pecked with a pointed, perhaps iron-tipped, stick, thus with the minimum stirring of the soil. The shallow-rooted annual crop plants have, in the first months, a relatively generous supply of plant food substances to draw on. But as the young seedlings cannot immediately use anywhere near all the available materials unless these are first absorbed and held by the soil, leaching and even slight surface wash may quickly carry away a large amount of the accumulated stores of plant foods and organic matter. Although the shallow roots of the annual crop plants cannot tap the deeper supplies of nutrients, the roots of the forest trees that have not been killed by the clearing and burning can do so. Neither tree stumps nor roots are dug out and plowing is never done in caignins.

Cogon grass and other weeds usually invade the clearing quickly, and the cainginero has neither the tools nor the interest to combat them effectively. Naturally the productive power of such cleared tropical soil declines very rapidly. Clearings are abandoned after one or two crops have been obtained, and more forest is cut away. This shifting cultivation, characteristic of most parts of the equatorial regions outside the paddy lowlands, demands continually new or regrown forest for clearing. The land must remain idle until the fo-
rest has grown up again into jungle dense enough to choke out the seeds and renew soil structure and fertility.

Cogon burns rapidly, even when green. When it is burned annually it becomes thicker and thicker, and only a very few kinds of small "fireproof" trees survive. Seedling trees of the tropical high forest are never able to grow up in the cogon. In fact, the grass fires tend to push the forest edge back, especially up the ridges.

Within Central Luzon the shifting cultivation system has no relation to the needs of domesticated animals. Wherever today there has grown up a cattle system, it relates to ploughing needs and is concerned with buffaloes or small oxen and does not derive from an earlier tradition of cattle farming or nomadism.

Shifting cultivation is a system well adapted to large hilly and empty areas where soils are poor and the rate of soil erosion high. As soon as population increases, shifting cultivation, rapidly overtaxes the capacity of the forest vegetation to reassert itself. Overburning of wild growth due to overpopulation induces rapid soil erosion, affecting the load and silting of river systems, possibly disturbing settled agriculturists far down the valley and remote from the overburnt areas. For these reasons shifting cultivation has generally become illegal, yet it still persists in areas not easily accessible or amenable to control.
From the shifting agricultural system very little is derived of commercial significance. Shifting cultivation generally is for subsistence only, yet it is an integral part of the regional farming tradition.
SEDENTARY SUBSISTENCE FARMING

Farming of the ordinary sedentary type has in this region evolved from shifting cultivation as pressure of population on the land increased. Fixed cultivation can only be sustained where local conditions counteract these inevitable effects of cultivation. A good part of this farm-land is given over to subsistence farming, a system where practically nothing leaves the farm. Subsistence farming is deeply rooted in the tradition of the people. Isolation, difficulty of access, and absence of communications largely force it upon the highlands in the region, which remains for the most part as isolated now as it was several centuries ago. The interest centers on rice, the balance of supplementary food needs (coconuts, fruits, and root crops) occupying a very small fraction of any one farm and often being gathered wild rather than cultivated. The dominance of rice, even among the hill people, is the more remarkable because the plant was apparently introduced by Indian colonists.

In total, subsistence farming in Central Luzon has continued with methods evolved locally centuries ago. The hoe and the dibble (a pointed gardening tool used to make holes in the ground for transplanting) are still the only soil-working implements in many areas, even on paddyfields. But ploughs of the soil-opening type have become widespread, generally home-made and entirely of wood. With the plough
came the need for draught animals and most subsistence farms now have at least one buffalo.
LAND USE CLASSIFICATION

See: Figure

The Bureau of Agriculture and Commerce classification of the topographic and land use conditions of Central Luzon is as follows:

1. Hot and Humid Lowlands. Low plains other than paddy land and lower gentle hill slopes; not more than a few hundred feet above sea level; mostly arable and mostly under cultivation. Low riceland, intensively cultivated, as in most of the Central Plain.

Swampy poorly drained land, principally along the lower courses of main rivers and coastal fringes. Much of this land (particularly that along the Pampanga River) might be drained and used for paddy production. However, drainage would eliminate the flood-regulating functions of these swamps and thus might seriously aggravate flood conditions on fertile agricultural lands along the lower reaches of the Pampanga and Agno Rivers.

2. Land at Intermediate Altitudes. Generally rough topography, suitable mainly for caingin culture or for tree crops; for the most part not arable (not plowable because of steep slope, danger of erosion, shallow depth of the soil). Much of this land is still under forest, both commercial and non-commercial; but, as seen from the air, caingin agriculture has already made alarming inroads into these forests in a number of places.

3. Higher Lands Topographically and Climatically Suitable for White Settlers. Higher slopes and some higher valley floors, between about 1,000 and 5,000 feet. The slopes are dissected by numerous gullies and canyons, but the flat or rounded uplands between are arable, particularly if cultivated on the contour. The climate is moderate to cool, making the higher part suitable for certain temperate zone crops, such as potatoes, as well as for coffee. Most of this zone is now in pasture.
leased out in large blocks; where the land is mostly rolling to hilly it is fully occupied and regularly planted to upland rice.

4. High and Rough Mountainous Regions.

Not useful for cultivation or for any kind of crop. These rough mountains must remain in forest; for on the roughest and highest parts even trees can hardly get a foothold.

Of the total land area of Central Luzon (4,562,100 acres) 1,278,600 acres are in permanent forest land, and 3,283,500 acres are "disposable" (suitable or free for agricultural use when required). Of this disposable land 1,554,400 acres are classified as farm lands, making a total of 34.1% of the total land in farms. Noteworthy is the fact that 57.4% and 53.4% of all land in the Provinces of Pampanga and Nueva Ecija respectively are in farms, while Zambales Province has only 10.1% of all land in farms but with a permanent forest cover of 445,200 acres of its 905,400 acre total.

The census of 1948 shows Central Luzon had 285,900 farms which was 17.7% of the country's total. Pangasinan had 86,600 farms or 5.3% of the total; Nueva Ecija Province had 78,300 farms or 4.8% of the total. The remaining Provinces aggregated a total of 121,000 farms.

It is interesting to note the sizes of farms vary in each Province. This is due to many factors of which relief, land grants, property lines, and custom have been influential.

In Pampanga, of the 12.6 acres average farm area, 9.3 acres are actually cultivated. A disadvantage, primarily of relief,
is readily noticed in the Province of Bataan where from an average farm area of 10.4 acres, only 6.4 acres are cultivated.
Typical scene along a country road. Sporadic clumps of bamboo in right foreground. A stretch of small patches of paddy bordered with scrub and tall coarse grasses. Ridged fields in upper right contain potatoes. Notice the variety of tree types and typically flat landscape.

Figure 22
THE ROLE OF BAMBOO AND RATTAN

See: Figure 17.

In order to understand the culture possessions of the Filipino people it is necessary to consider how important in their daily lives are two plants, bamboo and rattan. The Filipino lives in an age of bamboo. His house rests on bamboo piles; all supports, beams, and reinforcements are made of bamboo. The tubular structure of bamboo easily makes possible a type of construction without the use of nails or other binding material. The floor and walls of the house are composed of thin strips of bamboo or of planks shaped from cleaved bamboo tubes. Even the framework of the roof is made completely of bamboo. Fences are built of cut bamboo stems driven vertically into the ground.

Bamboo fences serve as barriers against marauding pigs. A section of a bamboo stem with lower modal joint division retained is universally used as a portable water vessel, as a container for storage fordringing water, or as a cooking vessel. Dry bamboo supplies excellent fuel. Young bamboo shoots when cooked are excellent for eating, appreciated both by Filipino and American. It is also used for weaving of mats, construction of bridges, sailing banca (small boats), water conduits in rice-terrace irrigation, and for water wheels in lowland rice areas.

Of equal utility in Filipino material culture is the
reed rattan palm. Because of its flexibility and tensile strength it is a building material without comparison. The native of the interior uses neither iron ferrules nor nails in construction work, and there are probably few articles of use on which rattan bindings do not appear.
Because it occupies a large area compared with other activities and employs over 80% of all Filipino workers, agriculture has been the primary activity of Central Luzon. The types of crop are much the same as those of Southeast Asia, though differing in emphasis and equally uninterested with animal farming. The largest of the cropped acreage is normally in paddy, one-fifteenth of it on the dry system. 35% of the cropped area is for commercial production and the emphasis is on sugarcane (on 8.7% of the cropped area) with lesser acreage of cassava, coconuts, beans, peanuts, and tobacco.

For social reasons, agriculture aiming at both food and trade has become more commercialized in Central Luzon than elsewhere. Maximum return, rather than sustained return, has been the farming objective, facilitated by the reliable, evenly distributed rains and the continuous growing season. Hence double cropping is very common.

Regional agricultural specialization appears very distinctly, encouraged by spatial isolation and by differences in soil. In the warmer parts of the world, where land can be flooded and the water can be held on the surface for about 3 months, paddy can be grown. If there is enough suitable power for puddling the soil and enough cheap labor for transplanting the paddy seedlings into the puddled soil, at least
a modest yield of grain can be obtained from even very infertile soils.

Rice will grow in most areas of Central Luzon, but the heavier soils, level landscape and alternating wet and dry seasons of the area cause it to be specially suited to lowland rice. The physical setting of Central Luzon is ideal for the commercial cultivation of sugarcane. Coconuts, which need a climate without a prolonged dry season, are extensively grown in the southern reaches of Central Luzon, reaching their prominence even further south on the island of Luzon.

Self-contained subsistence farming is less prominent in Central Luzon, for historic reasons, than in other territories, but local foods occupy nearly 60% of the cultivated area and meet the major food needs of the Filipino population as a whole. Central Luzon produced 42.3% (851,930 short tons) of all Philippine rice production in 1948, 6.5% of the corn, and 23.6% of the beans.

Rice harvesting makes heavy demands on labor because the cutting is by hand with a small sickle or a knife (the Filipino yatab). Farmers are obliged to use labor from other Philippine areas, customarily on the basis of giving the harvesters a portion of the crop. Communal farming help is less common in Central Luzon than elsewhere, probably the result of long association with Spanish land usages. Only
in the intensive paddy-growing Central Plain are modern rice mills to be found and milling is generally done by hand, after foot-threshing and wind-winnowing the rice.

Corn became one of the staples of Filipino diet after early and prolonged colonial association (via Spain) with Central America where corn was indigenous. In 1948 corn production in Pangasinan and Nueva Ecija Provinces totaled 28,000 short tons or 3.5% of the total Philippine production.

While other foods occupy only a small acreage in any one holding, yams, sweet potatoes, and manioc are prominent in local diet and very widely grown. During the war years 1941-1945 these roots, which are easy to grow, attracted cultivators and increased their total yield in 1948 to 16,000 short tons, offsetting rice shortages. Large quantities of legumes and savory or peppery vegetables are cultivated to form a rounded diet which for most Filipinos is vegetarian (by obligation rather than by religious conviction). The chief source of protein is inshore fishing which produces exclusively for local trade. Animal farming is negligible. Buffaloes and oxen are the usual rural draught animals, the former being customary in the rice and sugar areas of Central Luzon. Loss of half these animals during World War II was the most serious obstacle to rural rehabilitation.

Of crops grown fundamentally for commerce, the most important have been sugarcane, coconuts, and tobacco. Sugarcane
has long held first place in value. It was estimated in 1940 that almost a million Filipinos depended on sugar for their livelihood. Among the world's major sugar producing areas, Central Luzon produced 14,052,000 short tons in 1940. Sugar-growing practically disappeared in 1942 with the violent repercussions in Filipino rural life; by 1947 only 10% of the sugar acreage had been replanted and the production of sugar fell noticeably from its prewar level. Central Luzon produced 43% of the total Philippine output in 1950.

Most of the coconut crop produced comes from scattered smallholdings. The tree is a continuous producer after six years and small holders harvest the dropped nuts rather than organize gatherings from the tree. 90% of the nuts go to make copra, one-third by sun-drying, the balance smoke-dried. Copra is sacked and shipped in small boats to Manila, center of the oil extracting and export trade.

Minor cash crops are cotton, coffee, and agave. Cotton has never been a leading crop despite Spanish hopes. Coffee lost its importance it had last century. Agava is grown for its fiber, which resembles abaca.
The use of farm motors and of farm machinery in Central Luzon dates back as early as 1910. Some big sugar centrals introduced steam engines as motive power for big mouldboard plows. Tests were carried out to determine the suitability of using tractors that were run by producer gas. Large agricultural implements, mostly tillage devices, were imported from England and other European countries to prepare sugarcane areas. Sugar centrals and large private and government settlements contributed a great deal in proving that mechanized farming is an advantage in quality and quantity of work accomplished.

The loss of work animals and the destruction of many animal-drawn agricultural implements during World War II gave mechanization the chance to prove its worth. The Government lost no time in establishing the Agricultural Machinery and Equipment Corporation which handles not only the sale of tractors transferred from the United States Army by also the supply of much needed implements for farm operations. The use or non-use of mechanized equipment on the farm influences production, efficient farming, changes in farm practices and culture, and the problem of the increased idleness of the population.
EFFECTS OF WORLD WAR II

During the 1941-1942 campaign, Central Luzon saw many battles and destruction. More military action took place in 1944-1945. The direct long-term effects of these campaigns were not emphatic because agriculture cannot be denied to the enemy on a large scale. The war devastated internal communications, destroyed many homes, broke down the systems of internal trade, and destroyed the channels to those overseas markets which has been the principal destination of commercial agricultural produce. Naturally, breakdown of external trade channels occurred.

The first consequence of this disruption, as distinct from destruction, were to place a premium on subsistence farming, to cause all commercial cultivation to fall into desuetude, to undermine confidence in agriculture for cash, to cause the loss or destruction of draught cattle which were taken away for military use, to disperse labor forces, and to stimulate self-sufficiency policies. Agriculture in Central Luzon, where labor was available, rehabilitated quickly, due to the industrious farmer population and governmental advice, direction, and support. In the food crops, surplus margins were slowly restored. A postwar feature has been a decline in rice yields, mostly an effect of the loss of draught animals (although to report low yields was a convenient cover for black market sales).
Agricultural trends are difficult to determine today because there are major stratifications of local society which are in process of readjustment, aggravated by currency confusion and widespread ignorance. These will take time to reach equilibrium. During that period subsistence farming is likely to be a strong influence working against a great revival of commercial activity of any sort. Such may result that Central Luzon will not continue indefinitely in its prewar role of one of the Philippines' major sources of supply. Against this must be weighed the proved ability of tropical agriculture to respond quickly to new impetuses.
PROBLEMS AND PANACEAS

The reasons for the slow development of Filipino commercial crops, according to E. H. G. Dobby, are:

1. The early Spanish colonial system did not encourage pioneer agricultural activities.

2. The change of colonial power in the Philippines towards the end of the last century, followed by a Filipino-American War meant a state of insecurity and uncertainty at the very time when most other Southeast Asia territories were going ahead with commercial agriculture. By the time pacification had taken place, other tropical areas were too competitive to encourage new rivals in rice production.

3. Association with the United States tariff systems and the virtual autarchy of North America operated against the production of Filipino sugar, which had to compete with Cuban and Louisiana cane, of Filipino fruits, which rivalled California and Hawaiian products, and of Filipino tobacco, rivalling that of Georgia.

4. There was a sufficient field for investment and pioneering in the United States to dissuade from similar initiative so far away in the Philippines.

5. The working of Filipino gold mines conveniently paid for United States manufactured imports without stimulating Filipino agriculture to long-term improvement.

6. Isolated by distances and by politics from the rest of Southeast Asia, Central Luzon was little influenced by experiments, incentives, and developments taking place there.

The following statement made in 1915 by Henry Jackson Waters, then President of the Kansas State Agricultural College and Special Investigar for the Development of the Philippines, shows the problem unchanged:
At first thought, the remedy would seem to be to induce a part of the people now in the overpopulated regions to move to the unoccupied lands. This, however, is not easy to accomplish with the home-loving Filipino, besides, such a remedy would be only temporary at best. No country has been helped permanently, much less saved, through the emigration of its best stock. And the people who emigrate to a new country are the strongest and best people, and the weakest are left behind to become the parents of the next generation. Some plan, therefore, must be evolved under which the people may support themselves well where they are.

It is true that if the farm crops were wisely rotated, if the fields were better tilled, if improved seeds were planted, if fertilizers of the right sort were applied, and if all the other things which the Bureau of Agriculture recommends were done, the harvest would probably be sufficient to support very comfortably all the people now living in these regions. But it is idle to think of a farmer rotating his corn with clover or cowpeas so as to increase the subsequent yield, when the land is needed all the time to grow corn with which to support his family. It is equally futile to advise the use of fertilizers not readily available. Improvement in the system of farming will come slowly, scarcely more rapidly than the increased food, which the improvement brings, will be required by the natural increase in population and by higher standards of living. 141

The prosperity of Central Luzon depends entirely upon the development of its agricultural resources and the prosperity of its agricultural classes. If this area is again to be a happy and contented land, special time and attention must be given to the further development of agriculture. As the land is the basis of value, sooner or later, with its cultivation or idleness, it prospers or decays. 142
FOOTNOTES


7. Smith, op. cit., 36-38.


9. Ibid., 30-33.

10. Dobby, op. cit., 323.


15. Ibid., 131.


19. Ibid.


25. Ibid.


28. Ibid.


32. Ibid.

34. Mathews, op. cit., 414.
37. Mathews, op. cit., 552-553.
38. Ibid.
41. Mathews, op. cit., 422.
42. Ibid.
43. Ibid., 423.
47. Mesa, op. cit., 45-53.
49. Ibid.


60. United Nations Flood Control Mission, Methods and Problems of Flood Control in Asia and the Far East, Bangkok, Thailand, 1951, pp. 7-8.

61. Gaines, op. cit., Section I a 1.


64. Camus, Jose S., "Rice In the Philippines," The Philippine Agricultural Review, 1921, vol. 14, no. 1, pp. 16-17.


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73. Dobby, *op. cit.*, 331.
74. Plant Investigation and Agricultural Extension Division, *op. cit.*, 3.
76. Dobby, *op. cit.*, 333-335.
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80. Hainsworth, *op. cit.*, 55.
83. Uichanco, *op. cit.*, 81-86.
86. Ibid., 60.
87. Ibid., 58.
88. Ibid., 55.
89. Ibid., 59.
90. Ibid., 55.
92. Plant Investigation and Agricultural Extension Division, op. cit., 5.
93. Hainsworth, op. cit., 54.
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105. Philippine Department of Agriculture and Commerce, The Cassava Industry In the Philippines, pp. 4-5.
106. Ibid., 5-10.
108. Hainsworth, op. cit., 57.
111. Hart, op. cit., 76.
114. Hart, op. cit., 76-78.
117. Rosario, op. cit., 69.
118. Scidmore, op. cit., 110-120.
120. Agcaoili, op. cit., 145-152.
122. Roxas, op. cit., 239-240.
127. Ibid., 199-200.
128. Ibid., 202-203.
133. Commonwealth of the Philippines, *Forest Resources of the Philippines*, Manila, Department of Agriculture and Commerce, 1939, pp. 31-33.
137. Dobby, *op. cit.*, 325-327.
140. Dobby, *op. cit.*, 327.
142. Stewart, Alonzo H., "Agricultural Conditions In the Philippine Islands," Report to the Secretary of Agriculture, May 28, 1908, Document no. 535, United States Senate, 60th Congress, first session, pp. 4-6.
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Abstract of Thesis

DISTRIBUTION AND CHARACTERISTICS OF THE VEGETATION OF CENTRAL LUZON, PHILIPPINES

by

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(B.S. in Ed., Boston University, 1950)

for

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Master of Arts
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This study is an attempt to present concisely the fundamental facts about the distribution and characteristics of the vegetation of Central Luzon, Philippines, and to show the relationship of these facts to the life of the Filipino.

Central Luzon, with its tropical climate and fertile soil, is essentially an agricultural region. A variety of agricultural systems have been used for centuries. Today, progressive agriculture is practiced alongside primitive methods of cultivation. For more than three centuries Spanish colonial control restricted the expansion of Filipino economy and tended to centralize privilege, power, and wealth in the hands of a small section of the population. American control since 1900 attempted to reform and reshape the economy of the people, but the Americans failed to carry changes to the point at which they sufficiently improved the standard of living of the mass of rural people. The Filipinos still do not entirely feed themselves and have become dependent upon foreign sources.

Central Luzon comprises the middle part of the island of Luzon, the dominant physiographic features being the extensive Central Plain bordered by the Zambales Mountains on the west and the central Sierra Madre on the east. It is strategically located for successful economic development. The City of Manila, with its adjacent bay and Central Plain hinterland, is the economic hub of the country and the focus
of Philippine transportation and trade.

Forest vegetation of Central Luzon consists of mangrove stands along the coast, tropical rain forests in lowlands and on the lower mountain slopes, pine forests in higher elevations, and mossy forests on the slopes of some high mountains. Most of the land area of Central Luzon was originally covered with unbroken forest growth. Where forests are located within easy reach of a large agricultural population, they have been drained of their more valuable timbers. After these timbers disappeared, the edges of the forest passed through a period of heavy culling where patches of settlement occurred.

Grasslands, called cogonales, are largely man-made and result from shifting cultivation or burning. Hill tribes make patchy clearings in the virgin forests. The clearings thus gained are planted for one or two seasons without plowing the soil and then abandoned for a new clearing.

A characteristic of the forests is the great mixture of different species of trees, many of them merchantable. Consequently, commercial lumbering can be profitably and somewhat extensively carried out. In regard to quantity per acre and usefulness, the most important group of timber trees is the dipterocarps, which furnish important commercial wood. Rattans and other minor woods are also obtained from these forests.
Where there are muddy shores mangrove swamps are found. Tan-bark is collected, worked up into tanning extract in the City of Manila, and exported to the United States. Nipa palms are important as a thatch material. In fresh water swamps, starch-filled trunks of the sago palm are a source of food for some Filipinos.

Agriculture supplies not only the food for the Filipino population but a considerable proportion of the raw materials for manufacturing. The physical setting of Central Luzon is ideal for cultivation. All Provinces contribute to the country's chief source of national wealth - agriculture. Some areas, encouraged by spatial isolation and by difference in soil, have obtained special prominence in the production of certain crops. The economic structure of Central Luzon is based substantially on three leading crops: 1) sugar and its by-products, molasses and alcohol; 2) coconuts and their related products, copra and oil; and 3) tobacco and its associated products.

Rice, chief subsistence crop, is the principal cultivated plant. Upland rice is cultivated in dry fields, while numerous other varieties are grown on fields under water. Besides rice, corn and tropical roots such as cassava and camote are other important food crops grown for local consumption.

Most of the crops are planted in the ordinary way, and except in the case of a portion of the sugarcane crop, if fer-
utilized at all, it is not done on the basis of definite experiments to determine the amount and kinds of plant foods needed on the particular soils. As a result, despite good soil and climatic conditions, crop yield is relatively low, and cost of production is generally high.

The agricultural economy is based largely upon small holdings of individual land owners and tenant farmers. Maximum return, rather than sustained return, has been the farming objective, facilitated by the reliable, evenly distributed rains and the continuous growing season. Large plantations are few and recently enacted laws discourage the formulation of new large plantations. The average farm is a small plot of two or three acres with one or more water buffaloes furnishing the native power. Many individual farmers are organized into farming communals. The result of this system is inefficient farming, the majority of farm labor proving crude and primitive. Sugar estates and agricultural projects sponsored by the government and private corporations have encouraged scientific methods and increased the use of machinery.

The population throughout the Provinces of Central Luzon is unevenly distributed and ranges from a density of 562 in Rizal Province (excluding City of Manila which has an exceptional density of 43,601) and 454 in Pampanga Province to 165 in Bataan Province and 76 in Zambales Province.
The Filipinos of Central Luzon have settled chiefly in the fruitful Central Plain "breadbasket" as opposed to the custom throughout the remainder of the country, where settlement is concentrated along coasts. In places, usually along the larger streams, the density of population is conspicuously concentrated.

The picture is one of congested areas separated by nearly empty forested highlands. Only to a very small extent has this local congestion produced migration to the emptier islands. Official encouragement to such migration have produced few permanent results. Food for thought is the fact the soils are capable of producing ample food supplies to support at least double the present population.

During World War II Central Luzon suffered much destruction. The war devastated internal communications, destroyed many homes, broke down the systems of internal trade, and destroyed the channels to those overseas markets which has been the principal destination of commercial agricultural produce. The first consequence of this disruption, as distinct from destruction, were to place a premium on subsistence farming, to cause all commercial cultivation to fall into desuetude, to undermine confidence in agriculture for cash, to cause the loss or destruction of draught cattle which were taken away for military use, to disperse labor forces, and to stimulate self-sufficiency policies.
Agriculture, where labor was available, rehabilitated quickly, due to the industrious farmer population and government advice, direction, and support. In the food crops, surplus margins were slowly restored. A postwar feature has been a decline in rice yields, mostly an effect of the loss of draught animals. Agricultural trends are difficult to determine today because there are major stratifications of local society which are in process of readjustment. These will take time to reach equilibrium. During that time subsistence farming is likely to be a strong influence working against a great revival of commercial activity.

At first thought, the remedy would seem to be to induce a part of the people now in the overpopulated regions to move to the unoccupied lands. This, however, is not easy to accomplish with the home-loving Filipino, besides, such a remedy would be only temporary at best. No country has been helped permanently, much less saved, through the emigration of its best stock. Some plan, therefore, must be evolved under which the people may support themselves well where they are.

It is true that if the farm crops were wisely rotated, if the fields were better tilled, if improved seeds were planted, if fertilizers of the right sort were applied, and if all the other things which the Philippine Bureau of Agriculture recommends were done, the harvest would probably
be sufficient to support very comfortably all the people now living in these regions. But it is idle to think of a farmer rotating his corn with clover or cowpeas so as to increase the subsequent yield, when the land is needed all the time to grow corn with which to support his family. It is equally futile to advise the use of fertilizers if not available. Improvement in the system of farming will come slowly.

The prosperity of Central Luzon depends entirely upon the development of its agricultural resources and the prosperity of its agricultural resources and the prosperity of its agricultural classes. If this area is again to be a happy and contented land, special time and attention must be given to the further development of agriculture. As the land is the basis of value, sooner or later, with its cultivation or idleness, it prospers or decays.