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LAND USE IN THE ANDES: ECOLOGY AND AGRICULTURE IN THE MANTARO VALLEY OF PERU WITH SPECIAL REFERENCE TO POTATOES

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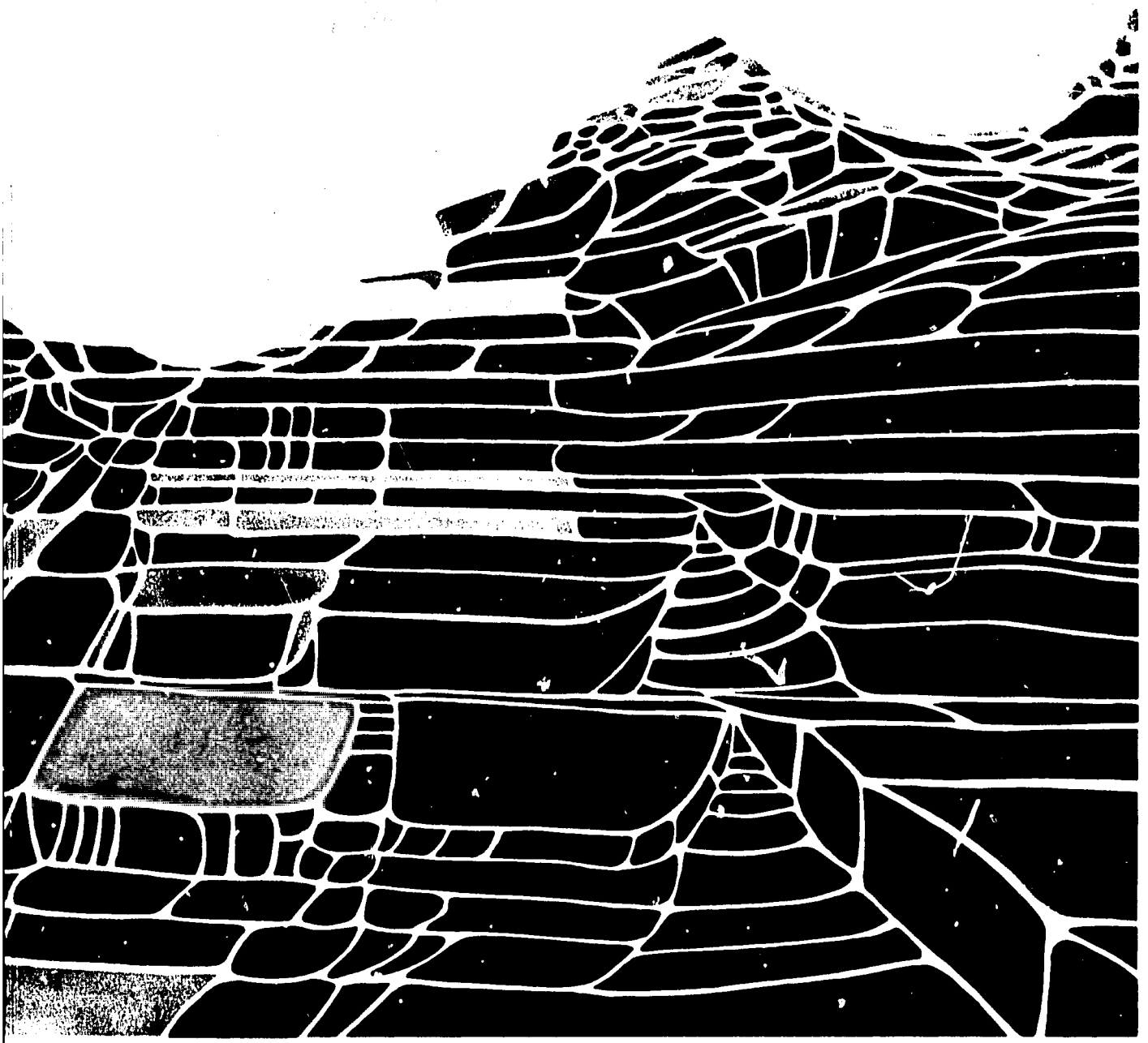
LAND USE IN THE ANDES

nd Agriculture in the Mantaro Valley of Peru

with Special Reference to Potatoes

Enrique Mayer



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Social Science Unit

LAND-USE IN THE ANDES:
Ecology and Agriculture in the Mantaro Valley of Peru with Special Reference to Potatoes

Enrique Mayer

Research assistance, map development
and graphics by Richard C. Shea

A Social Science Unit Publication
Under the Editorship of
Robert Rhoades and Douglas Horton

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Enrique Mayer

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I. INTRODUCTION

In 1954, the Mantaro Valley was studied by a group of economists and agronomists in order to recommend to Peruvian governmental agencies broad guidelines that would help in orienting the development of the region. Their first research recommendation was that ecological and land-use maps be made for the agricultural areas (IDS. 1954: XIV).

In the intervening 25 years, aerial photos have become available, and topographical as well as soil and geological maps have been drawn for the Mantaro Valley. ONERN, the government natural resource evaluating agency, has made excellent ecological, climatological, natural resource and land-use maps for several coastal, jungle and puna highland areas. However, land-use maps of peasant-dominated, highland agricultural areas, such as the Mantaro Valley, have yet to be made. This is due in part to the kaleidoscopic complexity created by a half million small fields in the area, the average size of which is about one-third of a hectare. To further complicate matters, a large number of crops are grown, and no clear pattern of cropping is visible, in contrast to Peruvian coastal valleys where cotton, sugar and a few other crops tend to predominate.

A. The Mapping Project

This report summarizes and interprets information on agricultural land-use in the Mantaro Valley. Maps have been prepared which indicate the major land-use zones in which potatoes are grown, their ecological characteristics and land tenure patterns. The text explains the methodologies utilized in defining land-use zones, and the interpretation and potential uses of the map work. Each major potato producing zone is described in terms of ecology, land tenure and use patterns, and aspects of crop production technology.

In preparing the land-use map, we took into consideration geographical factors and climatic variations and, following Holdrige (1967) and Tosi (1960) delimited ecological life-zones. A study of the 1972 Agricultural Census gave basic data on the distribution of crops in the valley and helped identify areas where certain crops predominate. Field work in the Mantaro permitted us to define the agricultural limits of different agricultural practices related to these crops. Zones were identified in which similar crops are grown in similar ways. With the use of aerial photographs, these zones were drawn with a high degree of precision on the agricultural land-use map of the Mantaro Valley.

The agricultural land-use map, which is to be found at the end of this report, has the following characteristics:

1. Agro-life Zones

Rather than showing the actual crops on each field, as the ONERN land-use maps show for coastal valleys, this map summarizes cropping patterns in agro-life zones and subzones.

The term agro-life zone is used to mean an association of crop and livestock activities in which vegetation, animal life, land physiology, geological formation, soil and climatic conditions are all interrelated in a unique and recognizable combination which has a distinct aspect or physiognomy.

In the Mantaro Valley, climatic conditions change abruptly over small areas, in relation to changes in altitude, and these climatic changes have a strong influence on agricultural activity. The three major agro-life zones of the valley are defined by altitude: the high (3,950 - 4,250 m.), intermediate (3,550 - 3,950 m.), and low (3,000 - 3,550 m.) agro-life zones.

2. Subzones

As humans exploit the ecological potential of an area a differentiation of activities and of land-use may develop within a given agro-life zone. These patterns have been identified and mapped as subzones.

Internal differentiation of agro-life zones has three main dimensions: irrigation, farm type and crop dominance. The low zone is the most highly differentiated. Hence, on the land-use map, areas of irrigation and rainfed production, farming, commercial and peasant farms and mixed farming and monoculture maize have been indicated.

In the intermediate agro-life zone the left margin of the river valley is dominated by tuber crops (potatoes, mashua, olluco, oca) while the right margin is dominated by cereal crops.

In the key to the map, subzones are specification in terms of the type of farm enterprise, whether farming is rainfed or irrigated, and the dominant crop. The following symbols are used:

P = Peasant C = Commercial	Type of Enterprise
D = Dry (non-irrigated) I = Irrigated	Condition of Land
M = Maize Dominant T = Tuber Dominant G = Grain Dominant	Crop Dominance

3. Identification of Places

The land-use map identifies all major and secondary roads and district capitals as well as important rural population centers. The districts north of the city of Jauja (Acolla, Marco and Tunanmarca) are referred to in the text as the Yanamarca Valley.

4. Bilingual Key

All maps and diagrams are bilingual.

5. Crop Distribution Sketch Maps

The distribution of major crops (potatoes, barley, wheat, maize) and horticultural crops are shown in a series of sketch maps, based on the 1972 Agricultural Census.

A recommendation for reading this report is that the reader consult the accompanying twelve maps as one proceeds through the text.

B. Applications of the Map

The land-use map is a research tool which shows patterns and interrelationships that cannot readily be seen from the ground. One use of the map is in the area of sampling for social science, ecology and agronomic research. The map indicates the relative importance of each zone and allows the scientist to isolate specific areas for intensive study. This holds for both surveys and agronomic experiments. It also assists in the interpretation and generalization of research findings. Such a map could also be of help in planning extension programs and determining recommendation levels which are appropriate for specific crops and zones.

The methods used to prepare the maps can easily be applied to otner regions in Peru and the Andes. The necessary elements are topographical maps, the national or regional ecological (or life zone) maps, and aerial photographs.

The ecological maps assist in determining and locating major agro-life zones. Field work and the aerial photographs are useful for refining the major agro-life zones and identifying subzones.

C. Factors that Determine Land-Use Patterns

Land-use patterns can be interpreted as the result of two groups of forces: natural and socioeconomic. The first group of factors (geography, soils, climate) are a major source of variation in agricultural practices, such as planting dates, crop mixes, rotation and fallowing and early or late plowing (or no plowing at all).

Socioeconomic factors also play a role, since farmers react to economic forces by, for example, modifying their mix of crops, by abandoning some types of land, by opening up others, or changing their input use. For this reason, economic history can be studied by observing changing land-use patterns.

In the Peruvian highlands history is especially complex, since national and international market forces are displacing and transforming an older non- or partially monetized peasant economy. The expansion of commercial farming can take many forms. Farmers who used to grow crops for themselves may begin to grow them for the market, or an "enclosure movement" may take place in which larger commercial farms replace self-sufficient peasants.

In this sense, new types of enterprise are similar to new species, which in Darwinian evolutionary terms, invade niches occupied by other, older

species. The superiority of the new "species" of large-scale commercial enterprise has its ecological limits in the same way that natural species have their own defined area or "niche." Large commercial farms are superior only in certain ecological situations; peasant farms can successfully compete with commercial enterprises in different ecological conditions, and can thus resist displacement.

One may interpret land-use maps with historical depth and speculate as to how certain types of farms with their specific aspects of land-use may invade and expand into a zone. The patches of orange in our map (commercial farms) could in the future expand into each other until they cover the whole low agro-life zone. This is not likely however for reasons of an ecological, economic and social nature. To date large-scale commercial farming has not made substantial inroads into the intermediate zone. However, in the high zone much livestock production is commercially oriented. In this report we entertain some of the reasons why land concentration in the low and intermediate zone has not taken place to the same extent as in the high agro-life zone.

Potatoes are the most important crop grown in the Mantaro Valley. However, this research report should make it clear that potato production and use cannot be understood out of context. Potato production and use reflect broader patterns of land use and of socioeconomic forces which have elements of both continuity and change. Only when these patterns and their dynamics have been comprehended is it possible to correctly interpret the findings on technical aspects of potato production in the valley

D. Delimitation of the Area Studied

The term Mantaro Valley (or Valle del Mantaro) is used in specific ways in this report which may differ from usage in other studies. The Mantaro River starts at Lake Junin (4 150 m.), flows through the high altitude puna zones past the mining town of Oroya (3 750 m.) continues in a rather narrow canyon which is also the route of the railroad and the central highway - as far as Puente Steward near Jauja (3 350 m.) where the valley opens up into a broad plain. It then meanders through this plain and becomes a narrow gorge at Chupuro (3.100 m.) south of Huancayo From that point on the river runs in a deep and narrow interandean canyon. It continues flowing in a southerly direction until the point where the Huarpa River joins it at Mayoc (2,100 m.), 190 Km south of Huancayo. Still as a canyon, it flows in a northerly and westerly direction and then doubles back where, together with the Apurimac River it forms the Ene River in the tropical forest or selva alta (580 m.). The total length of the course of the river is 700 Km.

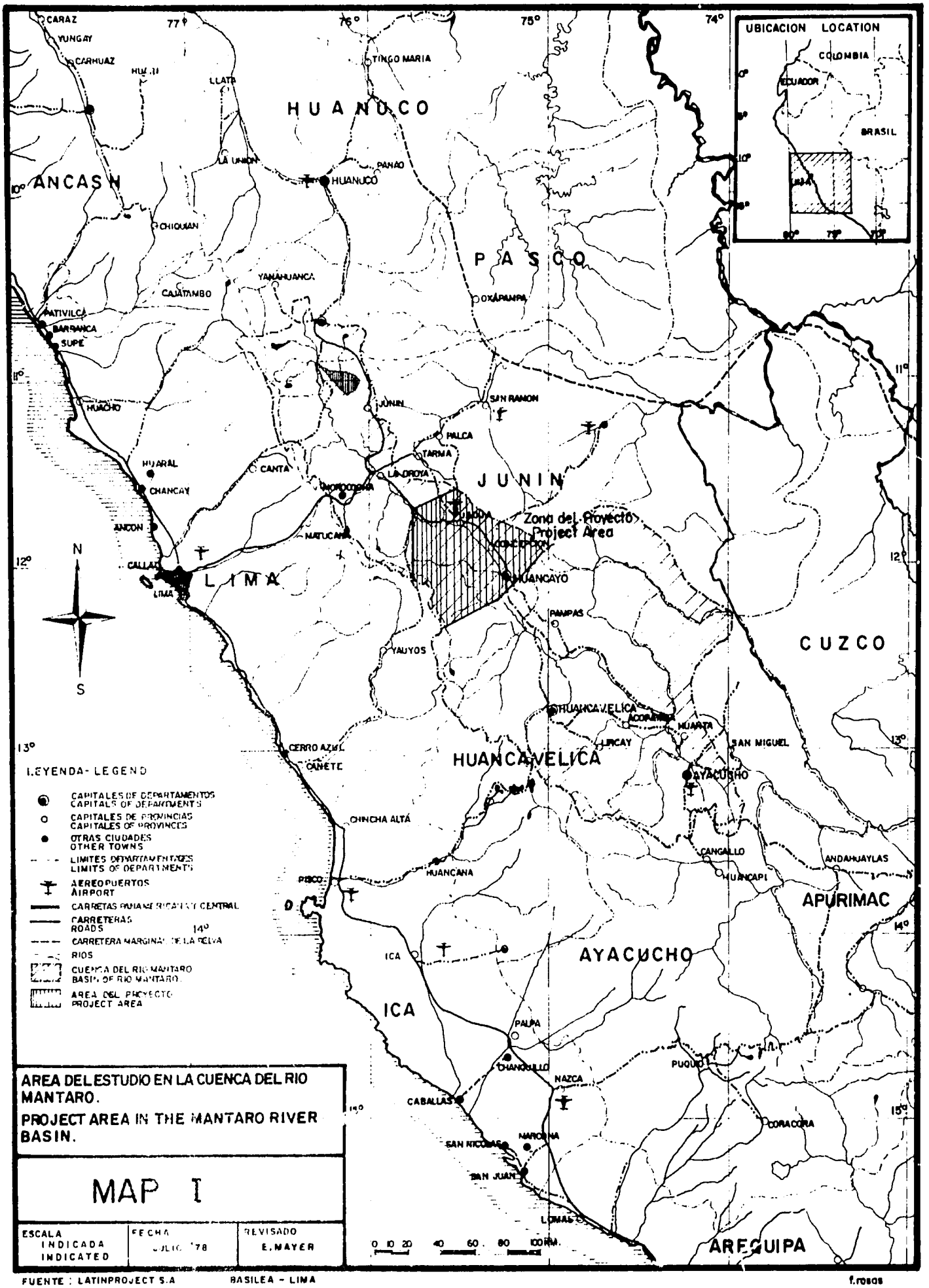
The area generally referred as the Mantaro Valley is the broad plain between the main cities of Jauja and Huancayo It excludes the northern Pampa de Junín, the southern canyon as well as the selva alta regions In this report we include not only the valley floor but also the agricultural lands that are located on the slopes of the Mantaro Valley up to the limits of agriculture on both the eastern and western sides (approximately 4 200 m.). A substantial great portion of the agricultural land of the Mantaro Valley watershed is located on the slopes and terraces of the intermediate zone, and these lands produce a large part of the potato crop.

In summary, the boundaries of the study area of the Mantaro Valley are from Llocllapampa (3,496 m.) in the north to Pasos and Chuquitambo (around 4,000 m.) in the south. On the eastern and western slopes, we include all tributaries of the Mantaro River, including the Yanamarca Valley north of Jauja and the Cunas Valley west of Huancayo, up to the agricultural limits in each of them. The total area under consideration covers approximately 2,000 Km2, and the cultivable area is approximately 65,000 hectares.

The cities of Huancayo, Concepción and Jauja act as the coordinating governmental and marketing centers of the region. All, or practically all, the places in the study area can be reached by truck or jeep within a two-hour drive from Huancayo.

E. Organization of the Report

This report consists of two main directions and, depending on special interests, the reader may wish to cover only one section. For those interested only in a discussion of natural conditions and delineation of agro-life zones, chapters 2 and 3 should be read. However, chapters 4, 5, 6 offer insights into the evolution and contemporary structure of Mantaro communities. Those latter chapters also, in part, describe general conditions of Andean agricultural communities.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BRASIL
HUANUCO
ANCASH
PASCO
JUNIN
LIMA
CUZCO
HUANCAVELICA
AYACUCHO
APURIMAC
ICA
AREQUIPA
Zona del Proyecto
Project Area
CARAZ
YUNGAY
CARHUAZ
HUARI
LLATA
LA UNION
TINGO MARIA
PANAO
HUANUCO
CHIQUIAN
YANAHUANCA
CAJATAMBO
OXAPAMPA
PATIVILCA
BARRANCA
SUPE
HUACHO
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SAN RAMON
PALCA
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CARRETERAS
ROADS
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CUENCA DEL RIO MANTARO
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AREA DEL PROYECTO
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II. THE NATURAL ENVIRONMENT

A. The Andean Highlands

Most of the highlands constitute a relatively flat plateau above the limits of agriculture, (approximately 4,000 to 4,800 m.) known as the puna. Agriculture is practiced in the lower lying river basins which are best regarded as gaps between sections of the highland plateau. Agricultural land is extremely scarce in the highlands and this is reflected in land-use patterns.

The area under study, the Mantaro Valley, is large relative to other highland valleys of Peru. It is about 60 Km. long and its width varies between 2 and 24 Km. It is flanked on both sides by higher mountain ranges: the Cordillera Occidental on the west and the Cordillera Central on the east. There are considerable differences between the western and eastern slopes. A brief description of a cross section going from the west to the east follows.

The Cordillera Occidental on the Pacific side, rises steeply from the coastal plain reaching a general altitude of 4,500 m. with a few snow capped peaks over 5,000 m. After the continental divide is crossed, the landscape becomes characterized by open undulating hillsides, small streams and numerous small lakes. A range of foothills between 4,000 and 4,500 m. runs along the puna in a southeasterly direction. A large portion of this range protrudes into the Mantaro River between the Pachacayo and Cunas tributaries west of Jauja.

As we move east, toward the Mantaro Valley, the landscape between 3,000 and 4,000 m. (which includes cropland), is a series of hilly terraces and collecting basins with small lakes. In some areas these lakes are desiccating, and reduced to small patches of marshy land. In others, particularly in the Cunas drainage area, V-shaped creeks and rivers have drained the lakes. The Cunas River is the main tributary of the Mantaro and is a typical fan-shaped collector running in a canyon which drains the higher terraces. Approaching the valley, the landscape alternates between flat plains (pampas) and mildly rolling hill country, giving the overall appearance of a series of stepped terraces, some flatter than others. At the edge of each terrace, there is a steep descent onto the next one. These terraces continue until the bed of the Mantaro River is reached. The terraces get broader at the southern end and narrower at the northern end of the valley. This same landscape continues across the Mantaro River, north of Jauja, into the Yanamarca Valley.

The eastern side of the Mantaro Valley, in contrast to the west, is composed of a relatively narrow plain on the river basin and then a rapid ascent to the high puna. A large portion of the puna rises above the level of 5,000 m., and a massif called the Huaytapallana chain is permanently covered with snow. The high Huaytapallana range is clustered on the southern end of the area. To the north (beyond Lake Pomacocha) the cordillera is lower in altitude and there are no more snow-capped peaks.

On the eastern side, there are no major collecting tributaries, only numerous short creeks and rivulets which drain into the Mantaro River. The two largest of these are the Shulcas River, which runs through Huancayo, and the Alayo River, which joins the Mantaro at the town of Matahuasi.

In summary, the main differences between the western and eastern slopes are the following: 1) the western puna is more extensive, lower and drier, while the eastern puna is smaller in area, higher and more humid; 2) agricultural land on the flanks of the western slopes descends in stepped terraces that are relatively flat and open. A considerable portion of the total agricultural land of the valley is in this area, and the agricultural front is expanding here. On the eastern slopes only the plain near the river is relatively flat, while the rest of the agricultural land is located on slopes which get steeper as one ascends. Agriculture extends much higher on the eastern than on the western. This is related to the greater humidity and more sheltered conditions that prevail on the eastern cordillera.

Figure 1 is a cross section of the Mantaro River Valley Basin, bisecting the valley roughly at the middle and running in a straight line from the southwest to the northeast. It can be located on the agricultural land-use map by laying a ruler through the villages of San José de Quero, Aco and Mito on the western side, and through Concepción and Ingenio on the eastern side.

While the main geographical factors that affect crop production in the Mantaro Valley can be observed along a west-east transect, north-south differences account for smaller, though significant, variations in agriculture. As the Mantaro River runs from Llocllapampa in the north to Chupuro in the southern part of the valley, it drops about 400 m. The lowest and warmest zones appropriate for maize production are concentrated at the southern end of the valley; the northern end, though similar topographically, is higher and cooler.

In the Mantaro Valley, agriculture reaches a maximum limit of 4,300 m. above sea level. The colored area in the agricultural land-use map indicates the total extent of agricultural land in the valley. The main body of land is formed by the Mantaro basin which is composed of a riverrine plain, slope lands and land situated along its main tributary on the west (the Cunas River). Land belonging to the Tulumayo River system near Comas has also been mapped because it constitutes an important potato growing area, though it is outside the limits of the project area.

The riverrine plain of the Mantaro is broad and relatively flat. Agricultural land on the slopes surround the riverrine plain like the rim around a bowl, which is broken in parts. More slope lands are found around the northern end of the valley than in the south Special mention should be made of the Yanamarca Valley directly north of Jauja, which once was the bottom of a large lake, whose desiccating remains are now the Laguna Tragadero. The Yanamarca Valley drains subterraneously into the Mantaro.

The differences between eastern and western sides, discussed above, are most clearly marked on the slope lands, while northern and southern differences are most important in the riverrine plain.

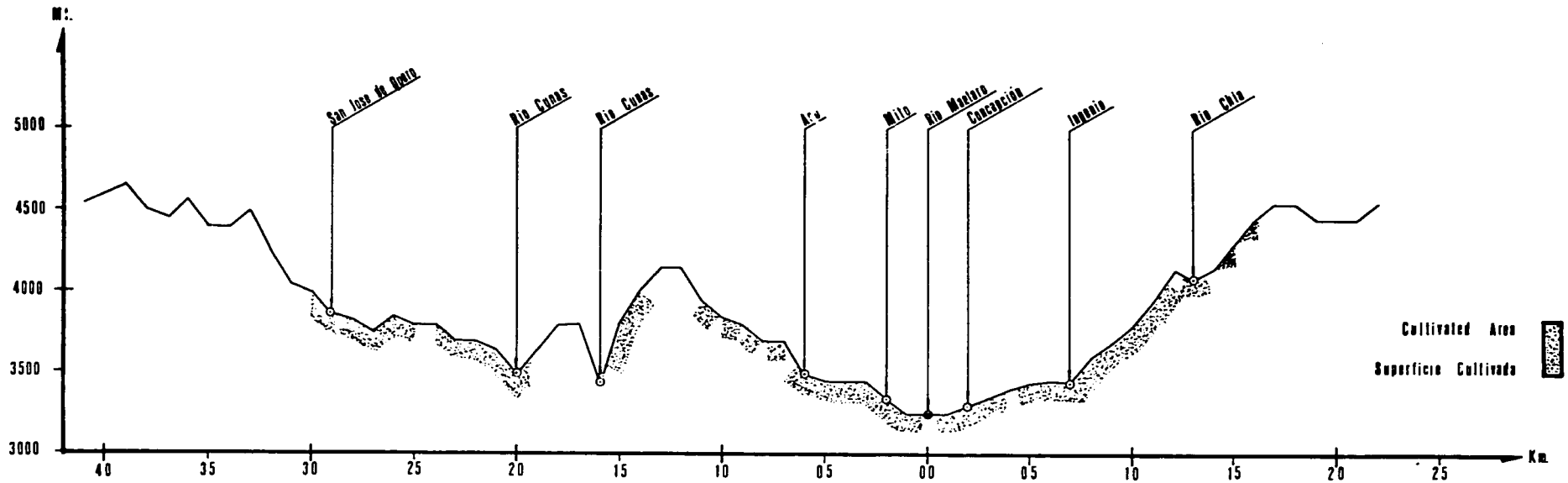

FIG. I. CROSS SECTION

The broad plain of the Mantaro was formed by glacial deposits of a conglomerate or gravelly composition. The western walls of the valley are mainly lime formations, while the eastern walls are predominantly paleozoic and igneous rocks. The studies consulted point out that the soils of the western side were created by the erosion of terraces which originally formed the valley.* The top soil of each terrace is composed of material transported from the higher one next to it. On the eastern side, in contrast, the top soils are formed by more recent land slides which originate in the upper reaches of the quebradas or creeks and form classical delta-shaped accumulations of soil on top of the glacier formation.

In general, the farmers we talked to indicated that the soils on the western side are of inferior quality for agriculture than those of the eastern side. They particularly pointed out the clayey composition of soils on the western side, which becomes hard when dry and sticky when wet. In contrast, they preferred the lighter soils of the eastern side.

Water erosion is denuding the soil coverage of the slopes, exposing bed rock in many places. This is particularly evident in the intermediate ranges of the slopes on the eastern side, as well as on the escarpments between the terraces on the western sides of the valley. Eventually material is deposited on the riverrine plains on both sides of the valley.

B. Climate**

The Andes reach high into the layer of the atmosphere containing most weather phenomena. They sharply divide the major air masses of the western southern hemisphere. These masses are the south pacific anticyclone over the ocean, and the south atlantic anticyclone. The former controls the cool air which sweeps up the west coast of the continent, the latter the moist, tropical air which flows across the Amazon basin. Both air masses move south during the southern solstice season (September to March) and back again each year. As they move south, a warm and moist low pressure mass forms over the Amazon basin forming the Intertropical Front, which migrates south until it lies along the eastern escarpment of the Andes. The cloud-bearing winds that cross the eastern mountains provide most of the rain over the interandean valleys. The amount of rainfall each valley receives is determined by its location on an east-west axis: the more easterly, the moister, the more westerly the drier.

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* There is good number of soil studies of the Mantaro, though most of the series described and mapped are of the riverrine plains only. The reader is referred to Megard (1968) for a geological survey and map of the Huancayo area, IDC (1954:61-68) study. SCIPA soil and soil use maps and the Ministerio de Agricultura (1971) study of soils in relation to potato production for further details.

** We have relied on Thomas and Winderhalder's (1976: 20-60) insightful discussion of the interplay of factors that produce climatic variations in the Andes. Though there still is no systematic meteorological data collection that covers the whole area we are considering, available local data for the Mantaro Valley are given where relevant.

Rainy and dry seasons are determined by the cyclical movement of the Intertropical Front which intensifies the spilling of cloud masses and precipitation through the passes and gaps of the Cordillera Oriental onto the interandean plateaus from September to April, with a peak in January and February. This occurs when the Intertropical Front is in its southermost position, pushed against the Andes.

In the Andes, rainfall is also affected by latitude: rainfall is greater and more continuous in the north (Colombia and Ecuador) decreases in amount and frequency as one moves south. Rains in the south concentrate in a single and well-defined wet season. Thus, decreasing precipitation gradients exist from north to south, and from east to west across the mountains. In the Mantaro Valley, however, decreasing precipitation along the east-west gradient is evident, but not along the north-south gradient.

1. Precipitation

Rainfall patterns in the Peruvian Central Andes in general and in the Mantaro basin in particular have the following characteristics:

a. Rainfall is Positively Correlated with Altitude: Other factors being equal, the higher the elevation, the more it rains. Table 1 gives average yearly measures of precipitation for different zones within the Mantaro basin.

Table 1: Average Yearly Precipitation as Related to Altitude, Mantaro Valley

Location	Altitude m.	Yearly Average Precipitation mm.	Source	Period of Measurement Years
Very High Puna	4,800--more	900-1,000	ONERN: 1976	Estimate
High Puna	4,100-4,800	800	ONERN: 1976	1954-1972
High Sierra	3,500-4,100	650	ONERN: 1976	1958-1972
Sierra	3,000-3,500	735	LATINPROJECT	1922-1967

b. More Rainfall on the Eastern than on the Western Side: At comparable altitudes, the eastern flanks, and particularly the eastern puna lands, receive more rain than the west. Table 2 indicates annual precipitation of five locations at roughly the same altitude, two of them on the western side and three on the eastern side.

Table 2: Mean Annual Precipitation in Selected Locations in Eastern and Western Flanks, Mantaro Valley

Location High Sierra	Altitude m.	Side of Valley	Mean Annual Precipitation mm.	Period of Measurement
Laive	3,850	West	896	1970-1974
Tucle	3,950	West	988	1970-1972
Huari	3,700	East	1,642	1972-1974
Acopalca	3,900	East	1,076	1972-1974
Punto	3,870	East	1,465	1971-1974

Source: SAIS Cahuide (1975: 17, 24).

In the lower sections of valleys, particularly in canyons, rising warm air deflects the clouds to the higher slopes of the valley where condensation and precipitation occur. Thus, in narrow valleys, an additional localized effect is that there is less rain in the bottom part of the canyon and more rain on its slopes. This effect is noticeable in the Mantaro River below Chupuro, but is a negligible factor in the project area.

c. Seasonality of Rains: Well defined wet and dry seasons affect the whole area. The rainy season begins in September or October, reaches a peak in January or February and ends in April or March. In general the higher zones have a more even monthly distribution of rainfall than the lower ones (ONERN 1976:29).

d. Irregularity of Rain Snow and Hail: Droughts which last one or more years are rare. Irregularities in the monthly distribution of rainfall are more frequent. Late rainy seasons, as well as rainy seasons interrupted by dry spells are common in the Mantaro Valley and occasionally cause severe disruptions in agricultural production.

Snowfall is restricted to higher altitudes and does not affect agriculture directly. Two kinds of snowfall exist: 1) that which accumulates on snow-capped peaks and glaciers (which provide permanent water sources for creeks and rivers); and 2) night-time snow, which falls on lower puna grounds and melts during the daytime. No seasonal accumulation occurs in the tropical highlands, and this affects water retention capacity.

Hail, in contrast to snow, is common everywhere, regardless of altitude, and hailstorms are frequent during the transitional months of the southern solstice when crops are germinating, and again when they are ripening. Hail tends to occur in localized patches.

e. Low Water Retention: The Central Andean highland features of topography and soils affect the capacity of the land to capture, store and distribute water. Steep topography, erosion and the sparse vegetative cover account for the fact that 60% of highland precipitation becomes run-off (Tosi 1960). In addition, much precipitation filters through the topsoil and high radiation rates act to evaporate moisture. These factors, combined with differential rainfall patterns, make lower-lying areas drier than higher ones.

2 Temperature

Temperature varies more with altitude than with season. It is estimated that mean annual temperature drops 0.5 degrees centigrade with each additional 100 meters of elevation, and above 4,000 m. the same change in elevation may produce an even greater temperature drop. Mean daily minimum temperatures show an annual cycle, lower in the dry season and higher during rainy season.* Frosts are associated with cloudless nights.

Troll (1968) calls the Andes a "diurnal temperature climate," meaning that major temperature changes occur in a 24 hour period. The pattern of hot days and cold nights overshadows temperature variations between seasons. In Huancayo, the mean daily difference between maximum and minimum temperature is 17°C in the dry season. (LATINPROJECT Table C-4-4)

Average annual temperature and minimum and maximum variations for different altitudes in the Mantaro region are given in Table 3.

Table 3: Average Annual Temperature, Maximum and Minimum Extremes and Altitude, Mantaro Valley

Location	Altitude m.	Mean Annual Temp. °C	Max. Monthly Mean °C	Min. Monthly Mean °C
Puna	4,100-4,800	4.8	12.9 Feb.	- 9 July
High Sierra	3,500-4,100	7.5	24.0 Feb.	-11 June
Sierra	3,000-3,500	11.3	24.9 Feb.	- 7 June

Sources: The data for 3,500 to 4,800 come from ONERN 1976; the data for 3,000 to 3,500 m. from LATINPROJECT. (Periods of observation are the same as those shown for precipitation in Table 1.)

In the plain of Huancayo, frosts occur every year between May and August, and every second to third year between March and April. Exceptional but damaging frosty nights occur in November, December and April. In general

* "Elevated minimum temperatures during the rainy season do not appear to be the direct result of increased insolation, but are due to retention of heat into space during the night. Seasonal changes in daily minimum temperature correspond to the seasonal pattern of cloud cover and precipitation (Thomas and Winterhalder 1971:31)."

in the lower areas of the Mantaro Valley, there is a continuous period of 240 days without frost, from September to April, that coincides with the rainy season.*

In the higher areas above 3,800 m. we found that farmers prefer to cultivate on slopes rather than on plains or in basins, since cold air moves down the slopes to lower parts, causing frost damage in the small patches. Eighty per cent of all highland frost are of this type and are locally called heladas blancas (white frost). Heladas negras (black frost), which are less frequent but potentially far more damaging, are caused by irruption of very cold, dry maritime air, and occasionally damage large areas of crops.

The main climatic factors which pose risks to cropping are: 1) late or irregular timing of the early rains, which may upset the agricultural calendar; 2) frost at any point in the growing period, and especially in April and May; and 3) hailstorms in the early and late phases of the growing season. The higher lying areas are more exposed to the last two factors than the lower areas.

3. Water Balance

Water balance depends on the water supply and the withdrawal of water through evapotranspiration. Evapotranspiration depends on: a) air temperature, which is high during the day and low at night; b) temperature of the surface, which shows the same daily fluctuations but with less amplitude; c) duration of sunshine, which depends on latitude, season and cloud cover (in Huayao,** there are approximately 9 hours sunshine per day in June and 5 in February); d) relative humidity, which reflects the seasonal cycle of precipitation and temperature (maximum 75% in March and minimum 54% in June, July and August); e) winds, which vary greatly from place to place in the valley, but as a rule are stronger and more frequent on plains and hillsides and in the puna, making the western side of the valley a windier region than the quebrada dominated eastern side (in Huayao the predominant winds are from the southeast and there is a constant flow of air all year); and f) atmospheric pressure, which in this region is a function of altitude rather than season, as in temperate zones of the world.

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* Both the LATINPROJECT (1968: 105) and the technicians at the Instituto Geofísico in Huayao point out that the data given for frost to be used for agricultural conditions can be relied on only to a certain extent since the temperature readings are collected in protective screens rather than in the open, as well as being collected 2 m. above the ground, thus information on air layers close to the soil is not taken into account. In addition, the data for Huayao come from an altitude of 3,312 m., whereas areas lying above this point are more exposed to more frequent frosts and the risk of it occurring during the growing season are increased. In the puna, above 4,000 m. night-time temperature below freezing point occurs 300 nights per year (Troll 1968: 22).

** A station on the western terrace (3,312 m.) where meteorological measurements are taken for this region by the Instituto Geofísico del Perú.

Table 4 gives water balance data for puna, high sierra and sierra zones, compiled from different sources but calculated in the same manner. The Pachachaca station from which the puna data are taken, is on the Pampa de Junin at the headwaters of the Mantaro, and therefore, only relatively.

Table 4: Water Balance in Relation to Altitude, Mantaro Valley (annual mean valves)

	Station Altitude		
	Puna Pachachaca* 4,030 m.	High Sierra Consac** 3,880 m.	Sierra Huayao*** 3,312 m.
Temperature	5.7 °C	8.0 °C	11.3 °C
Total Precipitation	712 mm	782 mm	735 mm
Evapotranspiration Potential	339 mm	471 mm	n.d.
Estimated Real Evapotranspiration	339 mm	403 mm	635 mm
Runoff	373 mm	379 mm	n.d.
Precipitation Deficiency	11 mm	120 mm	100 mm
Months With Humidity Deficiency (evapotranspiration potential < total precipitation)	June-6 mm July-5 mm	May-22 mm Jun-32 mm Jul-38 mm Aug-30 mm Sep- 6 mm	May-21 mm Jun-32 mm Jul 35 mm Aug-36 mm Sep- 7 mm
Very Humid Months (evapotranspiration potential ≥ 100 mm total precipitation)	Nov,Dec,Jan Feb,Mar	Dec,Jan,Feb Mar	Jan,Feb
Humid Months (evapotranspiration potential > total precipitation)	Apr,May,Jun Jul,Aug,Sep Oct	Apr,May,Oct Nov	Sep,Oct,Nov Dec,Mar,Apr May
Dry Months (arid) (evapotranspiration potential < total precipitation)	None	Jun,Jul,Aug Sep	Jun,Jul,Aug

* (ONERN 1976: 5051) Latitude 11°35' Longitude 76°01'
** (ONERN 1976: 44-45) Latitude 11°16' Longitude 76°00'
*** (LATINPROJECT 1968:100-116) Latitude 12°02' Longitude 75°09'

Table 4 reflects an adverse interplay of altitude, topography and climate in the Andes. At high elevations where it is humid and flat, low temperatures make agriculture almost impossible. Lower down, where temperature conditions are more favorable for agriculture, there is less level land suitable for cultivation; and moisture becomes deficient. Dryness is inversely related to altitude in the Mantaro Valley. LATINPROJECT (1968:106) notes that in the riverrine plain between Huancayo and Jauja "water demand for the purposes of agriculture may not be covered from September to December. Therefore, systematic irrigation may be of considerable utility."

A clearer understanding of the interaction of climate and altitude, latitude, longitude and topography will emerge as better meteorological data are collected in all regions of the Mantaro Valley. However, it seems clear that:

> The sources of variability in temperature and precipitation include sharp gradients of altitude, topography and meteorological changes which occur daily, monthly or annually. When these various elements are superimposed and interacting, a finely scaled mosaic of climatic conditions emerges (Thomas and Winterhalder 1976:36).

It is for this reason that studies of land use in the Andes have to take into account highly differentiated small areas within any given valley.

In this section we have shown that climate varies widely within the Mantaro Valley. The interaction of altitude, temperature, precipitation and evapotranspiration can produce a whole range of microclimatic conditions within a short distance. Two useful generalizations concerning climate is that humidity and coldness increase with altitude and that the eastern slopes are more humid than the western ones.*

C. Ecological Considerations

There are two contrasting approaches in the analysis of ecosystems. One is the zonal approach in which discrete communities are recognized, classified and listed. The second is the gradient approach, which involves the arrangement of populations of species along an environmental gradient with ecological-community recognition based on frequency distributions, similarity coefficients or other statistical comparisons (Odum 1971:145). The zonal approach is used in this study, for the following reason. Steep environmental gradients (like the altitude gradient of the Mantaro basin) are characterized by distinct or discontinuous plant communities, not only because of abrupt changes in the physical environment, but because boundaries are sharpened by competition and coevolutionary processes between interacting and interdependent species (Ibid: 145). An additional reason for choosing a zonal approach is that man acts in such a way as to further enhance discrete differences in cultivated plants.

However, two important considerations derived from the gradient approach need to be mentioned here. Ecological communities vary along any environmental gradient from generalized to specialized as stress factors (such as decreasing temperature of moisture) make the conditions of biological life more and more difficult. Natural generalized environments (moist and warm areas) are characterized by a high species diversity index: there are many different species, but a relatively low density of each species per area. Specialized (2.9, cold and/or dry) environments, on the other hand, have a low species diversity. Only a few plant species specially adapted to the difficult conditions exist in this habitat, and the density of these few species per area is high. The classical contrast is a tropical forest with many different

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* See also: FAO/UNESCO/OMN 1975 for a study of agroclimatology of the Andean zone, which is helpful in comparisons of the Mantaro with other regions on the Andean countries.

species of trees, vines, lianas shrubs, etc., but few specimens of each in a given area; versus a prairie with only a few species of grasses that make up the whole prairie.

These same criteria apply to cultivated plants. Along an altitude gradient one moves from areas where many different crops can grow towards areas where only hardier and specially adapted crops can grow. Thus, the higher one goes in the Mantaro basin, the fewer the types of crops that grow, until at very high altitudes only a few varieties of potatoes, and cereal crops can grow near the absolute limits of agriculture.

The second consideration is that temperature conditions at higher altitudes slow down vegetative growth. Thus, crops sown at higher altitudes take longer to mature than the same variety of plant grown at lower-warmer altitudes. In addition, the characteristics of the plant are modified in such aspects as size, morphology and biochemical processes.

In taking a zonal approach to the Mantaro Valley, we will bear in mind the characteristics of the altitude-determined environmental gradient, and will attempt to compare and contrast the characteristics of each zone with those located above and below it. For our purposes, a zone is a particular area considered as separate or distinct from other areas because of this particular internal characteristics. Three steps are necessary to study zones: 1) determine criteria for defining zones; 2) describe the internal characteristics that make a zone distinct; and 3) determine the boundaries.

The criteria that will be used in this report are the agricultural uses of an area, contrasted to other uses such as pasture, forestry or mining. We will focus exclusively on those zones that have agricultural use. Furthermore, when we make subdivisions of zones, based on differences in agricultural use of subzones the main criteria will be the different sets of crops that grow in each zone and subzone.

Deciding where to draw boundaries is, as Odum (1971:146) points out, one of the most interesting problems of classification. The boundaries will necessarily have to be determined by the criteria chosen to describe the internal characteristics, and these are chosen according to the problem or question posed at the outset.

The boundaries that concern us are the lines within which particular sets of crops grow. These are, in turn, determined primarily by climatic factors, and as has been discussed in this chapter, variations in climatic factors are correlated with altitude, within a localized regional context. Consequently, altitudinal lines--as expressions of variations in climate--are used as boundary lines in the Mantaro Valley.

In this report, we will approach the problem of zonation by a process of approximations, from larger units to smaller ones. First we will discuss natural-ecological conditions using Holdrige's "Life Zones" (1970) which have the advantage of linking ecological zones with climatic conditions.

Holdrige's scheme provides altitudinal boundaries for the major climatic and ecological zones.*

1. Life Zones

To date, the study of ecological zonation in Peru follows the guidelines laid down by Holdrige (1967) and the careful work of Tosi's Zonas de Vida Natural en el Perú (1960).** These zones are essentially plant communities related to three climatic variables: a) the mean annual biotemperature; b) the mean annual precipitation; and c) the potential evapotranspiration ratio. Tosi's system is a useful guide to Andean ecology, allowing comparisons of regions within Peru and with other areas of the world. It is used by government offices in Peru, such as ONERN, and hence has currency in policy circles.

According to Holdrige's scheme, the Mantaro River basin is located in the semiarid, subhumid and humid "humidity provinces," and ranges from nival and alpine through subalpine to montane "altitudinal belts" which in their interaction create the five life zones that will be described below. Three life zones have been considerably modified by human activity (particularly by agriculture). In order to facilitate the comparison with other regions, the "Diagram for the Classification of World Life Zones or Plant Formations" is shown below (Fig. 2); the life zones within the project area have been shaded.

The five life zones of the Mantaro Valley are described below.

a. Tropical Nival (4,650 m. and above)- Local name: Cordillera. This zone has a very frigid-humid climate, and is restricted to permanent snow-capped peaks and the surrounding glacial area. There is practically no life, except for lichens and micro-organisms. During the dry season melting snow and ice provide water for lakes, creeks and rivers, which are the source of irrigation water for lower areas. An example: the Cordillera de Huaytapallana east of Huancayo (highest peak Nevado Lasuntay 5,557 m.).

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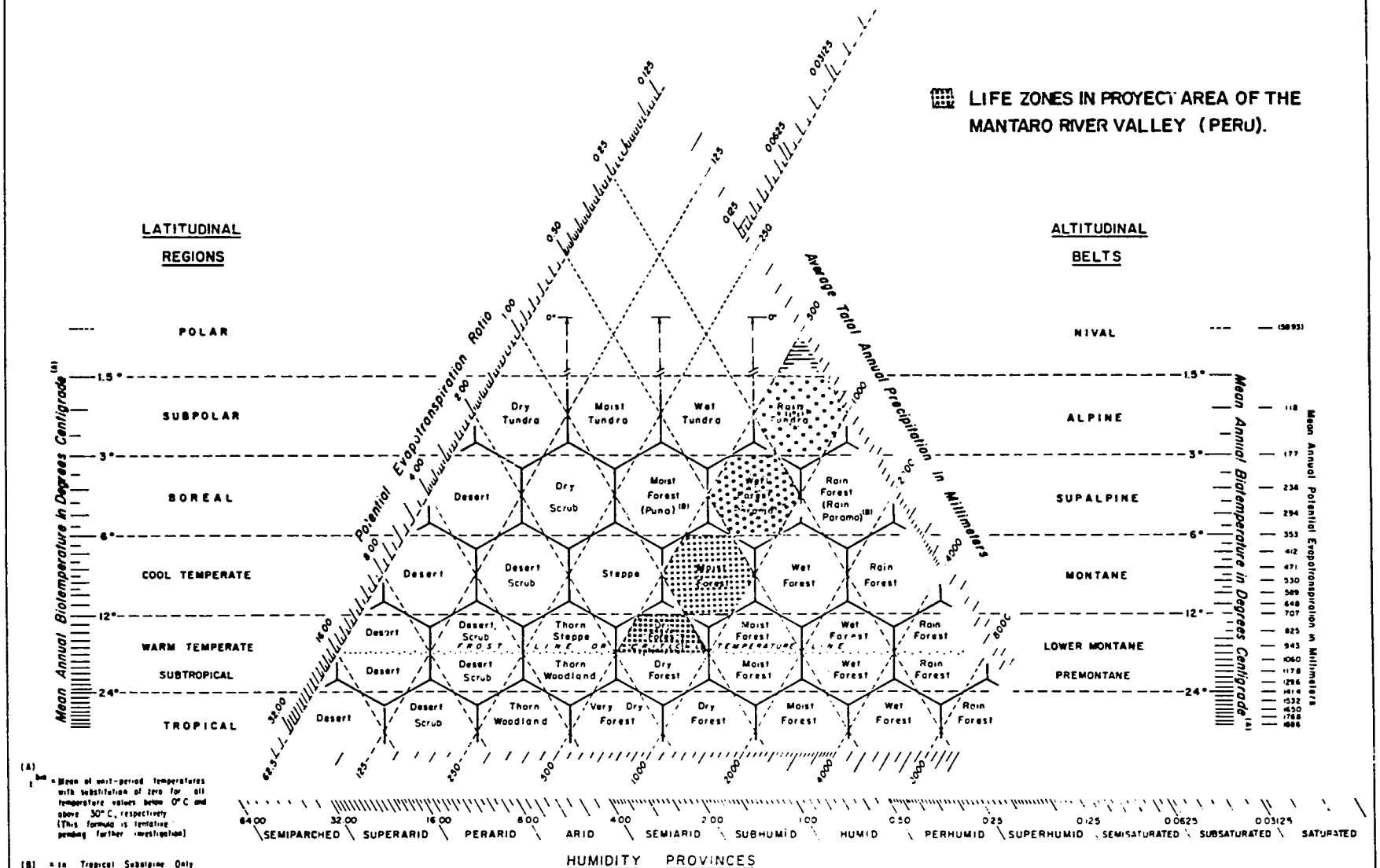
* Joseph Tosi analyzed and classified the ecological zones of Peru basing himself on Holdrige's work. Tosi's map, recently reissued by ONERN, identifies thirty-four life zones for Peru, roughly twenty of which are in the mountain areas. His boundaries are established by climatic factors and expressed by altitude lines.

** Given that Tosi worked with Holdrige's world scheme, his terminology is oriented towards foresting and hence his classification of the essentially treeless Central and Western Andes continues to use a forest-type classification. The debate whether the Andes were more forested, prior to precolumbian man-made alterations has not been settled. Moreover, Tosi's classification does not take into account the profound modifications caused by human occupations. Finally as Brush (1977:6) points out, the scale of the map is too large to take into account localized variations. These objections are overcome by the modifications introduced in the next chapter.

FIGURE : 2

DIAGRAM FOR THE CLASSIFICATION OF WORLD LIFE ZONES OR PLANT FORMATIONS



b. Tropical Alpine Rain Tundra (4,500-4,650 m.)- Local name: puna alta. This zone is associated with a frigid but humid climate, with freezing temperatures every night of the year. Alpine vegetation is of a tufty nature, and floristically diversified, covering the area with a springy carpet in which the plants live in "colonies" creating their own micro-environment. The main economic use of this zone is for pasturage, for camelids and sheep grazing. Example: the meadows below the Cordillera de Huaytapallana.*

c. Tropical Wet Subalpine Paramo (4,000-4,500 m.) - Local name: puna baja. This zone has a subhumid and semifrigid climate. Vegetation is predominantly grassland in which the gramineous genera Festuca Calamagrostis and Stipa predominate. It is used as pasture land. It has a disadvantage over the tundra in that the grasses become very dry and straw-like during the dry season. Despite its bleak appearance, this zone is a source of wealth in the Mantaro basin. Of all life zones, it was this one which came under the domination of the hacienda system in the last century, and subsequently, developed into modern sheep grazing ranches providing the second most important export of the region--wool. Most land expropriated by agrarian reform is in this zone. In its lower reaches, and where local topography affords some cover, a limited agriculture is practiced in this life zone. Lower areas of this life zone coincide with the high agro-life zone. Example: the pastures of the Laive production unit in SAIS Cahuide.

The population of this area is low, since most of the permanent settlements of people who exploit this area are located below 4,000 m. Three patterns of population centers are commonly found: 1) the most numerous is the herder's base camp or estancia. It is a cluster of straw thatched houses surrounded by stone corrals located in sheltered areas. Estancias are sparsely dispersed over the grazing territory; 2) there are also villages of herders with a row of houses strung out along a road and clustered around a school. These villages constitute the nucleus of a herding community; 3) the administrative centers of haciendas or cooperatives, which are made up of sheep shearing, wool processing and administrative facilities.

d. Tropical Montane Moist Forest (4,000-3,500 m.) - Local name: sierra alta. The climate is moist and cold. The area is used both for pasture and agriculture. The natural vegetation contains some trees of the Polilepis and Buddleia genera, as well as woody shrubs. But human activity has practically denuded it of its trees. Grassland with a predominant gramineous composition dominates the area. Agriculture is possible in protected slopes and the main crops are grains (mainly barley), tubers (potatoes, mashua, oca, olluco), quinua and field peas. This life zone meets the Mantaro River at Oroya, runs along the banks

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* Herders often extend the area of this type of vegetation artificially by permanently inundating certain areas for alpaca herding. They are termed bofedales or chucnales (see Palacios 1976:22-29; also 1977). The area is seasonally inhabited by herders who live in huts during the rainy season. These huts are widely dispersed over the area.

of the river to below Llocllapampa and then forms part of the slopes on both sides of the valley as an outer rim of the valley. It is also found in the fan-shaped collecting basin of the Cunas River, where a large hectareage of this land has been converted to crop production in this century. Sheep and cattle grazing are the main alternatives to agriculture in this life zone. A clear example of this alternate choice can be seen along the Central Highway. Traveling south, towards Huancayo starting from Pachacayo: the lands on the right bank of the river belong to the sheep and cattle complex SAIS Tupac Amaru II, and the land is devoted to natural pasture. The lands on the left bank along the road are held by peasants who cultivate its flat parts as well as the slopes. In this life zone we include the intermediate agro-life zone.

This zone is inhabited by a large proportion of the peasant population of the valley. Two types of villages predominate: 1) nucleated villages of herders who also cultivate tubers are clustered near the 3,800 m. altitude line; 2) agricultural villages located in mid-slopes areas specialize in the production of tubers and European grains. On the Valley's western side these villages are nucleated around a central plaza and school, while on the eastern side many are dispersed, that is, each family's house is located near its lands scattered over a wide area.

e. Tropical Montane Dry Forest (3,000-3,500 m.)- Local name: sierra. A temperate semiarid climate prevails. Though it rains about the same amount as in the life zone above it, higher evapotranspiration rates make this a drier zone. The mostly flat topography comprises the floor of the Mantaro River basin plus the alluvial areas of soil brought down from the sides of the valley. On the western side of the valley one finds a succession of natural terraces. In certain places, the riverrine plain is narrow, due to the presence of outcrops of hilly terrain; but around the cities of Jauja and Huancayo, the plain is quite wide. Almost all of this area is under cultivation, and extensive parts are irrigated. Population density is high, with innumerable villages and homesteads dispersed throughout the area. Natural vegetation, where it is allowed to grow, is abundant in shrubs, bushes and agave cacti, the European imported scotch broom or retama (Spartium junceum) is predominant in unmolested areas. Steep slopes have been reforested with Eucaliptus, also an import from Europe.

The whole area is under intensive agriculture, and produces a variety of crops. The major grains are maize, barley, oats, wheat and quinua. The tubers are potatoes, mashua, oca and olluco. Legumes produced include broad beans (habas) field peas and lentils. A wide variety of vegetables are grown, including onions, carrots, turnips, cabbages, lettuce, spinach, artichokes and garlic. Fruits include tumbo, nispero, membrillo, guinda, tuna, peaches and apples. Forrage and fodder crops for an expanding cattle and dairy industry are alfalfa, clover and rye grass, oats and barley. Trees grow abundantly in both fences, and groves. The most common is the Eucaliptus. Alder, guinda, quinual and quishuar are also planted. This area comprises the low agro-life zone.

Table 5: Characteristics of the Life Zones in the Mantaro Valley

Ecological Zone (Holdrige)	Altitude m.	Climate (Thorntwaite 1948)	Natural Vegetation	Ecological Conditions	Agricultural Crops	Land-Use
1. Tropical Nival (Cordillera)		Very frigid-humid	Lichens and microorganisms	Most specialized and restricted very little life	None	-
2. Tropical Alpine Rain Tundra (Puna Alta)	4,500-4,650	Frigid-humid	Alpine flora	Very specialized high altitude adaptation and to grazing activity	None	-
3. Tropical Wet Subalpine Paramo (Puna Baja)	4,000-4,500	Semi-frigid Subhumid	Gramineous grasses	Good grazing but specialized for high altitude agricultural crops	Papa shiri, mauna, barley in sheltered areas	Most land extensive marginal agriculture
4. Tropical Montane Moist Forest (Sierra Alta)	3,500-4,000	Cold-moist	Grasses and shrubs	More generalized environment	Potatoes, Andean tubers, European grains, habas, field peas, lupinus, quinua, onions	Less land extensive agriculture
5. Tropical Montane Dry Forest (Sierra)	3,000-3,500	Temperate semiarid	Grasses, shrubs and trees	Most generalized in study area	Potatoes, Andean tubers, European grains, habas, field peas, quinua, onions PLUS maize, clover, alfalfa, varied horticulture temperate fruit trees, etc.	Most land intensive diversified agriculture

D. Chapter II Summary and Conclusions

The main geographical, climatic and ecological characteristics of the Mantaro Valley described in this chapter are summarized in Table 5, by life zones. No agriculture or livestock activities are carried out in the highest zone. The next two of the higher life zones are used for grazing sheep and camelids, but only at the lower fringe (4,000-4,200) for crop production.

The two lowest zones comprise the agricultural area, which will be examined in greater detail in Chapter III. The above description of life zones was essentially static in nature, and may have, erroneously, given the impression that natural conditions determine land use patterns. However, numerous social forces act to disrupt the ecological equilibria and bring change, even in the natural environment. These include: 1) deforestation; 2) encroachment of agricultural land into grasslands; 3) dessication of lakes and marshes through drainage in order to open more agricultural land; 4) opening of agricultural land on steep slopes that causes erosion; 5) the creation of irrigated zones which modify local vegetation; 6) overproduction beyond the possibility of the ecosystem to regenerate itself; and 7)contamination. In the project area, erosion, soil exhaustion and pollution are the main dangers to long-term ecological stability.

It is important to bear in mind that the distinct life zones are closely interconnected, both ecologically and economically. For instance, the nival region provides water for irrigation in lower parts. The grassland areas of the alpine rain tundra, which support llama and alpaca herds, provide meat and fiber for the clothing of inhabitants of the lower valley as well as means of transportation and animal manure for their crops. The lower areas in turn, provide the higher areas with grains (particularly maize) and temperate-zone fruits and vegetables. Seed from intermediate zones is often exchanged for seed produced in the low zones, pasture animals spend periods of time grazing in the high zone and are brought down periodically to graze on the stubble of harvested fields or when they are needed for plowing.

Exchange between zones is favored by the short distances between them, and also by the fact that each zone supports a specific set of crops and livestock. Exchange between the zones links them in one overall agricultural system, and gives the Mantaro Valley a strong regional character.

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III. AGRO-LIFE ZONES AND LAND-USE

As mentioned in the preceeding chapter, Holdrige and Tosi's life zones represent a first approximation to agricultural zonation. However, for the study of a single valley, is necessary to focus on differences within each life zone and place greater emphasis on specific aspects of agriculture.

For these reasons we introduce the concept of "agro-life zone," which takes into account only the land used for agriculture. An agro-life zone coincides wholly, or in part, with a life zone, since climatic factors that determine life zones also affect the cultivation of domesticated plants. Within each agro-life zone it is useful to distinguish subzones which are the result of differential use of agricultural land. Hence, subzones differ from each other in terms of man-made modifications in the use of land, but within the framework of similar ecological conditions. Agro-life zones are not only areas with distinct sets of agronomic conditions, but also areas distinguished by sharp social and economic differences. In an agro-life zone, natural and social factors come together to create distinct configurations of land use, land tenure, enterprise types and technologies. the agro-life zones and their respective subzones are shown in the agricultural land-use map and summarily described in this chapter.

A. Agro-Life Zones

An agro-life zone may be defined, following Holdrige (1967), as an association of cultivated crops in which man-substituted vegetation, domesticated (and wild) animal activities, land physiology, geological formation and soil are all interrelated in a unique and recognizable combination which has a distinct aspect of physiognomy. In addition, one must consider human activities, especially those related to land tillage and domesticated animal use, that affect the interaction of the biological species with the physical environment.

An agro-life zone may be described by the set of crops that are grown, the relationship between agriculture and animal husbandry, the agricultural practices that are employed, and the relationship between agricultural and non-agricultural land, as well as the climatic and natural vegetative associations that are included in Holdrige's scheme.

> A life-zone is correlated with a set of agricultural practices, a time of planting and of harvesting and in rural districts with types of buildings related to the general agricultural land use (Holdrige 1967:15).

The usefulness of agro-life zones resides in the fact that, as in natural environments, agricultural conditions within them are more similar than between zones. Conditions studied in one representative place of an agro-life zone, are, by and large, valid for other places within the same zone.

In the Mantaro Valley three major agro-life zones can be identified: High, Intermediate and Low.

B. The Agricultural Land-Use Map

The land-use map was drawn after a period of two months field work in which we familiarized ourselves with the prevalent natural aspects governing agricultural production. We surveyed the area armed with topographical maps, altimeter and camera. Particular attention was paid to the shape and form that fields took (whether they were slope terraces, open fields in a plain, irrigated fields with Eucaliptus fences, walled fields, etc.). By talking to farmers, we obtained technological information and their views on how the terrain might best be studied, what subdivisions they considered important, which places were most appropriate to the cultivation of different crops, and so on.

When we returned to Lima we analyzed our material, grouped our field notes according to criteria of crop similarities and differences, and defined the major agro-life zones. Based on a statistical study of crop distribution, we then identified subzones.

Once these zones and subzones had been determined, we returned to our field data and specified which field type was associated with each subzone. Since we knew which field type (or pattern of fields) was characteristic of each zone and subzone, we could locate them on photographs.* Each zone is clearly recognizable from the air photo by the pattern of its fields. This allowed boundaries to be determined precisely in relation to specific features of the landscape, such as a topographical landmark, a road or group of houses. In this way the survey information was transferred with a high degree of accuracy to the land-use map.

The technical aspects of preparing the map included: 1) preparation of a base map; 2) drawing zones and subzones on the topographical map by comparing it with aerial photographs; and 3) transfer these patterns back to the base map. This work was executed by Richard C. Shea.

The agricultural land-use map indicates differences in the mixture of crops grown as well as the methods of cultivation, and hence reflects the complexity of agriculture in the Mantaro Valley.

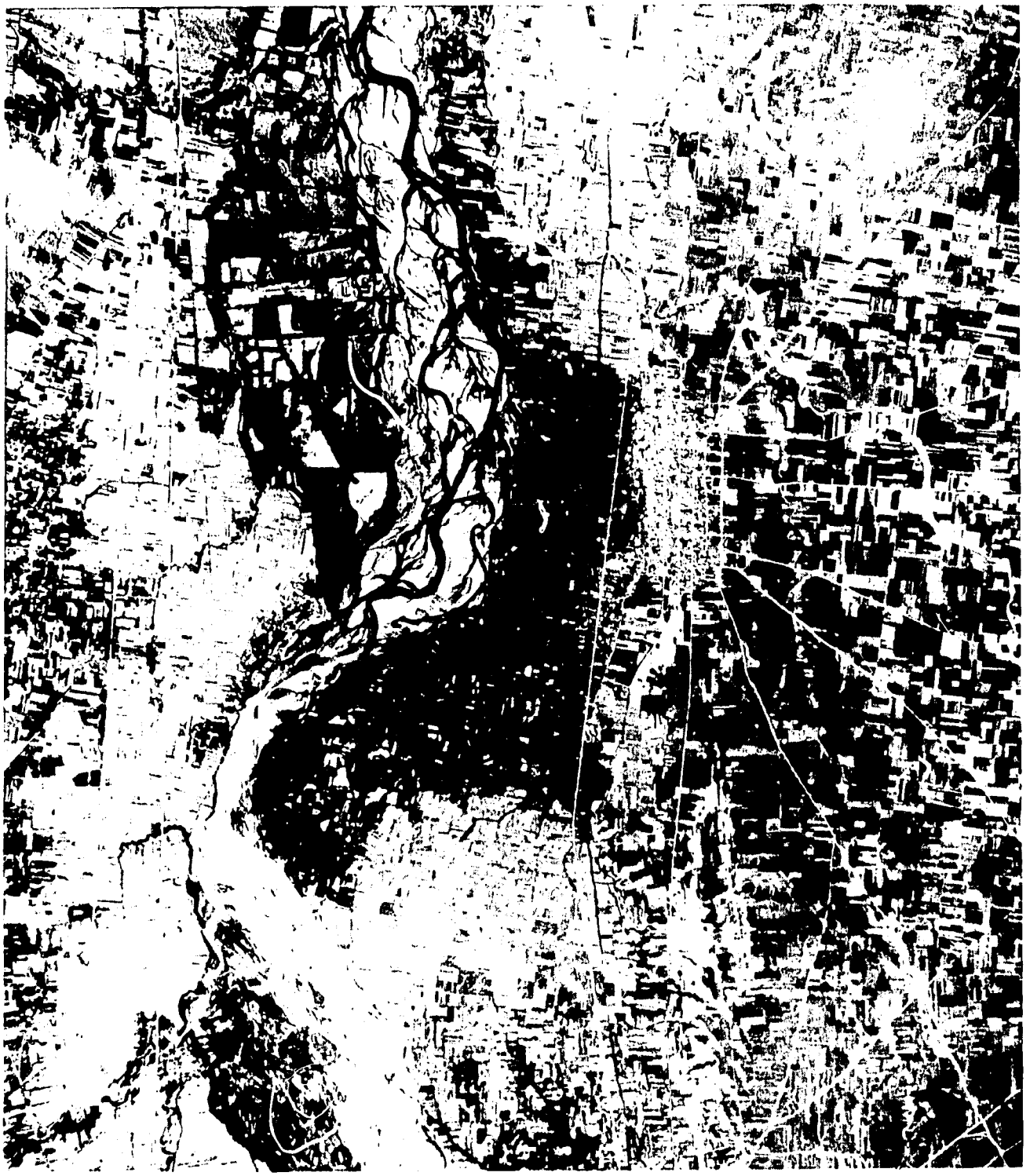
C. Agro-Life Zones in the Mantaro Valley

We will now briefly describe agro-life zones within the project area of the Mantaro Valley. For case in mapping, we followed altitude lines since these are primarily determined by climate factors which vary with altitude.

1. The High Agro-Life Zone (H) (3,950 - 4,250 m.)

The high zone is made up of narrow patches of land situated on both the eastern and western valley sides on the escarpments leading up to the flatter, puna altiplano lands, around or above the 4,000 m. altitude line. The upper

* The series of aerial photographs used were obtained from the Instituto Geográfico Militar. The date of the flights are June 16, 19, 20, 27, 1962; and May 20, 1963. The scale of each photo is: approx.: 1:60,000.



1. Aerial photo of the Mantaro Valley showing the subzones of the low zone: The large irrigated fields of commercial farming on the left contrast with the small tree-lined irrigated fields of peasants on the right. The different patterns made by commercial and peasant non-irrigated farming are also visible. The village on the right is Sicaya.

(Photo: Courtesy of the Instituto Geográfico Militar).

2. Aerial photo of the Mantaro Valley showing peasant agriculture: Maize is grown on the plain, tree-lined mixed irrigated agriculture is above it, as well as terraced hillsides for tuber and grain production. The village on the bottom left hand corner is San Jerónimo.

(Photo: Courtesy of the Instituto Geográfico Militar).

3. Aerial photo of the Mantaro Valley showing countless small fields that cover hilly slopes of the intermediate zone. Note isolated patches of frost resistant potatoes in the top right hand corner. Potato production in the intermediate zone accounts for about half the total production of the valley. The village of Ingenio is on the bottom left hand corner.

(Photo: Courtesy of the Instituto Geográfico Militar).

boundaries of this zone are natural pastures, while its lower boundaries are the more intensely cultivated lands of the intermediate zone. It has a subhumid and semifrigid climate, with a very high frequency of frosty nights. Most of the land in cultivation in this zone is composed of steep slope lands. In this altitudinal belt, the main crops are frost resistant bitter potatoes (papa shiri or mauna) and barley. On a very minor scale, oats and some Andean tubers such as olluco are grown as well. Land is in production only one or two years in a rotation cycle of four, ten or more years. Thus, in vast expenses of land, one sees only a few cultivated fields scattered over the landscape. Agriculture is not the main activity in this zone, the production of bitter potatoes for chuño (freeze dried potatoes) is a subsidiary activity of herders. This very specialized agro-life zone, small and marginal, is important because chuño is highly esteemed as a delicacy throughout the valley.

No subzones have been identified within this agro-life zone.

2. The Intermediate Agro-Life Zone (I_1 tuber dominant, I_2 grain dominant) (3,500 - 4,000 m.)

This agro-life zone occupies a band of territory running along the rim of the valley and the collecting basins of the tributaries to the Mantaro, varying in width depending on slope. In general, climate is moist and cold. However, the climate is highly varied, depending upon altitude and topography. Small variations in altitude produce differences in climate which are reflected in an increasing diversity of crops as one moves from higher to lower areas. One can also observe a progressive intensification of agriculture along this altitudinal gradient: land is fallowed for shorter periods and gradually more terrain is brought under cultivation in the lower areas. Most land in agricultural production is steep, necessitating the construction of slope terraces. About one-third of the land in this zone is in the V-shaped quebradas formed by tributaries of the Mantaro River, the rest is on the hill slopes.

Crops planted in the intermediate zone are potatoes, Andean tubers (mashua, oca, olluco), European grains (barley, oats and small amounts of wheat), a few legumes (habas, field peas, lupinus) and some quinua. A defining characteristic of the intermediate zone is the total absence of maize.

On the basis of a difference in crop dominance, this agro-life zone is subdivided into the tuber dominant (I_1) and the grain dominant subzones (I_2). The eastern side of the valley is tuber dominant; the western side and portions of the Yanamarca Valley to the north are grain dominant.

Crops are planted in the intermediate zone in varying systems of rotation and fallow cycles. The number of years that a field is left fallow increases at higher altitudes. Throughout the intermediate zone there are two basic cropping cycles: one of three continuous cropping years plus four years of fallow; and one of four crop years and three fallow. An ideal complete cropping and fallow cycle is seven years. At higher elevations in the eastern side one commonly finds three crop years and four of fallow. In lower areas there are four crop years followed by three of fallow. In some lower-lying areas, where soil conditions are particularly poor, two years of cropping and two of fallow years may also be practiced.

On the western, grain dominant side, fallow periods are diminishing sharply over time. The pattern of four years of cropping and three of fallow predominates in the higher areas; in the lower areas it is common to find fields put through two complete four-year cropping cycles before three fallow years, thus giving eight cropping years to three of fallow.

Significant differences in the cropping sequence are followed in the eastern and western subzones. In the eastern, tuber dominant zone the rule is potatoes/Andean tubers/barley with an optional fourth year of a European grain. On the western side, one finds potatoes/barley/barley and often a fourth year of barley. Andean tubers act as an alternative to potatoes to begin another cropping cycle rather than forming part of a sequence as on the eastern side.

Land preparation technology differs between the tuber and grain dominant zones. In the tuber-dominant zones, the Andean footplow or chaquitaclla (see Gade 1976) is used in the higher areas on steep slopes; the oxplow or yunta is used in lower and flatter areas. In the grain dominant zone, the chaquitaclla is never present. The oxplow predominates and occasionally tractors are also used where the terrain permits access.

On the whole, cultivation in the entire intermediate zone is carried out by small family farms (peasant farms). A sizeable proportion of the crops is used to feed the family members. Some of the harvest is sold, but the intermediate agro-life zone does not stand out as a commercial zone. Exceptions exist and should be noted: for example, in the upper reaches of the Yanamarca Valley, there is one SAIS (Ramón Castilla) and a small number of cooperatives that produce on a commercial scale. North of Jauja the area called Chocón is also an area where commercial farms predominate. In the Comas district, the intermediate zone is an important supplier of early potatoes to the Lima market.

3. The Low Agro-Life Zone (L_1, L_2, L_3, L_4, L_5) (3,000 - 3,500 m.)

If climate-related variability in agriculture is the main feature of the intermediate and high zones, man-made diversity is the main characteristic of the low zone. A combination of favourable conditions of the terrain and milder climate make this the most extensive and most productive of the three agro-life zones.

The diversity alluded to corresponds to the patchwork of irrigation in the valley and to different socioeconomic conditions under which agriculture is practiced. Some areas are under irrigation and others are worked during the rainy season only. We will call the latter dry zones. A second distinction separates areas that are predominantly large-scale commercial production areas, from areas that are in the hands of peasant family households, where a good part of the production is for home consumption. Five subzones identified in the low agro-life zone of the valley are listed in Table 6 and described below.

Table 6: Subzones of the Low Agro-Life Zone

	Subzone	Code in Map
L_1	Peasant Maize Subzone	dotted green
L_2	Peasant Irrigated Subzone	solid green
L_3	Peasant Dry Subzone	hatched green
L_4	Commercial Irrigated Subzone	solid orange
L_5	Commercial Dry Subzone	hatched orange

a. The Peasant Maize Subzone - This is a zone predominantly in maize production, which runs south of Huancayo to Huayucachi. Another patch of peasant maize starts north of Huancayo and stretches as far as the district of San Jerónimo. Before Huancayo became the important urban center it is today, the maize zone was probably a single strip occupying the lowest terrain with the mildest climate. The main crop is maize, which is grown continuously year after year in the same field. Occasionally, potatoes or a grain will interrupt the continuous corn production for a year or two. Maize is not intercropped with beans in the Mantaro Valley. Production of maize is mainly in the hands of small farms run by peasant households. Production fills the household larder, and is traded with peasant families living at higher elevations. Very little of this production is shipped outside the region.

b. The Peasant Irrigated Subzone - Irrigation canals are derived from the creeks and rivers that feed into the Mantaro and irrigated land covers substantial portions of the alluvial terrains on the eastern side. There is also a major irrigation canal that runs from Jauja to Huancayo, taken from the Mantaro. However, it is only used to a small extent because of river pollution.

Irrigation allows greater security in cultivation, and also permits cultivation of a greater variety of crops. Potatoes, maize, habas, alfalfa and vegetables, as well as grains (often used as fodder) constitute the main crops. In some sheltered areas, irrigation permits double cropping since planting can start as soon as frosts disappear. A common pattern is a short crop of vegetables or a fodder crop combined with a long crop of maize or potatoes. After four or five years of intensive production, the field is generally allowed to "rest" by putting in alfalfa for four to six years.

Alfalfa does not do as well as in other lower areas of Peru, and new fodder crops, such as clover and rye grass, are being introduced; even if there is irrigation all year, only alfalfa and barley survive the frosty months of July and August, so that there is still a period of one or two months in which there is no cultivation even in irrigated fields.

Peasant irrigated fields are commonly fenced with a row of eucaliptus trees, and some kind of low wall which provides protection from winds. Eucaliptus themselves are a cash crop as well as a source of timber and firewood. The hedges also modify localized climatic conditions, providing some protection from frost.

Potatoes, though they do well in these fields, compete with a series of crops for the use of space. It is often more profitable to grow carrots, artichokes, corn (for sale fresh on the cob) or alfalfa rather than potatoes. Hence, potatoes do not play the leading role in the rotation cycle as they do in the higher zones. We were not able to determine a consistent rotation pattern in these fields. On the whole, one can venture that potatoes grow in each field once every seven or eight years if alfalfa (which produces for four years) is included. Land is intensively worked. Tractors are used for plowing, while oxen are used for furrowing and as an aid to peasant cultivation. Animal and chemical fertilizer as well as chemical means to control pests are applied in all cases.

c. The Peasant Dry Subzone - Between the areas that are irrigated and on slightly higher terrain than the maize zone, peasant families practice a mixed agriculture. The crop mixture varies with minor changes in altitude. Bordering the maize are grown in alternating years for about four or five years, and then a grain crop is planted. In higher-lying areas, maize gives way (except in protected areas or near villages) to a crop mixture (more similar to the intermediate zone), with potatoes, Andean tubers, field peas, habas and grains as the favored combination. All of the fields in this zone are tilled in crop rotations, but without fallowing. As can be seen from the map, peasant mixed dry farming occupies the largest area of the low zone. In this zone, potatoes are an important crop, always playing the leading role in the crop rotation cycles.

Only detailed research, not undertaken in this study, could reveal what proportion of the production is destined for sale outside the region, though the generalization that it is subsistence-oriented is probably exaggerated. Agricultural technology is of a mixed character. Draft animals predominate in the preparation and cultivation of the soil. Fertilizers and chemical pesticides are widely used, though perhaps not very effectively.

d. Commercial Irrigated Subzone - An examination of the land-use map reveals that the commercial irrigated zones are contiguous with the peasant irrigated zones. There is a sizeable number of large farms around Huancayo and the other major population centers. The unit of production is generally above 5 hectares and operates as a commercial enterprise with considerable technical and managerial input compared to the peasant irrigated zone, the fields are larger, flatter, better drained and contain more fertile soil. The size and scale of operations permit owners to be full-time farmers and run their fundos (farms) as market-oriented enterprises with cost accounting procedures, sizeable capital inputs, heavy chemical fertilization and insect controls. As a consequence crop yields are much higher than on peasant farms. Potatoes

play an important role in the cropping pattern since, under these conditions, high yields can be achieved thus making potatoes profitable. Many of the commercial farms are seed potato producers, supplying the commercial coastal growers.

Few of these farms, however, are considered large by Peruvian standards. The borderline between peasant irrigated and commercial irrigated is rather uncertain. At the extremes, the differences are clear, but towards the middle of the scale, smallish commercial farms are similar in their characteristics to largish peasant irrigated ones. Along the continuum from small to large, commercial production of potatoes plays an increasingly important role. Seemingly, economies of scale are involved in commercial potato production, and with it comes a tendency to specialize and push towards monocrop production. These latter farms are highly specialized, obtain the highest yields and account for a high proportion of the tonnage shipped from the region.

e. Commercial Dry Subzone - The area around Sicaya and parts of the Yanamarca Valley are the two main areas that produce mainly for regional export in non-irrigated fields. Agricultural conditions are favorable, the terrain is flat and can be worked with tractors. The soils are appropriate and the climate does not regularly reach extreme conditions. Above Jauja, in Chocón, Huancas and the Yanamarca Valley, similar conditions of soil and terrain exist. These areas are on the boundary between the low and intermediate zones, with good, flat land relatively free from frosts. Such conditions favor commercial agriculture, which is practiced throughout the area.

Unlike commercial irrigated farms, which have all of their land concentrated in one area with clear boundaries between one farm and the next, and are administered from a central farmhouse, commercial dry farmers generally have their fields scattered and are interspersed with fields that belong to other units. No farmhouses or other facilities are near the fields. The base of operations is the farmer's house in the towns of Sicaya, Huancayo, Chupaca or Jauja. The fields are not as well levelled and drained as those of irrigated commercial farmers, and are neither fenced nor bounded in any fashion.

In these zones, European grains and potatoes sold as seed or for direct consumption constitute the main crops. Recently, carrots and onions have begun to be produced on an increasing scale. Technical management and inputs of fertilizer and pesticides are important factors, accounting for yields in these areas. However, these farms are not as productive as their commercial irrigated competitors.

In the commercial dry zone there is an increasing separation between the units of land ownership and operation. Many producers rent fields for one season, use their own machinery, fertilize and fumigate heavily, and once the harvest is out, return the field to its owner, who will then plant less costly and less labor intensive crops. In this way, a group of landless, entrepreneurial farmers is in the process of formation.

Each one becomes a specialist in one crop, such as potatoes, onions or carrots, and each year he puts together, through rental contracts a sizeable acreage of land (between 20 and 100 hectares). The fields are, by necessity scattered over a wide area. Labor recruitment is on a temporary basis, as the demands for work fluctuate between the seasons. This phenomenon is most visible in the two pampas of Sicaya and Chocón, but it is now spreading to peasant dry or irrigated areas throughout the valley.

In the commercial areas, some smaller family farms are worked less capital intensively than the commercial rente/lands. Toward the edges of the large pampas, where population centers are situated, and also higher up, commercial production shades off into peasant subsistence farming.

In the commercial dry areas, rotation patterns are strongly influenced by the sequence of renter entrepreneurs who sweep the area. Thus, a typical pattern for one field might be as follows: 1) in year one, the field is rented by a commercial renter who plants potatoes; 2) in year two and year three, the owner will put in barley taking advantage of the residual fertilizer and pesticides still in the soil; 3) in year four, an onion producer will rent the field; and 4) in years five and six, grains are produced, and so on. In general, potatoes/grain/grain constitutes the basic rotation pattern.

D. Crop Distributions and Agro-Life Zones

The previous section has described the main patterns of land-use in the Mantaro Valley, which are the product of interacting ecological and socio-economic factors in the area. In this section statistical data taken from the 1972 Agricultural Census will enable us to sharpen our analysis of the agro-life zones in terms of the crops grown.

The potato, which constitutes over half the dry food base produced is the most important crop in the valley.

Table 7: Major Crops of the Mantaro Valley

Crop	Surface Has.	Production M.T.
Potato	18,116	48,124
Maize Dry	10,011	10,404
Maize Fresh	850	1,761
Barley	13,780	9,896
Wheat	7,700	4,907
Andean Tubers	2,001	3,490
Haba Dry	4,288	2,518
Fresh	287	925
Peas Dry	1,417	596
Fresh	871	728
Forrage Barley	280	553
Forrage Maize	689	861

Source: II Censo Nacional Agropecuario (Perú-INE, 1976).

4. THE LOW AGRO-LIFE ZONE

A. PEASANT MAIZE FIELDS NEAR HUALHUAS.

B. COMMERCIAL FARMING
IN THE PAMPA DE SICAYA.

C. WOMEN WORKERS SELECT SEED POTATOES FOR A COMMERCIAL PRODUCER WHO RENTS HIS LAND.

5. THE INTERMEDIATE AGRO-LIFE ZONE.

A. THE WESTERN SIDE IN DRY SEASON.

B. THE EASTERN SIDE IN RAINY SEASON.

6. THE HIGH AGRO-LIFE ZONE. A NEWLY OPENED SECTOR IN STEEPLY SLOPING LAND BETWEEN ROCKS PLOWED WITH THE CHAQUITACLLA (ANDEAN FOOTPLOW).

In order to determine where the major crops grow, we analyzed the 1972 census statistics for Junin Department, Provinces of Jauja, Concepción and Huancayo. The smallest administrative unit reported in this census is the district. Out of all 84 districts within these three provinces, four have been eliminated (Pariahuanca, Acobamba, Andamarca), since they are jungle districts outside the study area. The districts of Comas, Cochas and Mariscal Castilla in the Tulumayo watershed have, nevertheless, been included in the analysis since they are important potato producing districts near the study area.

The process of independization and dismemberment of large districts into smaller ones has made them approximate the agro-life zones used in this report. Hence, we can use the district data as a rough approximation for the agro-life zones. The fact that maize is absent from the intermediate zone differentiates the districts of the low zone from those of the intermediate zone. Likewise, presence of sheep in large quantities indicates, intermediate and high zones. Districts without maize and without sheep can be considered wholly within the intermediate zone.

Using these criteria we obtained the list of districts listed in Table 8 and 9. They are listed from south to north and the distinction between eastern and western side is maintained. (See also Map II).

Table 8: Districts in the Low Agro-Life Zone

Province	District	
	Eastern Side	Western Side
Huancayo	Viques, Huayucachi, Huancán, Huacrapuquio, Sapallanga*, Chilca, Huancayo*, El Tambo, San Agustín, Hualhuas, Saño, San Jerónimo de Tunán, Quichuay.	Huachac, Sicaya, Chupaca, Pilcomayo, Huamancaca Chico, 3 de Diciembre, Ahuac, San Juan de Iscos, Chongos Bajo, Chupuro, Colca.
Concepción	Concepción, Sta. Rosa de Ocopa, 9 de Julio, Matahuasi.	Manzanares, Orcotuna, Mito.
Jauja	San Lorenzo, El Mantaro, Huamali, Masma, Ataura, Sausa, Jauja, Paca, San Pedro de Chunán, Pancán, Huertas.	Leonor Ordoñez, Muqui, Muquiyauyo, Huaripampa.
	n = 28	n = 18

Districts considered are those with more than 100 M.T. of maize and adjacent to the river.

* Districts with lands in three agro-life zones.

Table 9 : Districts in Intermediate and High Agro-Life Zones

Province	District	
	Eastern Side	Western Side
Huancayo	Cullhuas, Pucará, Ingenio	Carhuacallanca+, Chacapampa, Huasicancha, Quilcas, Chicche, Chongos Alto, Yanacancha, Jarpa.
Concepción	Cochas*, Mariscal Castilla*, Comas*, Heroinas Toledo+.	Aco, Chambará, San José de Quero.
Jauja	Apata, Yauli, Masma Chicche+, Julcan+, Yauyos+, Molinos, Acolla, Marco+, Tunanmarca+, Ricrán, Pomacancha, Jalljaillo, Curicaca.	Sincos, Parco, Paccha, Llocllapampa, Canchayllo.
	n = 20	n = 16

Districts considered are those with more than 4,000 sheep, and less than 10 M.T. of maize.

* 3 - Zone districts in the Tulumayo watershed.

\+ Districts in the intermediate agro-life zone only (with less than 4,000 sheep and less than 10 M.T. of maize).

1. Production and Yields of Major Crops

Table 11 shows surface area and production of the four major crops in the low and intermediate and high agro-life zones. Because there are so few cases of districts wholly within the intermediate agro-life zone and, hence, it is difficult to distinguish the production of the intermediate and high zones, the two are considered together.

Table 10: Area, Production and Yield of 4 Major Crops by Agro-Life Zone

	Low Zone			High and Interm. Zone		
	Area (000 ha)	Production (000 MT)	Yield (MT/ha)	Area (000 ha)	Production (000 MT)	Yield (MT/ha)
Potato	8,5	17,4	2,0	8,2	20,7	2,5
Barley	6,3	5,7	0,9	6,8	3,7	0,5
Wheat	4,4	3,0	0,7	3,6	2,2	0,6
Maize	5,4	5,7	1,0	1,1	1,1	1,0

Source: II Censo Nacional Agropecuario 1972 (Perú INE, 1976).

These figures indicate that about half the valley's potato hectareage is in the intermediate and high zones, and that potato yields in these zones exceed yields in the low zone. Whereas over half the valley's potatoes come from the intermediate and high zones, three-fifths of the barley and wheat and over four-fifths of the corn come from the low zone*.

Table 11: Surface Area and Yields of Potatoes, Barley and Wheat in the Intermediate and High Agro-Life Zones

	Tuber Dominant Sub-Zone			Grain Dominant Sub-Zone		
	Area (000 ha)	Production (000 MT)	Yield (MT/ha)	Area (000 ha)	Production (000 MT)	Yield (MT/ha)
Potato	5,5	16,7	3,0	2,6	4,0	1,5
Barley	3,0	1,6	0,5	3,8	2,1	0,5
Wheat	1,6	1,0	0,6	2,0	1,2	0,6

Source: II Censo Nacional Agropecuario 1972 (Perú INE, 1976).

Potato production in the grain dominant, western slopes is poor: yields are only half those of the eastern slopes. Barley and wheat also yield less on the western slopes than on the east, but the yield differential is significantly less than in the case of potatoes.

2. Crop Distribution

On the grounds that "one good drawing is worth a thousand words," we have presented statistical information on crop distribution in sketch maps. Map II indicates the districts which make up the study area. The white space running roughly north-south, and separating the two groups of districts is the Mantaro River.

For each district, data were compiled on the total cultivated area and the area in potatoes, barley, wheat, maize and horticulture. The surface area for each crop was calculated as a percentage of the total cultivated land in each district, and districts were then grouped into categories of 0-9, 10-19, 20-29, 30-39 and 40+ percent, with respect to each crop. One map was drawn for each crop, which indicates the percent land in each district in each crop (Maps II-VII). It should be remembered that district boundaries do not coincide with the boundaries of cultivable land. For example, the district of Yanacancha on the western side only has 407 hectares of agricultural land, of which 38% is devoted to potato production, i.e. 100 hectares. The rest of this vast district is pasture land above the limits of agriculture.

We shall now examine the distribution of land devoted to potato, barley, wheat, maize and horticulture in the study area.

* Since as seen above, no maize is, in fact, grown in the intermediate and high zones, the census figures reflect district boundaries crossing over zonal boundaries.

a. Potato - Map III indicates the proportion of cultivated land devoted to potatoes in the various districts of the Mantaro Valley. Potato cultivation is generalized throughout the valley; this crop is grown in every district.

However, the difference between the eastern and western sides of the valley is very noticeable. On the western side a smaller share of the cropland is devoted to potatoes than on the eastern side. The general proportion is 10-30%. The highest proportions of land devoted to potato production are in the districts of the eastern side, where the figure reaches 50%. Along the districts in the low zone, potatoes generally occupy 20 to 30% of the cropland.

Not all the districts that devote a high proportion of land to potatoes have high yields. (Maps III and X). The strip that runs east of Concepción all the way to Comas is the only one where yields and concentration of potato production coincide consistently (highest proportion of surface area and highest yields). The Comas area is in the Tulumayo River system which drains directly into the jungle area of Satipo, and consequently, this area receives abundant rainfall and has conditions which are highly favorable to potato production.

Map IX indicates that potato yields diminish as one moves from north to south on the east side of the valley and that this side has overall better yields than the western side. The same map also illustrates the high degree of yield variability. In general, the districts that have highest yields also have a high concentration of commercial farms. In Map X the districts are ranked according to the magnitude of their potato production. The districts with highest production statistics are Acolla (where the fields of Chocón are located), Apata, Cochas and Comas, Sicaya, Orcotuna and El Tambo.

b. Barley - Like potatoes, barley is grown everywhere in the valley. Its use as food, fodder and commercial sale value, and the campaign organized by brewing companies to produce special malting barley (cebada cervecera) make it a desirable crop. Additional factors are that barley has a greater cold tolerance than wheat, is generally more disease resistant, and is cheaper to grow, since it does not require as much fertilizer or pesticide (see Gade 1967:248).

In contrast to potatoes, barley dominates on the western side of the valley; its highest densities are in the upper areas of the grain-dominant side, especially in the southern districts. In the potato dominant districts, barley is present on merely 20% of the cropland, a factor related to crop rotation which will be discussed below.

The districts that have the highest concentration of barley also have the lowest yields. They are in the highest, driest and windiest lands in the higher western agricultural terraces.

c. Wheat - Wheat does not occupy more than 20% of the cropland in any Mantaro Valley district. Highest concentrations are adjacent to the

river, and predominantly on the western bank, a pattern which reflects wheat's poor adaptability to cold climates. There is a slight concentration in the Jauja area, formerly the center of wheat production.

In 1954, total production of wheat was estimated to be 20,000 metric tons, and the proportion of cropland destined to wheat was estimated at 30% (IDS 1954). Since then, the national policy of low price fixing and reliance on imported wheat has resulted in a drastic reduction of wheat production. Today the area cultivated is about 18% of the arable land of the valley and production is 8,000 tons. Barley and potatoes have replaced wheat in those areas where it used to be produced in considerable quantities.

d. Maize - Climatic conditions limit maize production to the lowest zones of the Mantaro Valley, as this plant is highly sensitive to frost. Thus, it only grows along the riverrine plain and is particularly concentrated in the southern end of the valley near Huancayo. Highest concentrations of maize are found in the districts of San Jerónimo, Chilca, Huancán and Huayucachi. Informants describe the area as "one continuous field of maize Production of maize continues in all bottom lands of quebradas and creeks to about 3,500 m. It is also grown in small amounts in districts of intermediate altitude and climate range, with low yields. A typical pattern in these districts is that the town is surrounded by a ring of maize fields while further out in the fields there is no more corn. Additionally, corn is grown in several districts for choclo (corn-on-the-cob) to be sold as a fresh vegetable in the market of Lima.

e. Horticulture - Map VI shows where gardening of fresh vegetables is concentrated. Two patterns emerge: a) higher concentrations occur around the four major population centers of Huancayo, Chupaca, Concepción and Jauja, which are major consumption centers as well as market centers for shipment to Lima. In these areas vegetables are grown on irrigated land in a double cropping sequence of vegetables/maize or potatoes or barley. After a few years of this sequence, the land is sown with alfalfa for 6-8 years, b) the second pattern mainly concerns onions and carrots, which, in many irrigated and non-irrigated districts, are becoming a competitive alternative to potato production. Carrots, onions, and recently garlic, seem to do quite well at higher altitudes, and the higher prices they obtain relative to other products make them attractive cash crops. Vegetable production has spread rapidly in the Mantaro Valley and the area now constitutes an important supplier of vegetables for the Lima market. Nevertheless, most districts on the map have only 1-4% of their cropland in horticulture.

E. Chapter III - Summary

1. The high agro-life zone occupies a small area of the valley and produces only frost resistant crops in rotations with ample fallow periods.

2. The intermediate agro-life zone presents the following features:

a. cold climate crops such as tubers and grains with some legumes;
b. an absolute absence of maize;
c. crop rotation with fallow cycles of varying patterns;
d. number of fallow years correlated with altitude;
e. predominance of peasant farming over commercial farms;
f. crop ecology and agricultural practices respond to the sloping environmental gradient; and
g. diversity of agriculture reflects complexity of micro-climates.

3. The low agro-life zone is characterized by:

a. cold and temperate climate which provides farmers with a greater choice of crops;
b. the presence of maize;
c. the existence of specialized irrigated zones;
d. crop rotations without fallow;
e. a progressive differentiation of agriculture brought about by an incipient process of concentration of land holdings and by the presence of different types of farming enterprises;
f. the highest concentration of large-scale modern farms which specialize in the production of marketable crops;
g. enterprises which compete with peasant farming for the same space, creating distinct commercial subzones on the most favorable land.

4. Only maize appears as a mono-crop zone with clearly defined boundaries.

5. Potatoes are more predominant on the eastern side of the valley; European grains predominate on the western side. The northern end of the eastern side has the highest percent, more than 40%, of cropland devoted to potatoes. On the western side potatoes and barley each share about 30% of the surface area, though barley dominates. On the eastern side, where potatoes dominate, barley occupies less than 20% of the surface area.

6. If tuber production (i.e. potatoes, mashua, oca, olluco) in general and European grain (i.e. wheat and barley) production are compared, the contrasts between grain dominant and tuber dominant areas stand out even more clearly (see Map VIII).

7. The Yanamarca Valley at the northern end of the east side, shares similar characteristics with the western side. Specifically, it can be compared with the Pampa de Sicaya. Both straddle low and intermediate agro-life zones. At the southern extreme of the eastern side, similar characteristics are also found in the area around Cullhuas, Pucará and Pasos.

8. Grain and tuber concentrations diminish as one moves from the high agro-life zone to the low agro-life zone.

9. Higher potato yields are more consistently achieved on the eastern side than on the western side. Higher yields of barley are also found in the potato dominant eastern side. Better yields of both potatoes and barley are achieved in lower rather than in higher areas.

10. Concentration of surface area in potatoes and barley is not correlated with yields. High yields are mainly a function of favorable climatic conditions, whereas concentration of surface area is correlated with hardiness or adaptive capacity of these two hardy crops to harsh climatic conditions. Crops that grow in both the low and intermediate and high zones (such as potatoes and barley) differentiate themselves between the zones as follows: higher yields but lower densities in the lower zone but lower yields and higher densities in the intermediate zones.

11. The intermediate agro-life zone is predominantly under peasant production systems, especially in the tuber-dominant zone.

IV. INDIGENOUS COMMUNITIES

Given the rugged topography of the Andean environment, indigenous populations have developed social and technological strategies to cope with specialized mountain conditions. Specifically, these strategies include: 1) domestication of a range of crop varieties which are adapted to a variety of ecological niches; 2) development of "technology" (tools, work techniques and farmer's lore that guides day-to-day and long-term decision making); 3) evolution of organizational forms that channel human effort in productive tasks, i.e. the organization of work; and 4) establishment of procedures by which varying regional resources are managed and administered-land tenure.

A land tenure system implies both the social units that produce crops and the conditions under which land is held and used. Furthermore, land tenure patterns correspond to underlying systems that channel and regulate productive efforts. For example, the market is an organizing system which works through the supply, demand and pricing mechanisms in allocating land to different crops and other productive uses. In order for this system to work a market in land is required, as well as markets for other inputs and outputs.

In Peru's Mantaro Valley, two basic and inherently incompatible organizing principles compete for the same set of productive resources. One is the market, which channels production for the urban, non-agricultural populations and for export. In contrast, there exists an aboriginal and much older organizational form which specifies that production be organized for the direct satisfaction of the local population's needs. The social unit (e.g., a local community, an extended family, or a nuclear family) directly produces all of its basic needs. This autarchy, or self sufficiency, must be understood against the backdrop of Andean mountain ecology. John Murra (1975) has shown that Andean social units attempt to control, for purposes of production, as many ecological niches or levels as possible. Each ecological level or subzone is specialized in its production possibilities and involves a specific set of crops. Autarchy can only be achieved by producing a variety of crops in each subzone of each agro-life zone. This attempt to maximize access to diverse zones has been termed "verticality" (Murra, 1975). Verticality has a number of specific implications for the land tenure patterns of the Mantaro Valley.

Land tenure patterns and the governing economic systems change over time. Correspondingly, the viability of verticality has in part disintegrated due to the penetration of the market system. Present land use patterns reflect the uneasy competition of the two conflicting systems. However, peasant autarchical and fragmented land tenure patterns are still viable and continue to resist the increasing encroachment of market penetration.

A. Dimensions of "Vertical" Control

Two levels of organization are important in understanding the dimensions of agricultural production as an autarchic system: the family and the community. At the level of the peasant family, households are the basic production and consumption units. With its own labor, a household will organize

and execute the various agricultural tasks on fields scattered throughout the diversified territory. This production unit comes into existence a short time after the marriage of a young couple and expands over time as children are born and begin to contribute towards production. The unit begins to decline when older sons and daughters marry and start their own household units, and finally the original peasant household unit dissolves upon the retirement or death of the original founders. Household units hold rights to small parcels of land throughout the territory, ideally distributed at various altitudes, so that some quantity of every crop can be produced given the available resources. What is harvested on these parcels will be used for self consumption, gifts, barter or exchange. Access to this land is guaranteed as long as the household is recognized as an active, full member of the community.

Above the level of the household is the community which defends the communal territory from outside encroachment (be it rivalling communities or haciendas). Communal authorities, acting as official and legal representatives, also govern relations within the community. More importantly, they administer the communal territory assigning different portions to several productive uses. They also regulate, in diverse ways, the access of individual households to lands within the communal territory.

Between community and individual household there exists a dialectical relationship of interdependence. The community leadership restricts, controls, limits and directs the individual households in their agricultural activities. However, the leadership of the community cannot exist without the consensus and approval of the component households. The dynamic relationship between community and the household is a form of social organization that constantly generates technological solutions to bridge the gap between the desired products and environmental realities. Simultaneously, the communal leadership can, or may, act as a brake against individuals who desire to change their production patterns beyond the established procedures. These changes can only be implemented if the community leadership accepts them, or when household independence is strong enough to resist the leaders and implement the changes despite opposition.

Under this system, land tenure may be characterized as dual or "parallel" (Fonseca, 1972:99). Some property rights are exercised by the community while others are exercised by the individual household. Thus, land tenure is not entirely communal nor entirely private. Several agriculturally-relevant decisions are split between the individual and communal level. For example, decisions concerning allocation of land to different uses and timing of agricultural activities may be made at the communal level, while levels of specific input use are made independently by the households.

Given that a community's territory extends over a broken environment, and that land can be put to alternative uses, the local population under community leadership assigns different portions of the territory to a variety of uses. Such specialized areas are here termed production zones, sections of communal territory in which a set of resources is under the overall management of the community. Each production zone is used in a distinctive way, which includes a set of crops, a pattern of rotation and fallowing, and a system for

allocating "free" resources, such as irrigation water, grazing land and firewood. Production zones are locally recognized, named and marked by clear boundaries. Since they extend over small areas, these zones have not been drawn in the valley land-use map. However, in a subsequent section in this chapter they will be described and analyzed.

All communities in the Mantaro Valley have created specialized production zones. Yet conditions of tenure and degree of communal control within any one zone varies. It may also vary between neighboring community, even though they are in the same agro-life zone. Degree of communal control over productive decisions has eroded over time. At present, communal control remains greater at higher altitudes. The following section examines the evolution of land tenure patterns in Mantaro Valley communities. Subsequently, we will examine the communal aspects involved in the production decisions of peasant agriculture within the communities.

B. Indigenous Communities in the Mantaro Valley

Knowledge of pre-columbian land tenure in the Mantaro Valley is limited.* Spanish administrators followed and built upon pre-columbian systems by apportioning land to semi-autonomous communities and thus insuring the self-sufficiency of local populations. As long as these communities complied with tribute obligations and made reasonable progress towards Christianization and Hispanization, the colonial administration was content. The populace was allowed to organize their systems of production autonomously.

The population, probably originally dispersed through all life zones, was forced to congregate in the low zone near the river and settle in nucleated villages according to a Spanish design. In order to apportion land to communities in such a way that access to all life zones was maintained, the community territorial boundaries were fixed in such a way that their lands ran in continuous strips from the edge of the Mantaro River all the way to the highest puna cutting through all life zones. In this way, horizontal altitudinal zones were apportioned among communities. In each life zone the community organized specialized production systems, using the puna for pasture of camelids and European sheep, the high and intermediate zones for the production of tubers and grains, and the low zone for corn and warmer climate crops.** Relocation to the low zone probably did not only

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* Many archeological remains of pre-Spanish peasant settlements are located on the border-line between the low and intermediate zone (3,500 m.). For example, the archeological site of Huacjamarca, above Parco was the center of the Ayllu of Lurinhuaila inhabited up to 1571 (Espinoza 1969:19). Perhaps the high location indicates that more importance was attached to the products obtained from the intermediate zone. We also know that social units in the Mantaro did control distant production islands in the tropical valleys to the east of Huancayo (over the Cordillera) where they produced ají, coca and other jungle products. The direct access to these lands was lost in colonial times (Mayer 1974:37).

** In 1571 the Ayllu of Lurinhuaila was forced to relocate and build a new village in Huaripampa (which still exists on the western side of the river due south of Jauja) and it had to share the village and newly appointed territory with the Ayllu of Ananhuaila (Espinoza 1969:16-17). In that year most of the present day villages close to the river like Mito, Chupaca, Sicaya, etc. were founded in the same way.

correspond to tighter Spanish social control, but also to a re-emphasis in the agricultural potential of this zone where European grains, like wheat, could be grown more readily.*

Given the distances between the village and land parcels, several mechanisms evolved for exploiting the mountainous terrain. Land near the village could be worked by walking back and forth every day. More distant land required temporary dwellings which were occupied when work had to be performed there, as well as shelter for persons assigned to guard the crops. Pasturing which required daily attention, necessarily implied the full-time occupation of some village members. Herding estancias (areas for grazing animals), which were movable or fixed, were utilized to exploit areas of the valley suited to grazing but not cultivation. Herders were initially attached to villages which provides them with grazing land and a source of food crops. Over time, however, herders became more and more differentiated and separated from their agricultural village nucleus. They became a dependent population who lost access to land in the lower zones, and who herded not only their animals but also those of village dwellers in exchange for food crops. Relatively cut off from access to food crops, herding peoples intensified the old patterns of cultivating at high altitudes and expanded the agricultural front in higher zones and finally to the highest limits.**

A similar process took place in the intermediate zone. Population expansion and greater need for food crops resulted in the growth of permanent villages at higher altitudes than the nucleus. These anexos (annexes), still subject to the "mother village," became specialized in the production of crops adapted to the intermediate zone.

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* Moving, however, did not imply the abandonement of the intermediate and upper zones, in the case of Lurinhuaila, Espinoza cites documentary evidence that the families continued to work their fields near their old, destroyed town.

** For example: The community of Moya studied by Fuenzalida (1970: 5-49) (south of the project area in the Department of Huancavelica) had six annexes spread out in its territory. Moya, a parish capital, became socially differentiated, with a caste of "Whites," another of "Mestizos" and a third of "Indians" according to local usage. Whites and Mestizos had most land in Moya and in several annexes as well. The inhabitants of the annexes occupied lands in the higher marginal lands and the pasture lands; and were ascribed to the lowest stratum to whom the despicative term "chuto" (savage!) was applied. Chutos had to serve in labor drafts in the local town, herd the animals of the Moyanos, and work on their fields. Access to land in lower zones was progressively denied them, so that barter relations (of meat and wool for maize), working for payment in kind, and the cultivation of a few hardy crops within their own territory became their means of obtaining vegetable food sources.

With the gradual filling up of agricultural space the anexos became increasingly autonomous. The process of agricultural intensification implied the creation of local anexo leadership who coordinated and administered agricultural activities, such as rotation and fallow cycles, management of grazing (on the stuble of harvested fields and on fallow land) and provided for the self-governing needs of new villages. Given the progressive growth of local autonomy, and a long list of grievances against economic exactions by the mother village, a stage was set for the eventual break-up and independization of the anexos from the mother village. All that was needed was the political opportunity to secede, which came with the advent of the liberal, secular independent state. During republican times many anexos became independent communities and districts. This process was accelerated in the decade 1930-1940 when the government recognized the territorial integrity of these newly formed communities.* In this way, villages located in the intermediate and high zones became independent from the villages near the river.**

This process of independization of the agro-life zones has continued until today. Beginning in the 1960s, agrarian reform agencies aided communities in gaining official recognition. Presently, communities tend to control not a number of ecological levels, but rather they specialize in the use of one level. A typology of communities today coincides with the agro-life zones described in the previous chapter:

1. Herding Communities in the High Zone

These villages derive their main source of income from herding in the puna, while maintaining access to the high zone and the upper part of the intermediate zone for subsistence production. There are also a few communities wholly in the puna without access to agricultural land, but they are the exception.

2. Agricultural Communities in the Intermediate Zone

These are entirely situated within the intermediate zone, occasionally having access to some small portions of pasture land. Consequently, a portion of their crop production must be marketed in order to satisfy family cash needs. These are the most "agricultural" communities in that many families are full-time cultivators.

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* Alberti and Sanchez (1974:49-58) describe how the village of Mito was "dismembered." In 1857 Sincos and Orcotuna, old villages previously subject to Mito, become districts, at the same time that Mito also was named district. In 1917 Aco seceded from Mito taking with it Usibamba + Chaquicocha, Consac and Hatunhuasi was sold to hacendados in the same year. Usibamba became a district in 1910. In 1941 Chambará seceded from Aco. In 1953 Llacuas Huachac seceded from Chambará. San José de Quero became a district shortly afterwards.

** Castillo (1964:8) describes how in this struggle for independence the people of Chaquicocha (a group of herders) achieved it after 20 years of conflicts, battles and litigation with all its neighbors. Finally in 1938 the government recognized Chaquicocha as a community.

3. "Urban" Communities in the Low Zone

In addition to controlling dry and irrigated lands in the low zone, "urban" communities also reach into the intermediate zone. Most, however, are restricted to the low zone. Agriculture here has become a subsidiary activity as amounts of (available) land have become limited. Thus, most families have other sources of income, including handicrafts, transportation, wage work and commerce. Crop production serves more to fill their larder, as a supplement to non-farm activities. There are, of course, full-time agriculturalists in the low zone, but in each community they constitute a minority.

Given the disintegration of village vertical control and a narrowing of the economic base in each dismembered community, individual families still attempt to maintain access to agro-life zones no longer directly controlled by their natal community. Some become members of several vertically arranged communities, simultaneously, a situation that is illegal but still possible. Other similar (also illegal) mechanisms include renting, share-cropping or borrowing pieces of land from relatives or near relatives in other communities. Finally, another strategy is to purchase land outside one's community. In the low zone, where privatization of land is more advanced, it is legally possible to own land within the jurisdiction of a village without being a member of that community. Thus, many families from agricultural and herding communities are reconstructing through purchase of land the ideal of vertical control of a maximum number of ecological levels.

In summary, as population expanded, agriculture in each agro-life zone became intensified and specialized. As a result of the internal dynamics of increasing autonomy, and aided by external conditions which encouraged administrative independence in each agro-life zone, a number of independent communities, specialized in their production patterns, have evolved.

Independization of communities has also implied a change in the degree of communal control over productive resources. When communities extended from the river up to the puna, they exercised control over a vast territory. As the anexos became independent, however, the unit under communal control became smaller, and each time another anexo hived off, the number of people involved decreased accordingly. Thus, the trend has been from the control of vast multi-ecological territories administered by one nucleus to communal control of smaller territories more restricted and ecologically specialized.

C. Social Aspects of Peasant Production Systems

An anthropologist can describe and analyze technological aspects of agrarian production, but not evaluate them in terms of applied agriculture. The job of evaluating agricultural practices in terms of maximizing productivity by commercial farmers is the domain of agronomists. The case of peasant farming is, however, special. A number of agricultural practices in peasant production systems are interlinked with each other and to patterns of land tenure and land-use. The following section draws from my previous research on traditional Andean agriculture, combines research findings of colleagues, and tests some of these findings in terms of the Mantaro Valley.

Primarily, I will describe the interlinkages of peasant subsistence and discuss how increasing privatization has altered traditional patterns.

The Andean production system operates through a dual decision-making system. At one level, the peasant household is the actual unit producing the crops while, at a higher level the community manages and administers the territory through controlling households. Ideally, this body controls a vast and heterogeneous territory. A complex organization of authority delegates control so that each level is in charge of a local specialized segment of territory. Decisions about land management are then both centrally coordinated and locally decentralized. A schematic representation of this system is given in Figure 3 below.

The ecologically specialized production zones are depicted in the center while on the right the levels of authority that administer and manage the territory are shown. Each production zone is under the management of a local set of authorities (3) who make day-today decisions throughout the growing season and see that rules are enforced through fining infractors and reporting problems to higher levels.

Level (2) of the authority system includes, for example, the superior authorities that controlling lower-level authorities of a set of two production zones (e.g. a and b or c and d). In the past, the anexo leadership had a certain degree of autonomy but still was under the tutelage of the overall communal authority (1).

The left side of the diagram represents individual peasant households who have access to land in each production zone, but for whom the conditions under which land can be worked vary according to production zone. This does not imply that there is no room for individual interpretation of the rules. Ultimately the peasant households will --through assemblies and political pressure on the authorities-- influence the conditions of land-use. Land-use patterns in this system specialize production in the zones, but the production units are diversified and undifferentiated.

This dialectic relationship symbiotic and conflict-ridden at the same time, can conveniently be analyzed along four main lines:

a) The long-term communal creation of specialized production zones, contrasted with the individual household's access to portions of the zone;

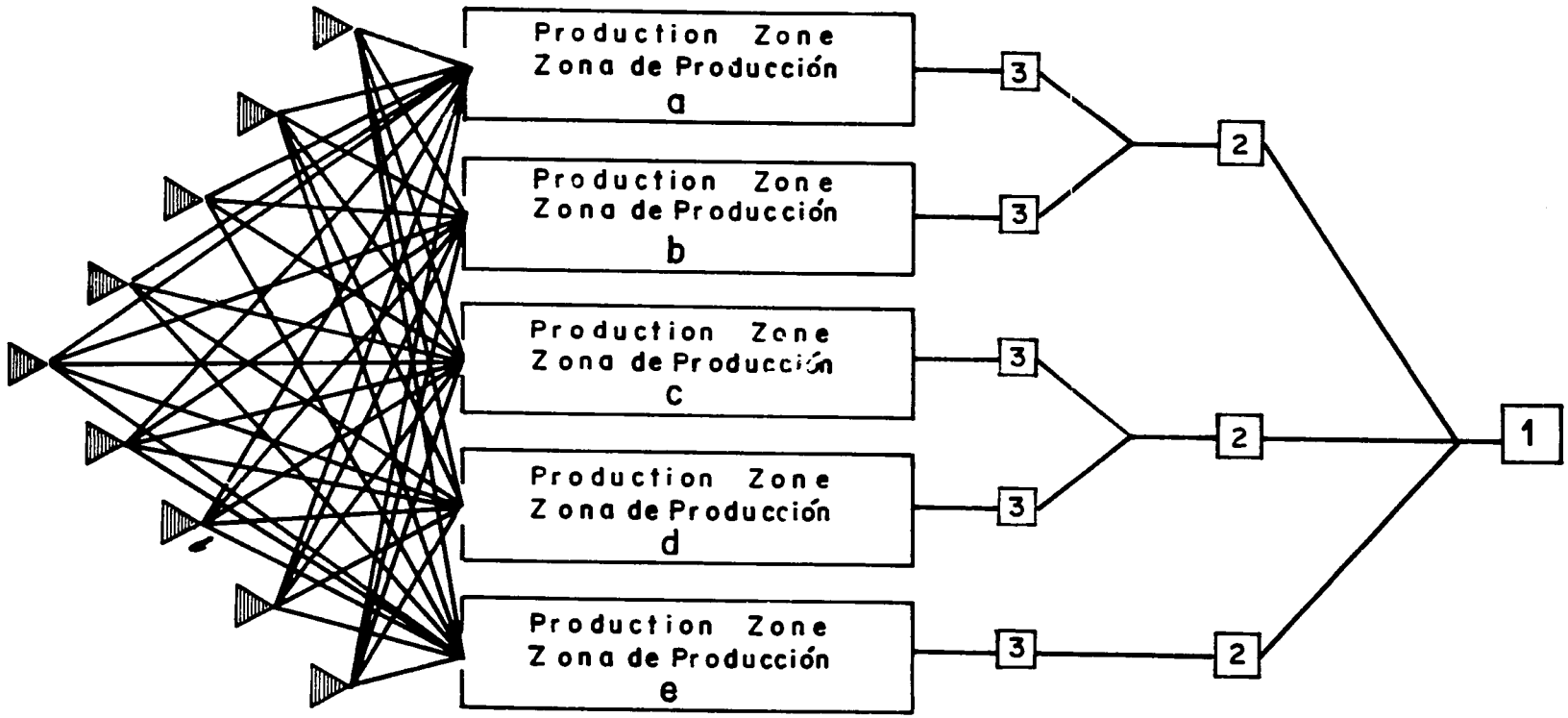
b) the communal creation and enforcement of rules for each production zone, versus individual compliance or resistance to the rules;

c) the communal coordination of the agricultural calendar in contrast to individual free allocation of productive labor time; and

d) the communal utilization of labor which is contributed by the households for certain production activities vis-a-vis the free allocation of labor resources by households.

Let us briefly examine each one:

Fig. 3 LAND MANAGEMENT UNDER PEASANT AGRICULTURAL SYSTEMS.
MANEJO DE TIERRAS EN SISTEMAS AGRICOLAS COMUNALES.



Peasant households.
Unidades domésticas campesinas.

Levels of authority that administer territory.
Niveles de autoridad que administran el territorio.

1. Long-Term Creation of Production Zones

The evolution of production zones implies crop selection, wherein a special crop complex suitable to that zone will develop. The specific combination of crops depends on what people want to consume and/or sell, and on the ecological limitations of that, and other zones. Usually, the crops that grow in a production zone can easily be identified by determining the rotation cycle practiced in that zone.

Crops are introduced, domesticated, and selected in each production zone by individual households, who constantly experiment in their fields and gardens. This activity selects the set of crops and the varieties that grow best locally. Once they are adapted, these crops will become generalized throughout the production zone and communal rules on cultivation procedures may be imposed. At any time, crops grown in any one production zone may appear to be fixed by communal rules, but the mix of crops will change over time.

In each production zone, through communal and household labor, the specific infrastructure needed to produce a set of crops develops. These include communal fences, hedges, irrigation canals, access roads, paths, and field types. In irrigated zones, for example, the community will, through communal labor, build the main irrigation canals, while the individual families will build the access canals and distribution systems within their allotted fields. In the case of terracing, each family constructs terraces on its allotted territory, but the overall design and lay-out corresponds to the decisions of the supra-household level. Fields are carved out of the morphology of the terrain, and as any man-made thing, the design of the field corresponds to the way it will be used; i.e. the requirements of the plants that will be grown. For example, in the intermediate zone, on hilly sloping lands a system of terracing, which we have named andén rústico (or slope terrace) predominates. This system is particularly appropriate for tuber and grain cultivation without irrigation.

Cut from the sloping hillside at angles of 20 to 30 degrees, the terraces normally do not have stone retaining walls; the lower part forms a sort of lip or platform. The andén rústico follows the contour lines of the hills and is always flanked by bushes (chilca, maguey, etc.) which contain erosion and keeps animals out. (See figure 4).

Drainage of the andén rústico is problematical and is solved by each farming family by the furrow type developed for given fields during each cultivation cycle. The type of furrow also varies from crop to crop. Steep vertical furrows provide for rapid runoff, but erosion is a hazard. Diagonal horizontal or zig-zag furrows are also used. In the Cañete Valley I observed a system called tulpa. A tulpa is a group of three plants spaced in an equilateral triangle. The field pattern is like a honeycomb. At cultivation, each plant is treated separately by building a little mound around it. Torrential rainwater meanders around the mounds, minimizing erosion and maximizing moisture retention. The degree of moisture retention can be controlled by the height of the mound. (See figure 5).

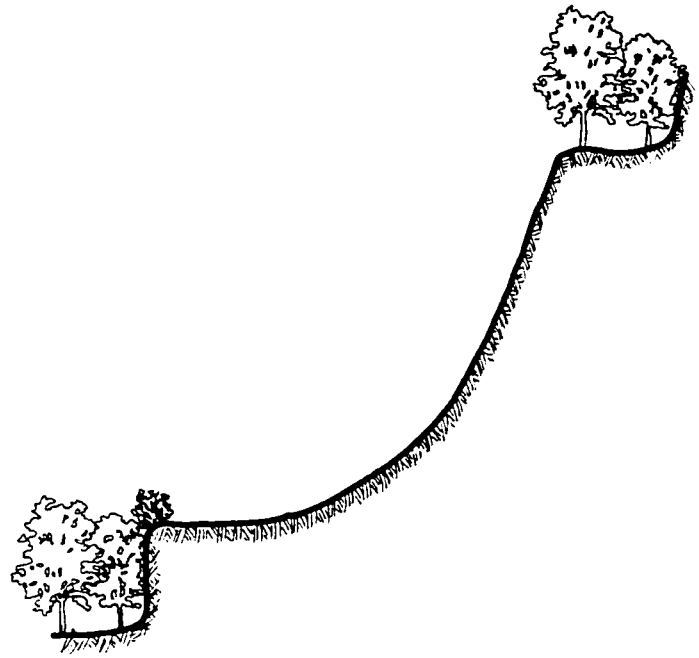


Fig. 4 Profile of a slope terrace.
Perfil de un anden rústico.

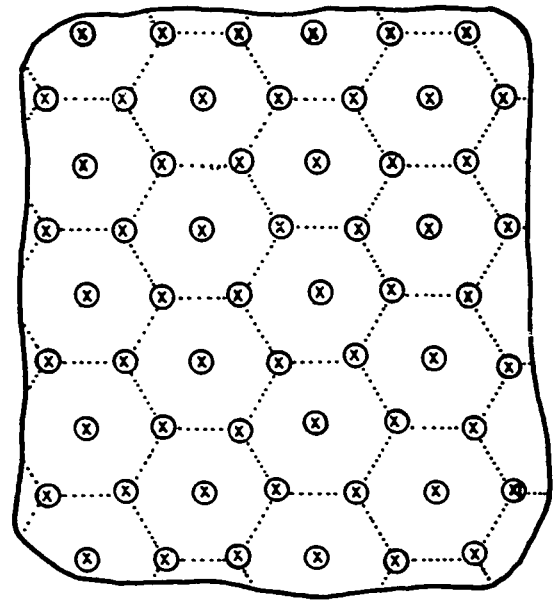


Fig. 5 Frontal view a slope terrace planted in tulpa style.

Vista frontal de un anden rústico sembrado al estilo Tulpa.

The maintenance of an area with andenes rústicos depends on a proper system of furrowing, and on adequate fallowing. Each year of cultivation, no matter how carefully managed, does imply a loss of soil.*

In summary, each productive zone has a specific infrastructure that correspond to the needs of the zone's crops, and which is designed and built by communal labor and individual households. Moreover, each production zone is characterized by different rotation/fallow systems. The higher the altitude, the longer the fallow period, the shorter the rotation cycle and the fewer the crops included in each cycle.

2. Creation and Enforcement of Communal Rules in each Production Zone

Rotation cycles may be communally organized or left to the control of individual households. The most communal system is the sectorial rotation/fallow system still practiced throughout the Andean area of Peru and Bolivia. It has been described by Matos (1964:19-27) for the island of Taquile in Lake Titicaca where it is called the suyu system; by Carter (1967) for the Aymara speaking Altiplano areas in Bolivia and Peru where it is called the aynoqa, in Cuyo-Cuyo on the eastern slopes of the Andes in the Department of Puno where it is called the manta system. Custred (1973) reports that in the highlands of Cuzco the system is called laymi, Fonseca and Mayer (1976) in the Cañete Valley report it as the moyas de aisa; Fonseca (1972:36-44) in Yacán in the Chaupiwaranga area of Cerro de Pasco informs us that these lands are called manay lands ("those lands which have to be given"); and Mayer (1974: 33) in another community of the same area discovered the term muyuy ("that which goes around"). In the Huancayo area, residents call the system turnos ("land that is worked in turns").

Today, this system is associated with high-altitude peasant agriculture, with the cultivation of potatoes and Andean tubers, the use of the chaquitaclla or Andean footplow and to a communal control of agricultural decisions. Silvia Rivera (personal communication) reports that even haciendas in the Altiplano of Bolivia used this system, where the hacendado, together with the elders of the peasant would determine the rotation cycle, and the hacendado's parcels rotated around the aynoqa with those of the peasants.

Under ideal systems observed in several communities, the community controls all land and each year allots to each household a portion of those lands projected for the cropping cycle over the next three or four years. When land enters a fallow period, it reverts to communal control and use as pasture. In this system, not only crops but also fields are rotated. Both are coordinated by the community as shown in Fig. 6.

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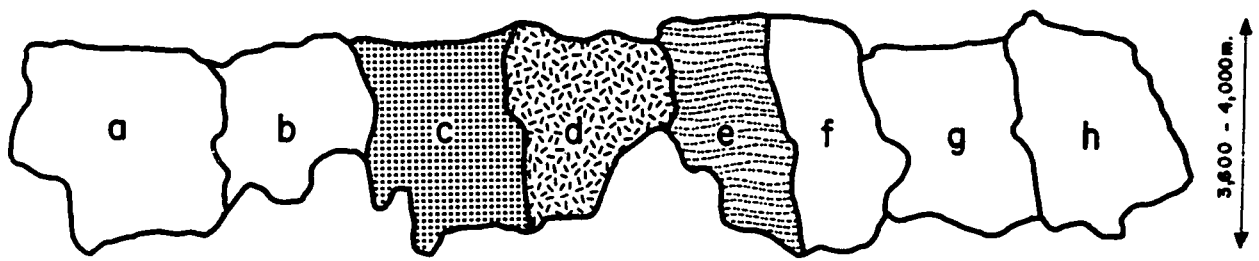
* In my field work I have never yet come across peasants who reconstruct their andenes rústicos but I did collect some myths about their ancestors who knew their own soil by smell and each year that land was worked they would go to the lower terrace and sort out their own soil from that of their lower neighbor's and return it to the upper terrace. So at least myths of maintenance work can be found.

Fig. 6 SECTORIAL FALLOW / ROTATION SYSTEM.
SISTEMA SECTORIAL DE ROTACION / DESCANSO.



Year 3 .....rastrojo huapal polón descanso.....
Año 3

The community divides its territory at the same altitude into several large sectors, each one with roughly the same productive capacity. It decides in year 1, for example, to open up sector c. Every family with rights to land will receive one or two parcels in it. Each family will, when the season is declared open, break the ground with their plows and plant potatoes. On an appointed day, perhaps before the distribution ceremony, the farmers will, as a communal work party, close and fence off the sector, repair its stone walls and drive sheep and other animals from the land. Prior to that, the families may have concentrated their sheep on the sector in order to fertilize its soils.

In year 2, sector d will be opened up in a similar way. In sector c, the families will plant Andean tubers following the potatoes. In year 3 sector e is in potatoes, sector d in Andean tubers and sector c in barley. Year 4 opens up sector f and sector c will start its first year of fallow. In this example, each sector will thus go through a rotation cycle of three years of crops and a fallow of six years. Each farmer, and the community, will simultaneously work three sectors, opening up a new one each year and starting one in its fallow period. While all peasant families cultivate the same crop in each sector, crops "move" around the territory. A sector which is in potatoes after fallow is called in the Mantaro area, polón or pulun, a sector in its second year of cultivation is a huapal, and a sector in European grains is called rastrojo.*

The number of fallow years in such a system depends on the number of the years each sector is in crop production (i.e., its rotation cycle), and the total number of sectors in the production zone. There is evidence that such a traditional agricultural system prevailed throughout the Mantaro Valley on non-irrigated land in all agro-life zones except for the maize-zone which produces the same crop on the same fields year after year.** But population growth and increasing land scarcity, independization of agro-life zones, and privatization of land have dismantled many of the features of this system.

First, privatization has implied that annual redistribution of land in each sector becomes a symbolic affair, since the families retain the rights to the plots they worked in previous cycles. As a result, differences in the amount of land available to families become more generalized.

Secondly, increased pressure on the land has modified the management and distribution of land resources. There are various ways in which this takes place, and various successive stages:

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* The first two terms are Quechua; polón bears a linguistic similarity to the term used throughout the jungle purma for secondary forest in slash and burn agriculture. The last term is Spanish and means stubble, reflecting the addition of a European cultigen to the cropping sequence.

** Within this same type of system lower lying areas may have had longer cropping cycles and shorter fallow periods.

a. Increasing the size of each sector to give land to an increased number of families. This implies the elimination of several sectors, which also diminishes the number of fallow years in each one of them. Situation 1 in Figure 7 shows this possibility.

b. Lengthening the cropping cycle, without changing the size of the sector. More crops, some repeated in the rotation sequence, are cultivated at the expense of fallow years. This is situation 2 shown in Figure 7.

c. Both processes combined to create a larger sector, although the community no longer decrees how, where or what should be rotated. There are only two sectors left (one in crops, the other in fallow) which alternate annually. In this situation, each family must have a greater number of parcels in each sector, since all the crops that a family needs must be produced in one sector. This dispersion of one family's parcels is shown in situation 3.

d. The community gives up regulation of land use and the whole territory is parcelled out. Then, families privately decide upon rotation patterns and the years of fallow, according to their resources and needs. The unshaded parcels in situation 4 are those that have been left fallow.

e. Progressively, fallowing is abandoned between one rotation cycle and the next. This is depicted as situation 5 in Figure 7.

This sequence of disintegration, based on an historical process, also provides a geographical representation of the present-day situation, since the communities in the low agro-life zone began the process of dismantling their sectors earlier than in the intermediate and high zones.

In the high zone agriculture is extensive, in that one or two years of crops are followed by a lengthy period of fallow, ranging from 4 to 6 years on the western side, 5 to 10 years on the eastern side of the valley. Sectorial rotation is far more prevalent on the eastern side than the west. It is apparently necessary to fallow for long periods, not only to compensate for loss of soil fertility, but also to slow erosion and retard or reduce the build up of pathogens affecting crops.* A common rotation sequence is: bitter potatoes (generically papa shiri) followed by barley or oats for forage and then fallow. Often the forage crop is omitted. In some places olluco is also cultivated. In eastern-side communities (e.g. Masma Chicche, Queros, Ranra, Cochas, San Antonio de Ocopa, Marcatuna) the rotation is often sectorially organized, but on the western side of the valley it is usually individually organized.

In the intermediate agro-life zone, differences in agriculture between the eastern and western sides are sharpest. In the upper parts of the tuber-dominant eastern slopes, a sectorial rotation (situation 2) with three years of cropping is still common. At lower altitudes, four crop years (with the final grain repeated) and three fallow years, individually rotated, are the

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* A commercial farmer in Llacuaripampa (on the western side at 3,800 m.) told me that he tried fertilizing in order to avoid the fallow period, but did not obtain satisfactory results.

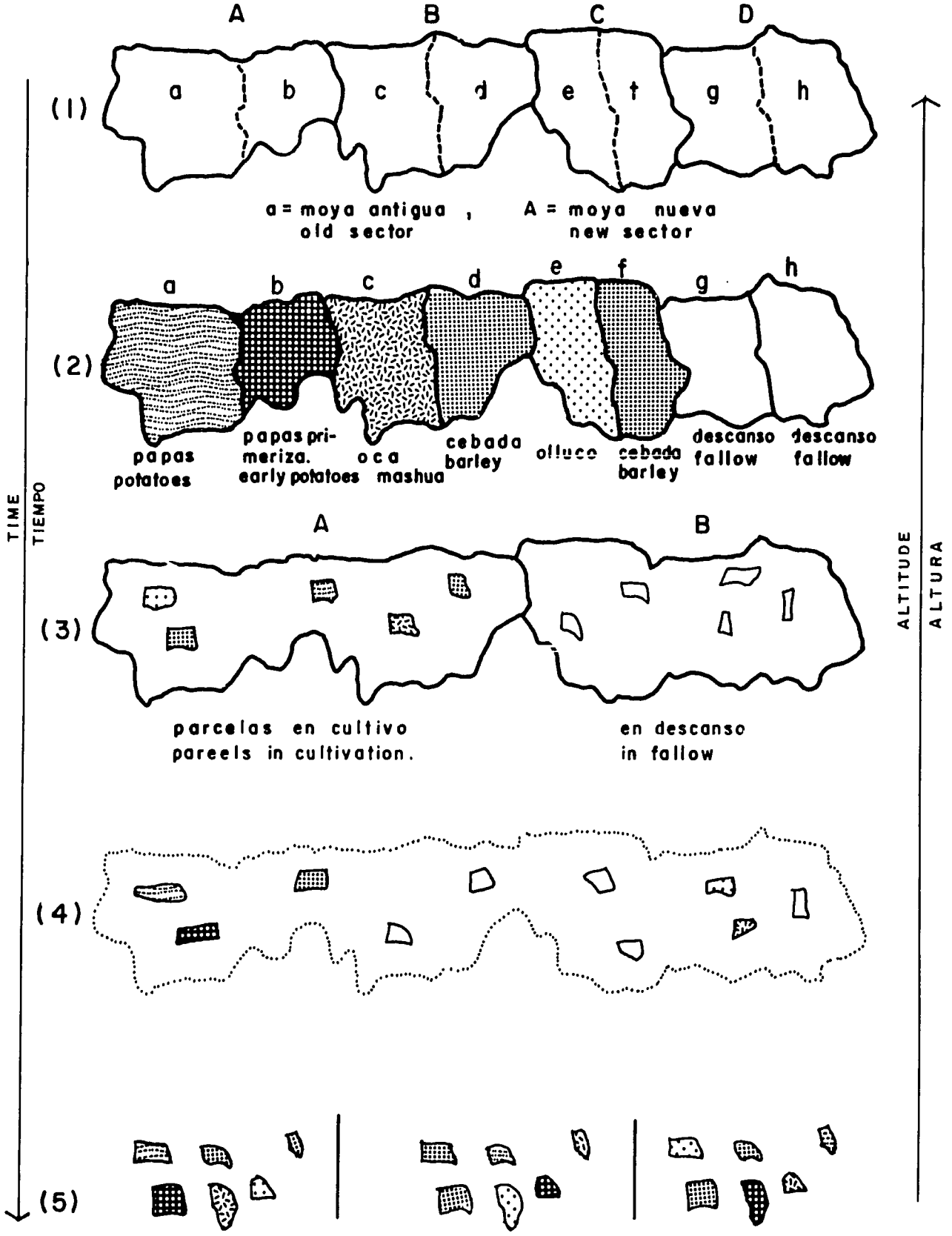

Fig. 7 DISINTEGRATION OF SECTORIAL FALLOW / ROTATION SYSTEMS

norm (situation 5). In some badly eroded hilly areas with poor soils individual rotations with two crop years (potato/grain) and two fallow years alternate are practiced.

In contrast, in the western grain dominant intermediate agro-life zone, all rotations, no matter how high, are individually organized, and the number of fallow years is sharply diminished. Also, in this zone, the sequence of crops is: potatoes/grain/grain/grain, or Andean tubers/grain/grain/grain, rather than potatoes/Andean tubers as on the eastern slopes. This accounts for differences in surface areas devoted to various crops (that was noted in the previous chapter).

On non-irrigated lands located in the low agro-life zone, fallowing has been completely eliminated although farmers still maintain the same sequence of rotation as in other areas. They even use the same terms. Most fields will go through two or three complete cropping cycles of polón/huapal/rastrojo/rastrojo before the field will be left uncultivated for a couple of years. The reason is not only shortages of land, but also that in the low agro-life zone if a field is left in fallow it is quickly invaded by Kikuyo grass which is very hard to remove when the crop cycle starts again.

But all over the Mantaro Valley, regardless of location the peasant farmers still maintain the ideal cropping cycle of polón/huapal/rastrojo. Potatoes always play the leading role in these rotations as the first crop in the cycle, ideally after fallow.

A cropping cycle is also a fertilization cycle. Many farmers fertilize fields with animal manure and chemical fertilizer at the initiation of each cropping cycle (the potato crop) and allow the later crops to depend on residual fertility. Thus, except in areas that have been fallowed for many years, potato planting is always accompanied by fertilization. This is not the case with other crops in the sequence. Continuous cropping in the low zone requires increased application of both chemical fertilizers and pesticides.

In a rotation sequence, the best fields, in terms of fertilization, are those termed polón, the second best are the huapal fields, and rastrojo fields are the lowest level. The choice of crops for polón is inevitably potatoes, because, as one informant stated, "potatoes take the juice out of the soil." In the low agro-life zone and the lower parts of the intermediate zone certain farmers consider crops to be good for a huapal. Usually on the western slopes this involves some kind of legume, habas, peas, or lentils, and on the eastern slopes Andean tubers. Where soil is poorest and most exhausted, barley may be planted. In our survey, we found very few farmers who repeated potatoes in a huapal. In general, only commercial farms repeat potatoes in a field for more than one year. A recommendation that results from this finding, is that fertilization requirements for peasant farming in the low zone and lower parts of the intermediate zone are really for three to four year cycles, rather than for a single crop of potatoes. With increasing use of soluble, chemical fertilization, residual fertility may be inadequate for later crops.

A major reason behind the communal coordination of rotation/fallow cycles in sectorial systems is that fallow land is also free grazing land for all the community members' animals (Mitchell 1974:9-10; Guillet 1976A: 13; Mayer 1977). An increase in cropping and a decommunalization of rotation/fallow implies a reduction of access to free pasture lands. On individually rotated land, animals now have to be pastured on a family's own fallow parcels, guarded by a member of the family or tethered to a stake wherever pasture is available (e.g. along roads or on the borders of fields). Occasionally, we found that a family will let one field become full of Kikuyo after 8 to 10 years of cropping in order to have a meadow for pasturing their animals, even when they know that the nutritional value of Kikuyo grass is minimal. Thus increasingly, in the low zone, fodder for animals (in the form of barley or oats) as well as food for human consumption has to be produced in farmer's fields.

In well irrigated areas of the low agro-life zone, communal aspects of rule-making are largely absent. Availability of water on an individual basis gives farmers along the canals the freedom to cultivate crops intensively and independently. In other parts of Peru, particularly on the coast, and in areas where irrigation water is a limiting factor, the supra-household decision making level involves an association of farmers along a canal. Water rationing may dictate quite stringent constraints on how, when, and what may be cultivated in the fields along the canal. Irrigation in the Mantaro permits a growing season of one short crop and one long crop each season. The incidence of frosts in most parts of the valley in the dry months acts as a block to complete double cropping. A typical sequence in Ahuac is the following:potatoes + horticultural crops/maize + horticultural crops/habas + horticultural crops/barley + horticultural crops/alfalfa (5 to 6 years).

3. Communal Coordination of the Agricultural Calendar

As we previously noted, plants grow slower in higher agro-life zones and it rains for longer periods in the intermediate and high zones compared to the lower zones. Consequently, the agricultural calendar varies between the three agro-life zones. Crops mature at least a month later in the high zone than in the intermediate zone, and two months later in the intermediate than in the low zone. Barley takes almost 11 months in the high zone, 10 in the intermediate and 8 in the low zone. Potatoes mature in approximately 8, 7 and 6 months in the high, intermediate and low zones. Lengthy growing periods in the upper zones do not permit short and long crops each season, while in the low zone long spells of dry weather have the same effect if there is no irrigation.

The community controls the agricultural calendar by fixing dates between which certain agricultural tasks must be initiated and finished. Generally, selected Catholic saints' days are used as a rough guide. Occasionally, the activity is ceremonially initiated and closed off by the authorities who have the communal lands worked that day. Often the calendar is manipulated so that leaders can most effectively pressure the community to contribute their labor to communal tasks. Furthermore, this control allows for the accumulated experience of everyone to be presented, discussed and judged. The agricultural calendar must be coordinated with rainfall patterns, the probable

incidence of frosts, the dates of the important fiestas, and so on.* At the level of the individual household, the organization of the calendar is quite complex. Each crop, may be planted "early," at the "main" planting time or "late." In Quechua the corresponding terms are punta talpuy, hatun talpuy, and ipa talpuy; in Spanish the terms are: primeriza, principal, and última siembra.

Each year potatoes are always planted first followed by Andean tubers and finally by grains. This order is also maintained in the harvest, with potatoes first and grains last. In a few intermediate zone communities, Andean tubers are planted in July right after the potato harvest. These tubers then lie dormant in the ground until the first rains stimulate sprouting. Only in the western high zone, did we find a grain planted before potatoes. Here barley, an important crop takes long to mature.

Planting strategies in higher and lower lying fields for the different crops are the result of complex and finely tuned task calculations. Farmers will spend endless hours discussing the agricultural calendar and weighing each factor carefully. One of the reasons for this complexity is the desire to spread risks in an unpredictable environment.

In high and intermediate zones the first plowing after fallow is generally done between January, and April with the footplow on the eastern slopes and with pick-axe and oxen on the western slopes. The ground is replowed lightly at planting time in September. The reason for such early plowing that only in these rainy months is it possible to break the soil.

An alternative to this system of early plowing (termed chacmeo), based on the principle of minimum disturbance of the soil, is practiced in the eastern tuber dominant intermediate and high agro-life zones. This is called tipka in Quechua and siembra en crudo (raw planting) in Spanish, and consists in opening a small patch of turf with the chaquitaclla and lifting it up like a hinge. The helper introduces a seed tuber and then the turf is closed up again. This activity is done in July or August. Vertical rows are thus planted and a wide space is left between furrows. When the tuber has sprouted, it is fertilized with sheep dung. Four months after planting the operation of volteo begins. The men cut out large pieces of turf from the space between the rows and place them upside down between the growing plants, so that the grasses face downward and the roots exposed. The potato plant is thus flanked by two large pieces of turf between its roots and leaves. This practice serves to create deep runoff channels between the rows. In the second operation of recultivo, two months later, the pieces of sod which have begun to disintegrate are loosened up and more earth is piled up around the potato plant. Harvesting is done by taking apart these "mounds". Most papa shiri in the eastern high zone is planted this way.

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* These dates can be changed at short notice by the authorities in response to irregularities in rainfall patterns. An analogous example should make this clear: in a university the dates for the initiation of classes, midterms and finals are scheduled by the administration. The actual dates of the exams, however, may vary between departments, classrooms and even from student to student. Strikes and government decrees that close universities are as unpredictable as weather is for farmers. An "incomplete" for a farmer means a loss of the crop.

In the low zone, farmers keep the Catholic saint days as a reference to guide them in their decisions, but the communal control over the agricultural calendar has disappeared. Also, in the low zone, plowing in the rainy season, January to April, is no longer necessary because the soil is never left to fallow and consequently does not require such difficult manual effort. In the low zone, preparation of the soil begins in August and September, mostly with oxen, but occasionally with tractors, which allow deeper plowing.

On irrigated land, the agricultural calendar relates to short and long crops. Short crops include peas, habas, vegetables and forage crops (unripened grains); long crops include potatoes, barley and wheat. In irrigated areas potatoes can be planted in late August and a crop of early potatoes is available in February.

In no zone does the community interfere with farmer's decisions about which potato varieties should be grown. Farmers categorize potatoes into three groups, papa shiri (bitter potatoes), harinosas (floury), and blanca (white) or común (common). They recognize improved varieties by name, but categorize them as "common" varieties. There is an altitudinal distribution of varieties. Papa shiri grows almost exclusively in the high agro-life zone, the harinosas are grown in communities that maintain a subsistence strategy, while the común varieties grow throughout the low and intermediate zones. In communities on the eastern side, subsistence varieties produced without fertilizer and without pesticides are termed papa regalo (gift potatoes) and are considered to be of high quality.

Since every farmer knows that sooner or later the potato seeds "get tired" and must be replaced, a system of seed exchange has evolved. Improved or hybrid varieties diffuse gradually from the lower into the higher zones in a process of exchange and adaptation. The altitudinal limits of the improved varieties are thus reached through a process of trial and error. Fields of the variety Mariva, for example, are found at over 4,000 meters.

4. Communal Utilization of Household Labor

Communal labor is generally used to keep up and expand the production zones by maintaining and building roads, irrigation canals, and opening new production zones and communal fields. The rate at which this permanent capitalization takes place depends on the community's organizational capacity to recruit labor. If the households have a very busy agricultural schedule or if many members work off the farm, community leadership will have more difficulty in obtaining and guiding the faena labor force. Still, such labor recruitment constitutes the most important source of capital improvement available to communities.

In many ways, indigenous Mantaro Valley communities constitute viable organizations which could play a leading role in the agricultural regeneration of the area, if proper policies were implemented. However, market penetration and a lack of adequate policies are pushing the communities to dissolve the communal aspects of agricultural activity. This results in a progressive atomization of peasant families which, coupled with continuing

fragmentation of land into smaller units, is causing peasant agriculture to become less productive. This topic is best understood by examining those factors which impel peasants to decommunalize their lands.

D. Trends Towards Privatization of Land

The term "privatization" subsumes two distinct processes. First is the development of individual property relationships, rights and mechanisms of land transfer based on monetary values. The second process is the progressive growth of independent, farmer-level decision making concerning land use. The trend towards privatization under this aspect implies increasing freedom of the owner to decide without the interference of an outside body how, when and under what conditions his land will be utilized.

In studies of land tenure, the two processes have generally been treated as one, the development of property relationships generally subsuming the progressive growth of independence in decision making. In the Andes, however, the two processes are distinct and are evolving in different ways. Land may be private in the "property" sense, but still subject to communal decision making concerning production and occasionally land may be communal property, yet its use may be conditioned by individual decisions. Since we are concerned here with the relationship between land tenure and agricultural technology, communal control over production decisions is just as important to us as the aspect of property.

1. Variation of Tenure Conditions with Altitude

The degree of communal organization of agricultural production is greater in communities lying in higher areas than those in lower areas, and this is reflected in land tenure. In herding communities pasture land is communally owned, although individual families hold usufruct rights to assigned estancias, which cannot be sold nor inherited. Upon retirement of the household head, his heir may apply to the communal authority to have the land reassigned to him, but the authorities may deny this request, and not all community members have access to an estancia.

Where sectorial fallow systems are in operation in the high and intermediate zones, two systems of tenure exist. In one, land is alloted to family households each year in equal amounts for the duration of the cropping cycle, and then reverts to the community in fallow years. In the second system families "own" their plots in each sector and return to work them each time that the sector enters the cropping cycle. During the years that a sector is in fallow individual property rights are -so to speak- dormant. In areas where rotation/fallow systems are individually organized, property rights of individual families tend to be greater than in sectorial fallow systems. In the "urban" communities of the low zone land tenure is private in both senses of the term. It can also be bought and sold freely and its use is individually determined.

Access to land is restricted in intermediate zone communities and most tightly controlled in high zone herding communities. An outsider wishing to

acquire land in either zone must agree to become a member of the community, which implies acceptance of communal obligations. Land thus acquired would have to be used in the ways specified by the village. In many communities, particularly the herding ones, a further condition is that the candidate be a kinsman or spouse of a member.

In conclusion, there is a gradient of privatization that roughly coincides with altitude. However, at equivalent altitudes we find variations in the degree of communal control over productive decisions, which are clearest when the eastern and the western slopes of the intermediate agro-life zone are contrasted. These differences seem to reflect patterns of population density, the intensity of farming systems and historical circumstances that have weakened communal structures most on the western side of the valley.*

Ecological factors make communal land use patterns more prevalent in higher than in lower zones in the Andes and elsewhere. As Netting (1976) and Rhoades and Thompson (1975) have shown, this pattern is prevalent in Nepal and Switzerland. Brush (1976)states the following:

> In the Andes and Himalayas, as well as in the Alps communal tenure is associated with high altitude zones... Lower altitude zones in all three mountain areas are subject to individual tenure... Production within these zones differs from the higher ones in being more frequent and dependable, and land in lower zones is more intensively used than land in higher zones.

Advantages to communal tenure include rational range management which controls the conditions under which vegetative cover recuperates itself in agriculturally disturbed land. It also minimizes damage caused by stray animals. Extensive agriculture also minimizes the incidence of contagion between plants, as does long fallowing. In specialized high mountain environments plant life regenerates with difficulty and erosion is a severe problem. Land fertility may be maintained with long fallows without applications of inorganic fertilizers.

2. Decommunalization and Fragmentation of Land

In addition to tenure variance with altitude, it can also be demonstrated that within a given zone there is historical variation tending towards the progressive privatization of land. It is likely that in the low agro-life zone similar rules of use existed as in the intermediate agro-life zone. By controlling the use of such an important productive resource as land, economic surplus and political power could be gained. In the old ayllu (the ancient Andean family organization that formed the basic cell of Andean society in pre-European times) and in the colonial community, internal cohesion was based on the common ownership of land. A large measure of internal village solidarity was derived not only by owning the land in common but also by working it in a coordinated manner.

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* See also Mayer (1977) for a study in the Cañete Valley that shows how privatization varies with altitude and over time.

Pressure towards decommunalization came from the presence of non-Indian (i.e. non-community members) Spanish and Mestizo residents within the villages. The only way they could obtain land without joining the communities (becoming Indians!) was through purchase, which, in turn, required the "decommunalization" of land.

The process of decommunalization was slow and included a long period when land was allotted for life to an individual. Later these grants (dádiva) came to be seen as grants in perpetuity, inheritable to one's descendants. Cotler (1959:41-50) describes how, during the period 1900 to 1935 in San Lorenzo de Quinti in the sierra of Lima, communities "sold" lands to its members. These lands, in most circumstances, were already private in usufruct. What was actually obtained from such a purchase was the right to fence the property, determine land use and call the land their own. The communities were thus alienating their own patrimony and transferring it to private hands. In the Mantaro Valley, similar forces produced the dissolution of communal control.

In Muquiyauyo, as early as 1742 only half the land was officially under communal control, by 1887 this portion had decreased to less than one-fifth (109 hectares). The remainder was private property owned by non-community members who defined themselves also as non-Indians. In 1904, the Indian community, fearful of the trend by which land was continuously being transferred to non-Indians, parcelled all its remaining land amongst its 239 families. In this way, the last legal difference between Indians and Mestizos was abolished (Adams 1959 and Grondin 1977: 9). In 1938, the community acquired by purchase 36 hectares of church land which was rented to individual community members. Since 1938 portions of this land were donated to the grade schools, teacher training college, medical post, hydroelectric plant and other public institutions. Today the community has 24 hectares which are rented to its members for a small fee. No conditions are imposed on how the land is to be used.

Within a community the process of privatization takes place by production zone: land tenure conditions are seldom modified for an entire community in one fell swoop. In Quilcas, near San Jerónimo, flat irrigated lands are private, while sloping croplands and puna are communal.*

In many places the community has reserved itself one or two parcels in each production zone which on sundays and legal holidays is worked by community members in obligatory work contributions called faenas. The harvest from these lands is sold to provide community funds. However, these few parcels of community land constitute a very small proportion of the total available land. "Progressive" communities in the intermediate agro-life zone run granjas comunales (communal stables) of sheep and cattle this way. A notable one in the Mantaro Valley is Usibamba.

What constitutes communal land thus has drastically changed in definition over the centuries. Formerly a large territory was owned and administered by the community in which members had conditional rights of usufruct, but

* The puna lands are co-owned with the communities of Ranra and Saños.

today communal land is reduced to a small fraction of land in each zone and is operated by the corporation of the community. Often, this land is simply leased to community members. For individuals conditions of tenure have gradually evolved from rights of usufruct to full private property rights. As mentioned, this process is practically complete in the communities of the low agro-life zone, and it is proceeding inexorably in the intermediate agro-life zone, while in the high zone considerable land is still held communally.

Once land is privatized, the question of inheritance becomes important. Under strict communal control, a person has rights to land as a community member. If there is an annual distribution of land he obtains a plot by right of membership. Under more private arrangements, a parent's land is divided up amongst all the children. Partible inheritance, introduced by Spain, has led to the fractioning of land into smaller and smaller pieces, to such an extent that land units have become "pulverized" into minute parcels, sometimes with no more than two furrows. Population pressure and lack of alternative occupations intensify the process of pulverization. This situation known as minifundismo, is characteristic of all the communities in the low agro-life zone. There some families have managed to concentrate property in viable farms, but the great majority do not have enough land to feed their families, let alone generate an adequate income and savings. In cases of larger farms, these have frequently been bought with money earned from non-agricultural activities such as working in mines or operating trucks (Gianella 1971).

E. Chapter IV - Conclusions

Guillet (1976 A:23) sums up his paper on the supra-household sphere of production communities in the following terms:

> The supra-household sphere arises as a response to constraints on household production requiring collective processes. The principles through which the supra-household acts include redistribution, equality of opportunity and renewal of resources. Through the supra-household, land, water, pasture and collecting rights are allocated to individual households, agricultural tasks and labor utilization are scheduled and coordinated, essential technological inputs into household production are created and maintained, and individual households are defended by collective action against threats of encrosion by outside forces. In return, each household is expected to supply labor when called upon, serve in the cargo (authority) system, provide support for local officials, report for battles over land disputes and contribute in cash and kind when asked.

These are the advantages to peasant households when they are joined together in a community. In the low zone, communities are present, but in many ways they have been stripped of their leadership capacity to direct the agricultural productive system, though other services are maintained. In this zone the process of atomization of agricultural units is far more advanced than in the intermediate and high zones. In the low zone many of

the previously externally imposed rules are internalized as "good farming practices" by the individual households.

The presence of a "coordinated agriculture" in the Mantaro Valley has implications for extension work. Many of the modifications an extensionist might recommend with regard to changes in, i.e., seed, varieties, planting dates, rotation and fertilization practices, must be communally approved and generally accepted before they can be put into practice by any farmer. Many sociological studies have tried to identify the innovative farmer through whom modern practices may be introduced and diffused to the rest of the farming population. This innovative family may be very willing, but when he does try the innovation, he may run against the opposition of the collective body.

On the other hand, the effectiveness of extension work may be enhanced in sectorial rotation/fallow systems, where large areas are planted in the same crop, at roughly the same time and, hence, where possibilities exist for coordinated disease control and proper fertilizing. In these situations, extension work should be carried out at two levels simultaneously. Those aspects which form part of the communal domain should be treated at that level in ways similar to an electoral campaign; that is, convincing all the divergent interest groups within the community. On the other hand, certain other innovations, such as ways of making furrows and spacing of plants which are within the domain of individual farmers, can be dealt with on a household basis.

Finally, in highland Peru, coordinated agriculture, organized by communities and ruled through a system of authorities, constitute a mechanism for local-level planning and adaptive utilization of available resources, aimed at providing for both present-day needs and long-term ecological stability. Even though communities are beset by pressures from within and without the possibility should not be overlooked of using them as building blocks for rational land management policies.

V. HACIENDAS AND COMMERCIAL AGRICULTURE

In the preceding chapter we have seen how fragmentation of land has increased under a trend toward privatization which is, in turn, the corollary of a historical trend of dissolution of communal control over land. The counter movement of concentration of land by new types of agricultural units --haciendas and commercial farms-- will be discussed next. The hacienda, or landed estate, was owned by an upper class person, occupied a vast land area, and was worked by a resident labor force of Indians, who instead of being paid wages, received a small parcel of land to produce their own sustenance. The hacienda, a form of agrarian enterprise widespread throughout Latin America and the Andes, originated in colonial times, although its development, expansion and importance in the nation's economy came late in the colonial period and in the first century of independent republican life, when a market for rural products began to develop. After a period of peak development, the Peruvian hacienda system began to decline. It was finally abolished by the agrarian reforms of the 1960s.

The hacienda was a self contained economic, political and religious unit with limited specific types of relations with the outside world. It produced enough subsistence for all members, the resident peasant serf (colono, yanacon) and the patrón (owner).

In addition, a marketable surplus was sold by the owner in the regional, national and international markets. The hacienda ideally owned enough natural resources, land, water, wood, and livestock to make this possible, and thus sought to expand in similar ways as communities by utilizing as many ecological zones as possible. Politically, the hacienda was also independent.

Haciendas in the Mantaro Valley underwent drastic change in the last century tending towards transformation and dissolution. Within the project area haciendas were weak and relatively unimportant until the turn of the century, although in surrounding areas they were strong and pervasive. In fact, the Jauja-Huancayo area has been noted in Peruvian history for the fact that the villages and communities largely prevented the formation of haciendas within their territories. Particularly notable was the absence of haciendas in the low agro-life zone. In the intermediate zone only a few areas became dominated by haciendas. Most important were the haciendas in the upper reaches of the Yanamarca Valley and of the Cunas River. These few haciendas were characterized by mixed production systems involving agricultural products and livestock. Compared to equivalent haciendas in other parts of Peru, Mantaro haciendas were small, relatively isolated from each other, and gave the peasants more freedom and contact with the outside world.

A. Sheep Ranching in the High Agro-Life Zone

Only in the high agro-life zone and the vast puna lands above the agricultural limits did full-fledged haciendas develop. These haciendas specialized in the sheep production and expanded with the opening of the international wool market and increased urban and mining-camp demand for mutton. The puna haciendas formed from the nucleus of puna land belonging to communities

of the low agro-life zone, but whose title, instead of being in the name of the community was in the name of the local headman or curaca. Over time the curaca's heirs began to see these lands as their property and began to sell them to immigrant families. Expanding outwards, these embryonic haciendas often began to purchase or usurp land fraudulently and occasionally violently at the expense of community territory. By 1911 the process of alienation of puna land from community control was practically complete, although certain communities continued to maintain some land. A period of consolidation and concentration of property developed after 1911. Large hacendados bought out smaller ones and multi-hacienda corporations or partnerships were formed. By the time the government began to expropriate Mantaro haciendas in agrarian reform efforts starting in 1965, two very large corporations (Cerro de Pasco Mining Corp. and Sociedad Ganadera del Centro) dominated and controlled most of the puna.

By becoming so large, however, these haciendas necessarily had to undergo internal transformations. Originally the productive system was similar to that of old haciendas. Each shepherd Indian was given a flock of around 1,000 sheep to herd throughout the year on apportioned sections of pastures of the hacienda. At the end of the year the shepherd had to account for the original sheep plus natural increase, replacing lost animals from his own flock. Instead of receiving wages, the shepherd was allowed to graze a specified number of his own sheep alongside those of the hacendado. The task of herding required the full cooperation of the herder's wife and children, since flocks require 24 hour care and must be broken up into subunits (ewes and lambs) in one group and rams and wethers in the other.

The hacienda utilized Indian herders not only as a source of labor, but also for their specialized skill and detailed knowledge. Herding skills are an ancient tradition developed, transmitted and improved over at least 5,000 years. Skills developed in domesticating and herding camelids were adapted to herding sheep. Hacienda managers built on this fund of knowledge and improved conditions of production. They imported sheep from New Zealand and Argentina and crossed them with local types. A breed of sheep, the "Junín" was developed, which was specially adapted to the puna environment.

Seasonal feeding habits were studied and an improved system of rotating grazing areas was worked out. Vast areas were fenced, partly to aid the rotation system, and also to keep herders belonging to neighboring communities from encroaching on hacienda pastures. Sheep shearing, wool selection, sanitary controls and lambing operations were gradually technified and geographically centralized.

With these developments the native herder increasingly became a skilled worker, and his sheep became viewed as a nuisance to the hacienda flock. Not only did the herder's sheep (named waccho) compete with the hacienda sheep for grass, they also transmitted disease, spoiled the genetic characteristics of the improved stock, and led to overstocking of pastures. As a result, haciendas launched a campaign to eradicate the herders' stock. Hacendados tried to limit the number of a herder's sheep, tried to buy them or hired new herders who had no sheep of their own. The haciendas of Cerro de Pasco Corporation were most successful in eliminating waccho herds from their lands partly

because, as a mining corporation, it could offer the displaced herder employment in the mines. The campaign to eliminate waccho herds was in full swing in the haciendas by the time they were expropriated (Martinez Alier, 1973).

These changes implied the transformation of the traditional hacienda into a modern capitalistic sheep ranch. Apart from the technical changes already described, this transformation implied also an enclosure movement by denying peasants access to puna pastures. This was done by creating rigid hacienda property boundaries (even closing off ancient travel routes) and eliminating waccho herds. It also implied a massive investment program over many years. Only when Cerro de Pasco, an American corporation, and the Sociedad Ganadera del Centro took over, did capital generated elsewhere begin to be invested in hacienda transformation. Changed conditions of production brought increases in yields, improved quality and handsome returns to the owners. This also reduced access to puna lands for local populations, diminished employment opportunities and displaced a large herding population, which was crowded into neighboring communities. Thus the traditional hacienda in the puna disappeared in this century by transforming itself into a modern technified ranching system. Traditional herding practices and knowledge played an important role in transforming productive processes, since technical improvements were built on and based themselves on skills and knowledge already present.

Upon expropriation by agrarian reform, these haciendas became cooperatives or SAIS (Sociedad Agraria de Interés Social), and operated as modern corporations. The new owners (communities which had lost lands to hacienda expansion plus the workers on the haciendas) are share-holders in the SAIS and their delegates sit on the board of directors (Asamblea General) which elects an executive group (Consejo de Administración). This body then hires managers, administrators and salaried staff which is in charge of running the productive units. Profits in 1970 were divided up as follows: reinvestment 72 percent, distribution to share holders 27 percent. Each share-holding community received approximately 100,000 soles in 1970 (Ministerio de Agricultura 1971). These were applied by the community to improve a social service such as road construction, drinking water systems or church embelishment. Agrarian reform thus changed the ownership composition but did not alter the productive system nor incorporate the peasants into the operation.

B. Disintegration of Haciendas in the Intermediate Agro-Life Zone

As puna haciendas became modern capitalistic corporations, haciendas in the intermediate agro-life zone disintegrated internally and became communities like those described in the previous section. The story of puna hacienda expansion and transformation is the story of how hacendados eliminated the peasants from the land and how they changed productive systems inside their property. In contrast, the story of the haciendas in the intermediate agro-life zone is the story of how the peasants liberated themselves from the patrón and eventually eliminated him.

The most notorious cases are the peasant movements in the Yanamarca Valley studied by Alberti (1972) and F. La Mond Tullis (1970). These haciendas produced agricultural crops and sheep. They relied exclusively on peasant

know-how, tools and labor force to obtain the saleable crop. Moreover, the haciendas were older in origin and through inheritance these haciendas gradually split into smaller units under separate heirs. Alberti (1972) and Tullis (1970) document how since World War II the atomized peasants on the haciendas organized themselves under various guises as school committees, community councils, even sindicates and began to resist and boycott the patrón. Since patrones were entirely dependent on the peasant labor, internal resistance eventually forced them to sell land to peasants, who then proceeded to parcel land, sometimes reserving certain portions for communal purposes.

The struggle to evict and obtain control of the land was bitter and violent, and involved the development of some form of local leadership. In one case, a political refugee hid in the hacienda by assuming yanacón status. In others, sons of peasants sent away to school returned and assumed this role. Most struggles involved long and complicated lawsuits, jail sentences for the leaders, harassment of the peasant population, confiscation of crops and animals, physical beating and eviction. Peasant tenacity won out, and in a period of 20 years they freed themselves not only from the obligatory work days owed to the hacendado, but also eventually gained control of the land. Crucial in this struggle was the fact that the peasants could continue to survive with their small plots while the hacendado saw all his income dwindle away as the boycott progressed. Interestingly, original peasant demands did not question the right of ownership of the patrón, but only involved requests for better working conditions, the right to build schools, and similar social amenities. In the face of patrón resistance, their demands became more radical wherein the whole system came under question.

Except the hacienda Yanamarca itself, all other haciendas in Yanamarca became communities similar to those described before. They commercially control pasture land and a few parcels within the agricultural zones, while the rest has been parceled out amongst members. Yanamarca is a cooperative, although members have private plots of land and receive wages from working cooperative lands.

The need to raise cash to pay lawyer's fees, petition expenses, and finally to buy the property from the hacendado caused peasants to transform their agriculture. According to Tullis (1970:110) as early as 1965 peasants in Tingo:

> had begun to use commercial fertilizers and other elementary forms of modern agricultural practices... Productivity has markedly risen. During the best of the hacendado's years, aside from livestock, only six to seven truckloads of potatoes were ever marketed from the hacienda. Today (1969) an average of thirty to forty truckloads are shipped to Lima each year in addition to a like amount of onions.

Small haciendas in the Cunas River managed to hang on to their property despite peasant attacks by selling yanaconas their plot of land and subsequently relying on paid wage earners.

C. The Growth of Commercial Farming in the Low Agro-Life Zone

In the low agro-life zone, haciendas never gained a real foothold, partly because all land was granted to Indian communities and partly because land had to be bought piece by piece as it came on to the market, thus preventing the growth of large holdings. Even if land was being concentrated by purchase, inheritance rules acted as a fragmenting force. The largest landowner in the low agro-life zone became the Church, which acquired land by purchase or pious gifts; and since celibate institutions have no heirs, they managed to hold on and increase their holdings over a long period of time. Their property, however, was scattered all over the valley and administered by the local churches. Communities expropriated these church lands in the 1930's . Other larger church farms which became an embarrassment to them after Independence, passed their lands into private hands around 1850. Only the Franciscan Convent of Santa Rosa de Ocopa retained its property until 1970.

All of these farms (fundos) built up relatively slowly and never reached the size of highland haciendas. Differences in terms of internal organization, particularly the absence of yanaconas and their lack of isolation from surrounding peasant land raise the question whether these farms ever were real haciendas. For these reasons I prefer to call them commercial farms.

With the coming of the railroad in 1908 Huancayo began to grow as an urban center. Until that time the only real city in the Mantaro Valley was Jauja. Huancayo's rapid growth as a hub in communications, its role as a center for merchants and its eventual elevation to department capital caused an unprecendented population growth and internal differentiation.

An immigrant national and foreign local elite began to develop which invested its commercial profits in the acquisition of land. Piece by piece they bought out peasants who owned land in choice areas around the town. Some of these units were started some generations before by muleteers who made Huancayo an important stopover place and needed land to feed and fatten up their weary mules and horses. In contrast to the scattered parcels of lands owned by the Church, these new properties were solid blocks of land with continuous boundaries and high adobe walls bounding them. Much was irrigated land, or became irrigated when the new owner built canals.

Since the land was good, these farms were generally run as modern enterprises by one of the sons of the original owners. Also, since these small parcels were being acquired piece by piece owners were reluctant to parcel them out again to the politically active yanaconas in exchange for free labor. Thus, these lands were worked with paid labor. Alternatively the original owner might rent the whole farm to a professional farmer such as an Italian, Spanish, Yugoslav, Chinese, Swiss, German or enterprising Peruvian. Production on these farms was varied and plentiful, and supplied the towns with vegetables, dairy products, chickens and eggs, meat and grains. Specialized production of honey and fruits was also introduced. The railroad permitted the sale of these products in the mining camps and in Oroya. Chinese farmers introduced horticulture and truck-gardening. The establishment of

government research stations, agricultural technical schools, and the existence of some farmers with agronomy degrees resulted in the application of advanced technology and modern farming methods. Over time, some of these farms became specialized potato producers. Agrarian reform has affected these farms by limiting the size of landholdings to 15 hectares irrigated land. Owners of more land had to find ways to keep it (by, for example, dividing title among family members) or divest themselves of the excess acreage.

D. Chapter V - Conclusions

The fate of the hacienda was associated with the ecological conditions in which they were located. Haciendas in the puna, based exclusively on herding, expanded from an early period onwards, until they came to dominate the whole puna. Then a process of take-overs converted them into large corporations which improved the technological conditions of production, displaced peasants and became agro-businesses. In the intermediate zone, the hacienda system disintegrated. In the low zone it never really got a foothold. Puna land is vast and rather uniform-- ecological conditions are the same over a very wide area, permitting the expansion of one system of exploitation up to its ecological boundaries requiring few adjustments of technology. Economies of scale seem to apply. In the intermediate zone ecological conditions are heterogeneous-- climate, soil conditions and slope vary markedly within a small area. Economies of scale are not prevalent here, and various forms of risk place limits on the expansion of the hacienda. In the low zone, the ecological base for hacienda expansion was favorable, but strong peasant communities, and later, the atomization of peasant landholding, prevented land concentration.

Both the haciendas of the high and intermediate zones originally relied on peasant technology. Puna haciendas built on this knowledge and skill and transformed technological conditions in such a way that the peasant was no longer fully in charge of the productive process. A large portion of the decisions and actual work was organized by the centralized hacienda administration. In this way the hacienda's dependance on the peasant gradually diminished. Given the homogeneous environment, these technological changes could easily be applied over a wide area. In the intermediate zone, haciendas continued to rely on the knowledge, techniques and even tools of the peasants, given the heterogeneous environment. Thus, the hacendado became overly dependent on his peasantry and was easily defeated when they refused to produce for him. As long as production decisions must cope with diverse and changing environmental conditions, the centralized decision making mechanisms of the hacienda or the modern agro-business are at a disadvantage in comparison to the decentralized peasant system.

Various types of farming units coexist in the low zone, and none clearly dominates. Although most farms are small family enterprises, these do not play a leading role in production for the market. Nor are they a dominant force in the region, as were the puna haciendas or are the intermediate zone communities. Rather, commercial farms (which do not cover even half of the land area) play the major economic and political role in this zone, and continue to make inroads into peasant areas. If we look at the traditional

maize zone, commercial farms have entered this zone around Huancayo, and have changed both production patterns and land tenure arrangements.

In the low zone the displacement of peasant production systems is an important but slow process. Land is now securely in the private hands of a well-educated peasantry. Many of the fraudulent or extra-legal methods that were used in the last century can no longer be used to concentrate property. In addition, peasant households are increasingly unwilling to part with their lands, no matter how small and fractioned. At present, most peasant earn the bulk of their living from non-agricultural activities, but still hold on to small parcels of land. Migration to mines and to Lima does not imply (as in other parts of the world) a loss of interest in agriculture or an abandonment of the land. Migrants will abandon their claims to land only when they earn a reasonable and secure income in the city, and their future as urban people is assured. This is not the case of most rural-urban migrants in contemporary Peru.

There are, however, indications that land use might become increasingly commercial in the low zone. The willingness of families to rent their land for one or two years to commercial renters and the fact that many heirs are content to leave land in the hands of their siblings while they are away are two signs of commercialization. Also, many families which previously produced subsistence crops are now switching to cash cropping.

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VI. AGRICULTURAL FARM TYPES

Historical trends reveal a process of differentiation of farm types from a basic peasant family farming subsistence unit to the later appearance of non-Indian farming types. These became converted to fully commercial farms as the market for agricultural products began to expand. On another front, peasant farming families were incorporated during colonial times into haciendas, which later disintegrated in the intermediate agro-life zone while, higher up, they become modern sheep ranches. The peasantry itself became differentiated into several subtypes. Some were able to maintain basic subsistence agriculture on their fields because they had alternative sources of cash. Others restricted from opportunities to earn a cash income, switched to cash cropping. A third group incapable of converting much of their production to cash crops and also incapable of finding alternative employments, barely subsisted on what their fields provided them. Finally, a landless commercial farming type of enterprise is also emerging. The typology that follows is based on impressions and not on a detailed survey which, given resources and time limitations, was not undertaken in this study.

A. Peasant Agricultural Farm Units

In prehispanic times the only real producers were peasant families which with their simple tools but large fund of knowledge, were able to produce a crop in any of the many environmental conditions of the Andes. Working singly on their family plots or jointly on the fields assigned by their chiefs or Inca conquerors the peasant family was the basic diversified farm unit. This peasant family unit depended on many decisions which were collectively taken and authoritatively imposed by a form of communal leadership. The combined impact of both levels of decision making generated the organization and technology that permitted agriculturalists to conquer nature and also to come to terms with it, to obtain food but at the same time to maintain ecological balances.

The impact of modernization liberated the peasant family from communal control just as it was liberated from hacienda domination. Liberation, though has been a mixed blessing. In some instances as in the puna, liberation has been followed by the displacement of the peasant herder. Elsewhere, it has led to the progressive reduction of access to other ecological zones and a fractioning of land. Peasants have seen their lands become mestizo property or owned by commercial farmers and have had to look on passively as high adobe walls have been built around them. Their children will never be able to buy such land back.

Population pressure and fragmentation through inheritance resulted in scarce land resources for each family. Loss of production possibilities in the higher production zones also meant the loss of cash resources. At the same time more and more of household consumption includes items, such as clothing, shoes, roofing materials, pots, cooking fuel and equipment, which can only be obtained with cash. Reduced yet again in terms of resources, and unable to cover cash needs some peasant families are impelled to devote their

own land to the production of a crop which will not be eaten but sold for cash to buy back industrialized food, in the hope that a favorable exchange rate will provide for food needs as well as some minimal cash needs. When even that solution is not enough to keep body and soul together, non-farm income has to be obtained from wages, handicrafts or commerce. Soon income thus earned excedes income derived from the small farmlands. Every possible penny saved will be invested in the education of children so they can obtain non-agricultural jobs. The bulk of the peasant population in the Mantaro Valley today can no longer survive on the family farm.

If a survey were taken, representative cases of each step in the process would be found. Thus, within this broad category of the most numerous farm type, the following subdivisions can be tentatively identified.

1. Peasant Self-Sufficient Farming

The often-used term "subsistence" can mean two things: 1) a farmer barely "survives" on his farm; or 2) he produces everything he needs to live sufficiently on his own land without participating in the market. According to the second meaning, it is not necessary that the farmer be poor, so the term self-sufficient might be a better one. In terms of the first meaning, a subsistence farmer may sell all his produce but still with the money he earns he can barely subsist.

The self-sufficient peasant family will produce a diversified mix of crops in order to cover all the food items in its regular diet. By the same token, staple components of the diet (like potatoes) will be grown in family fields, even if the soil, climate, and conditions of infestation produce low yields and other cash crops could be grown. Furthermore, self-sufficient families tend to seek access to land in as many production zones as possible, whereby the farmer will have one or two fields in each zone and can grow the products he needs under the best possible conditions in the region. A rational tendency for a subsistence farmer is to seek a dispersal of his fields over a varied territory.* Thus, the rationale behind dispersal of fields, rotation practices and intercropping, will lead towards a varied system of production, diversification of crops, scatter of fields, and access to as many production zones as possible.

In the subsistence strategy, potatoes play a crucial role in cropping plans, for they constitute the most important staple in his diet, not only out of tradition and taste preferences, but because of the potato's high nutritional value.

The subsistence farmer will not use hired labor, if it can be avoided. Moreover, how he deploys family labor resources will affect what and how he produces. For example, if there are two women in the household (e.g., mother and daughter) he can acquire sheep and cows, which can be pastured on the borders of the fields every day. When the daughter goes to school, someone else has to pasture them or the animals have to be sold. Family based labor

* In contrast, commercial farmers seek to concentrate property in one place, where conditions for his crop are best.

also affects the different strategies of the agricultural cycle. For example, the self-sufficient farmer can spread out sowing time in order to meet better climatic conditions, something a commercial farmer may find costly. Conversely, the subsistence farmer with labor shortage may be forced to plant or harvest at agronomically inappropriate times because he is too busy elsewhere. If his alternative employment is as an agricultural wage worker, he may be employed at peak times, to the detriment of his own crops.

Another feature that responds to this strategy is that cash inputs in agriculture will be avoided as much as possible. The family household would prefer to substitute a labor intensive process for cash inputs. For example, if the land needs deep plowing, they prefer to hack away with a pick-axe rather than hire a tractor. Labor they have as a given, cash is always in short supply. Costly chemical fertilizers and pesticides will thus be avoided and used only when there is no other option.

A final feature of the self-sufficient farmer is his relationship to other families with whom labor inputs can be shared on a basis of "today you help me, tomorrow I will help you" (see Mayer 1974). There is also a relationship with farmers from other agro-life zones with whom special exchange rate barter networks are established. Potatoes, chuño, meat, and wool for maize are the most common ones. In this way, given that direct access is no longer possible, variety of diet is insured. These exchange rates bear no relationship to monetary production costs, but are a way in which peasant families allow each other access to a variety of products even though in their fields production variety is more limited. (See Mayer 1971).

Today, however, no Mantaro family can live without a steady source of cash: the self-sufficient strategy in agriculture can only be pursued if there are other sources of cash available to the family. Farm lands are used to grow crops that directly feed the family and provide supplementary income. In this case, it can be argued that it is not necessarily the poorest of the poor peasants who pursue a subsistence strategy, but rather the better-off families, who begin to see their farm lands as a supplement rather than the only basis for sustenance.

In the Mantaro Valley, two actual situations document this phenomenon. One is in the high and some intermediate communities where peasant families earn most of their cash from raising sheep and alpacas thus freeing their agricultural resources from market penetration. They concentrate on producing food crops in a way that fits their tastes. Production under these conditions constitutes one of the best examples of "organic farming" in Peru today. Many families do not like the taste of artificially fertilized potatoes, and employ farming methods that minimize the use of chemicals. In the same field many varieties of potatoes will be planted, a practice which preserves genetic variety by the fact that peasant taste preferences are present in seed selection criteria.

Self-sufficiency strategies are also pursued when the family engages in wage employment, commerce, and handicrafts. Thus alternative employment produces the same effect as sheep herding on agriculture. Employment outside

agriculture is available throughout the region, but is easier to obtain in the low agro-life zone. Consequently, the amount of land worked is in part limited by the quantity of labor inputs the family is willing and able to devote to it. Since the family is employed in other tasks, available labor for agriculture is usually limited.

2. Peasant Commercial Farming

Peasant commercial farming is found under two contrasting conditions. The first is when non-farm sources of cash are limited, and the family is forced to devote its meager land resources to generate both food and cash. This situation does apply to the poorest of the poor farmers. Generally speaking,"the poorest of the poor" will follow agricultural practices consistent with the subsistence strategy outlined above (i.e. seek a diversity of crops, scatter of fields, provide its own labor and avoid cash inputs). As cash is needed, the family head may dip into the storage bin and sell a portion of his produce. This type of commercial peasant farmer will not convert his fields or his practices to grow cash crops, rather he will sell parts of his subsistence crops in order to get cash, often literally at the expense of his stomach. Such indeed is the fate of the real subsistence farmer.

Conversely, some peasant families own enough land so that farming brings better "wages" than non-farm sources. This type of farmer will convert his land resources to cash cropping. The decision of what crops to grow will no longer be determined by nutritional preferences and subsistence strategies, but in part by market conditions.

This type of farmer will pursue a mixed strategy. He will try to hang on and exploit his subsistence fields as well as utilize more productive land for cash crops. Given rotational practices, the possibility of alternation between cash and home products exists. In terms of commercial potato production it appears that this type of farmer is a relatively indifferent producer. Other cash crops are more profitable and less risky than potatoes (for example, carrots, onions, corn-on-the-cob, artichokes, horticulture, malt barley and alfalfa). However, he will not avoid potato production altogether. This generalization is particularly true in the low irrigated zones. If a family has land in both irrigated and dry land, potatoes will play a smaller role in rotation sequences in the irrigated zone than in dry zones where options are somewhat more restricted.

In the intermediate zone, whether or not peasant land will be devoted to commercial potato production largely depends on whether the family in question has access to puna grazing lands. And this factor depends largely on the kind of community. On both sides of the Mantaro Valley a series of communities wholly within the intermediate zone are denied access to low and high zones. Therefore, there is no choice but to produce commercially those crops like potatoes which are suited for that ecological context. This applies to the eastern side communities of Masma Chicche, Conopa, La Libertad, Casacancha, Culhuas and Vicso, Armachay, Llacuaripampa, Achuscullo, Quicha Chico, Quicha Grande located on the opposite side.

The conditions under which a peasant family will become more cash oriented in agriculture can be readily specified. The size of landholding is not a solid predictor since commercial farming can occur under two conditions: little land and no alternative sources of cash income (at the bottom of the scale) or much land, generating an income equal to or greater than the non-farm wage level. Thus, the real criterion is how much he can earn in outside pursuits compared with how much he can earn from the farm.

There is obviously a point in the size of land above which it will be possible to successfully compete with the non-farm wage levels. In addition, the larger unit of land will absorb more labor and thus provide full employment for the family.

The fluidity of this situation must be stressed. It is very easy to shift back and forth between the subsistence and the commercial strategy since the conversion costs from one to the other are low and off-farm income sources are unstable. Labor availability within the family plays a role, as do consumption needs of the family. When the family is large and numerous workers available, a shift towards commercial farming might be advisable. When children move off the land to obtain work elsewhere, the parents might reduce the scale of their cash cropping, and finally when they are old, parts of the land may be assigned to children in inheritance. Parents then may receive maintenance remittances from their sons and thus "retire" back to a self-sufficient strategy. We also mentioned before, that it is not so easy to buy land and enlarge family property (although it is every farmer's dream to do so). This means that commercial peasant farming does not necessarily build on its own profits to expand production. In other words, it is practically impossible to capitalize and reinvest in more land to expand the operation of the farm. Rather, a diminishing of farm size is the reality of peasant farming in the Mantaro Valley. An indication of this trend is that land holdings are generally accumulated by households, such as those with members in mining, who earn and save money outside cash cropping activities. Capitalization of peasant families (not of peasant farms) is derived from the combined activities of all family members.

In conclusion, peasant farming is by far the most numerous farm type that exists throughout the Mantaro Valley. In all zones, land units are very small and fractioned and generally not capable of fully supporting a family from the land alone. Although market forces have altered and changed basic patterns of peasant life, one can see that there are constant -if unfortunately futile- attempts by the actors in this drama to reconstruct an ideal system of life. The present day situation is such that even when some families or communities achieve a semblance of their ideal of life, it is apt to be short lived.

B. Commercial Farming in the Mantaro Valley

Not all peasant families, however, meet such a fate. Some have inherited a larger share of land, which if worked diligently perhaps allowed the expansion of their holdings, permitted the education of some offspring who, in turn sent money home which then allowed further purchases of land or even investment in new technology. Hard work on the farm, skill in marketing and

good luck in some cases brought years of profit. When production capacity outstrips available land, that land which was previously borrowed for subsistence now is rented to enlarge the area planted. Under these precarious conditions, such farmers often produced more than the competing commercial farmer. Ruthless methods of cheap labor recruiting, hard work, careful planning, good weather, and propitious prices allowed the accumulation of capital which, was most likely invested in an urban undertaking like a gas station, trucks, urban property or a business. Once the new venture stands on its own feet, high risk agriculture is abandoned in favor of more secure ways of making a living.

The commercial fundo farmer looks on this peasant entrepreneur with envy, and regards him as an unfair competitor. Unlike the renter, he has high fixed costs. Moreover, as a farmer he pays taxes; his machinery costs considerable to maintain and he may have a credit with the agrarian bank which has to be repaid by the end of the year. There is only one solution: to intensify production, become a specialist in one crop, fertilize heavily and use chemical methods to combat the increasing infestation of his fields.

In addition to the these two basic types of commercial farmers, there are also absentee farmers, both of peasant origin and non-peasant, and a few cooperatives, new farm types instituted by agrarian reform which are still struggling to find adequate ways of becoming viable. Let us briefly look at each one of them.

1. Landless Agricultural Entrepreneurs (Mayoristas)

The fact that most people in the Mantaro Valley are unwilling to sell their property (even when they do not live in the valley and do not derive much income from it) constitutes an impediment to the process of concentration of land for commercial purposes. Even though this land is not available for purchase, it can be rented for one year quite easily. Many families who live in the mines or work in non-agricultural jobs are willing to rent their plots of land for one season or two. This practice builds on an old tradition of borrowing pieces of land when needs exceeded resources.

There is thus space available for commercial production on land that nominally belongs to peasants. This space ever shifting in location, is taken up by a group of commercial farmers who own no land, or very little, and who produce commercial crops on a large scale. Locally they are known as mayoristas, or semilleristas.

These new entrepreneurs, usually live in one of the villages of the low zone and have acquired agricultural experience on their own small plots. They are familiar through their own background with peasant mentality and use this knowledge very effectively to obtain rental contracts and labor. They also have knowledge through experimentation and imitation of modern agricultural techniques and apply them to the best of their ability, for they know that high yields per hectare underlie profitability.

By necessity the lands they work are scattered over a wide area, so their agricultural enterprises are built on mobility. The main areas where

rental farming is important is the Pampa de Sicaya, in the low agro-life zone and the Pampas de Chocón near Jauja, but this does not restrict them, and in fact they operate throughout the non-irrigated areas of the low and intermediate zone.

In our field work we have also seen these farmers work in the upper levels of the intermediate zone opening up land that was never used for agriculture but pasture.* Other areas where mayoristas operate are in the Yanamarca Valley, in the districts of Pomacancha, Janjaillo and Tunanmarca. Mayoristas seemingly predominate on the western side of the intermediate zone, because they need the flatter sloping lands where they can use tractors and trucks. The steeper slopes of the intermediate zone in the eastern side of the valley. as well as the small size of their fields act as impediments to their expansion in those areas.

Scattered land, and land that changes every year, allows mayoristas to specialize in the production of crops in such a way they need not worry about rotation. There are onion specialists, carrot specialists and potato specialists who sweep the area. The land they work depends on how much they are able to put together, and it ranges from 20 to 100 hectares.

One potato producer interviewed makes sure that the land he is renting did not have a potato crop in the three preceding years. If he is fortunate in obtaining fallowed land, and he can talk the owner into a two year contract, he will plant potatoes for two consecutive years. Most of the time, though, the field is rented for one year only. He is more careful when renting irrigated land because the plots may be too small and often the soil "is so exhausted it is not worth much."

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* An example is in the community of Chala Nueva in the district of Jarpa where the community, which received land from an ex-hacienda through agrarian reform, signed a contract with such a grower for three years at S/.13,000 per year. These lands had never been worked. The renter opened up the land using tractors and wage earners. The first year he planted barley which did well, the second year potatoes which were lost to frost, and the last year the fields were planted with carrots and onions and promised to do well. The community (which had given the lands to the school funds) rationalized the advantages as follows:

1) A source of cash to build the school;
2) The renter was actually opening agricultural land for the community which they, working with oxen and by hand, would not have been able to do as quickly;
3) The renter used fertilizers and pesticides heavily. They figured that thus they would receive fields that were plowed, contained residual fertilizer and was "cured" with pesticides. The next year, the rental was over, and then the community planned to use their own communal labor and their members' oxen to plant barley at low cost, and hopefully high yields. In the meantime the renter had enough time to line up new lands for rent elsewhere.

The rental came in 1977 to between S/. 700 to 1,000 ($1 US= 200 soles) a yugada (1/3 hectare) plus a good-will gift of one or two sacks of potatoes to the owner (about S/. 1,000).

Their contract is a simple written piece of paper that avoids lengthy procedures with lawyers and courts and does not bring to the attention of local authorities illegalities involved. The owner of the land sees several advantages in this contract. Apart from the money (which is relatively low) the owner gets a field that has been properly treated with tractors and fertilizers. Using the residual fertilizer he still can obtain two or three good grain crops without major expense. Normally, the mayorista will own all farm implements, since proper timing is an important factor and to have to wait for the day a rented tractor can come to work is a hindrance.*

The organization of production for mayoristas is the following: the mayorista is in full, day-to-day control of the operation and makes all the decisions on the spot. He has a regular salaried staff of two overseers, the drivers of his trucks (who also double up as overseers) and the tractor operators. There are also guardianes (watchmen) and a cook for the workers. The bulk of his unskilled labor force is hired on a weekly basis according to the needs of his production schedule. At peak agricultural times mayoristas scour the surrounding villages for workers. Because women earn less, they rely heavily on women and child labor. All the selecting of the harvest was done by women, and many field workers were women as well.**

One interviewed mayorista noted that seed potatoes were classified into first (for sale to coastal growers), second and third class (the latter two were sold in Huancayo), and first, second and third class eating potatoes. The varieties he grew were Mi Perú, Ticahuasi, Yungay, Revolución. He claimed that his production costs fluctuated between S/. 107,000 to 110,000 per hectare. Average yields were 9 tons per hectare, average price (estimated low) 15 soles per kilo. Profits 2'500 000 for 1977. Cash turnover 9.5 million soles.

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* One mayorista interviewed owned five tractors with accesories (three types of plow, harrower and fumigation equipment). One tractor was not operational due to lack of spare parts. He owned two trucks and he had built expensive specialized storage and handling facilities. Fertilizer and pest controls were bought wholesale for the growing season and stored in the facilities. He used a different, more "specialized" set of fertilizers than those normally mentioned by the peasant farmers we interviewed.

** The day I visited the operation one of the truck drivers had just returned from far away (Huánuco), where he had gone labor recruiting (enganche) offering a slightly better pay than the normal wage in Huánuco, but which was still 30% less than the going wage rate in the Mantaro Valley. Wages included food and lodging of notorious low quality. Another mayorista bought all his workers cheap Japanese transistor radios which were discounted from the wages throughout the season, a modern version of the old fashioned debt peonage.

Although such a grower is often admired (at the end of the season he sponsors a huge fiest killing a whole bullock) he acts much more as a patrón with his workers and "landlords." Unlike peasant farmers he deals mainly in cash and credit rather than reciprocal services. Therefore, he is simultaneously liked and feared. People appreciate the growers' no nonsense approach although often exploited by their ruthless labor recruiting practices and tough bargaining. In short, mayoristas behave as early capitalist entrepreneurs risking all and making big profits. Capital accumulated may go into improving machinery and processing but the rest is invested outside agriculture. Such business does not as yet concentrate property and displace the peasantry; rather it lives with the peasant sector in a symbiotic, albeit, transitional and exploitative relationship. He rents peasant lands and hires peasant labor. The presence of the market, new technology and the conditions of the peasantry described above, make this type of farm enterprise possible.

2. Commercial Farms (Fundos)

The commercial farm approximates more closely the western ideal of a farm. It is usually one continuous piece of land of more or less homogeneous conditions within one or two subzones. The boundaries of property lines are clearly delineated, and they are owned and/or operated by one person in charge of all decision making aided by a small staff of permanent workers who are in charge of the more responsible jobs, and a seasonally hired labor force that performs field labor at peak periods for a clearly defined wage and no other benefits.

The owners or renters of such farms (fundos in local terminology) are not or do not consider themselves of peasant origin. They identify and lead life styles similar to middle and upper class merchants and bureaucrats of Huancayo and Jauja where they keep a house and can easily commute to and from their farms. They are well acquainted with modern farm methods, have easy access to agronomic advice and will grow commercial crops in the most advanced and technified methods within their knowledge and within their budgets. They often experiment with the latest techniques and thus become early innovators of new methods of cultivation in the valley. Machinery for them is not only a necessity but also a form of prestige. The decisions as to which crops they will grow are based on careful calculations of costs and returns. They watch price fluctuations carefully and may even try to influence the level by sending representatives to Lima and arguing their case and putting pressure where it counts. Formerly, fundo owners were a powerful group in the Mantaro Valley, having easy access to credit banks, political authority and a sympathetic ear of ministry officials. When fertilizer is rationed, they can obtain it first and when government services are given out, they will be eager to avail themselves of them and insist on proper service. At regional fairs and exhibitions, their products easily win first prizes. They are the best potato growers in the valley since they have many years of experience and accumulated help and advice as well as choice land and well running machinery. Many are seed producers for the coastal growers.

Compared to the mayoristas, the fundo owner has higher production costs since he has more fixed capital, a more permanent staff, higher social benefits that have to be paid to workers, and he usually disdains the ruthless labor

recruiting practices relied on by his competitor. Also, unlike the mayorista, the fundo owner is limited by space. What the mayorista makes by cultivating a large expanse of land, the fundo owner has to achieve by higher yields per hectare. These can be achieved by more careful fertilization, fumigation and cultivation. Fumigation, for instance, will be in response to disease symptoms and specific dosages will be worked out, while the mayorista may make a decision to fumigate, for example, twice during the year and no more. Fundo owners are also able to harvest early when the price of their products are high, usually because they have irrigation.

At present, fundo owners are faced with a choice of becoming dairy farmers or specialized agricultural producers. In the case of the second group, potato growing plays a crucial role. Given their skills and orientation, size and field conditions and the availability of operating capital achieved in terms of high yields per area make potato production a choice crop.

Unlike the other types of agricultural enterprises, which are located in both intermediate and low agro-life zones, commercial farmers are restricted exclusively to the low agro-life zone, mainly on irrigated land (see land use map). Thus, fundos occupy choice land with the mildest climatic conditions. The two experimental stations of the CIP are ex-fundos and are therefore located where land and climate is best in the Mantaro Valley. Hence, conclusions resulting from experimentation on these stations may only have validity to restricted conditions within that particular zone and type of land. Experimentation in intermediate and high agro-life zones might be advisable.

3. Other Types of Enterprise: Absentee Farming and Cooperatives

Absentee farming (chacritas) is pervasive in the Mantaro Valley. Many merchants, factory owners, contractors, laborers and miners from Huancayo, Jauja, Oroya also own land which they work. These absentee owners, however, will grow commercial crops, albeit less intensely managed and cared for than the other two commercial types. Often a relative or a hired employee will be second in command on the farm, while the city owner frequently comes to inspect the farm and make the major decisions concerning production decisions. Cash derived from the other occupations will be invested in operating the farm, wage earners are hired as needed, and supervision will be intensified at planting and harvesting times. The degree of intensity and care invested in such operations depends, as with subsistence peasants, on the size of the farm, on income derived from the other activities and on time and interest of the landowner. The range is from some modified miniature version of the Sunday gentleman farming to very efficiently worked farms, where differences between this and full-time fundo owners are minor or non-existent. Whether such farmers concentrate on potato growing on a commercial and intense scale depends on how much they perceive that this crop is a risky undertaking, and confidence in their own farming skills.

Cooperatives as new farming enterprises were instituted throughout Peru on expropriated haciendas and agro-businesses. Most important co-ops in the Mantaro Valley are, consequently, sheep raising enterprises, since large modernized haciendas were located in the high zone. Since haciendas in the

intermediate zone disintegrated before agrarian reform there are very few agricultural co-ops in the Mantaro Valley. Two exceptions are the Yanamarca co-op (ex-hacienda Yanamarca) and the SAIS Ramón Castilla (ex-hacienda Casa Blanca).

The basic idea of a co-op is that the owner-workers elect a body of executive representatives who will run the enterprise like a commercial firm. Also, co-op members seek and expect full employment and "good" wages from their labor. Co-ops thus have higher hired labor costs than competitors, and they have managerial-decision making problems resulting from the reorganization of the enterprise according to the new land reform ideologies and laws. In the Yanamarca, the new managers are the ex-Yanaconas who now face a whole new range of problems. In the past they made costly, wrong decisions. However, the SAIS Ramón Castilla hired an administrator. In both co-ops members maintain and operate their own plots alongside those of the co-op. In Yanamarca we came away with the impression that production on members plots was more important and effective than on co-op land. In Ramón Castilla, the case seems reversed. Land is very high in altitude, and most income derives from sheep raising. Members of the co-op cultivate potatoes in corrals as an addition to their income. The co-op itself, which inherited a tradition of seed potato production on some very flat low puna lands, had launched heavily into a potato production program which they hoped would get them out of a heavy debt. The potato program of the SAIS Ramón Castilla should receive technical help since it is an example of a new form of enterprise that Peru hopes will improve agricultural conditions as well as create a more just social and economic social structure. Another important reason is that potato production in this co-op is the highest commercial (4,000 m.+) enterprise and experiences with conditions of technical large-scale potato production in high altitude conditions are being accumulated there. Several improved seed varieties have been launched from Casa Blanca in the 1950's, and there is no reason why the new co-op could not assume its old role again.

C. Chapter VI - Conclusions

In concluding the discussion of farm types the following points should be stressed.

First; the diversity of the situation. Unlike other areas in Peru where a sharp distinction can be observed between peasant and commercial agriculture, the Mantaro Valley case is blurred. Only at the extremes can the difference between a commercial fundo and a peasant subsistence farm be detected. In the middle ranges, where the majority of situations lie, definition is not that clear, and perhaps no longer that important.

Secondly; the dynamism of the situation. Often certain types of enterprise have been seen as a rigid block to agricultural change. It would be a mistake to make this kind of argument in the Mantaro Valley. Most conditions of tenure do not seem to imped processes of technical change.

Third; the indefinition of the majority of farmers. The peasant sector is particularly characterized by this indefinition. This is not only the result of peasant traditionalism, but the result of the interaction of a whole set of factors such as size of land holding, composition of family and outside employment opportunities.

Fourth; the role of cash flow as an important determinant. Unlike many presuppositions about self-sufficient economies, everyone in the Mantaro Valley is highly monetized, and both market prices and the level of wages in the region influence agricultural decisions.

VII. CONCLUSIONS

Agricultural land use in the Mantaro Valley reflects the interaction of two major variables: ecology and types of farming enterprises. The interaction of these variables produces patterns and zones that have been identified and mapped.

Variation in agriculture follows ecological principles. In general, the higher areas are restricted to a few specially adapted crops. As one moves down, more and more crops enter into production. We find mainly tubers in the high zone, tubers and grains in the intermediate zone and a wide range of crops in the lower zone. Rotation cycles become longer and more diverse, and fallow cycles diminish and disappear as one moves from the high to low zones. Although potatoes are grown throughout the valley, the manner of cultivation differs between zones and subzones. It is recommended that a team of agronomists, ecologists and social scientists study in greater detail, and with greater skill, the agricultural practices in each zone and subzone, their rationality and possibilities for improvement.

Peasants constitute the majority of farmers in the area, and they occupy all possible climatic and ecological environments. The use they make of the land depends on where they are located and on their needs and resources. In addition to covering their subsistence base, they have to market some crops in order to cover their cash needs as well. Thus, peasants open up more and more areas for commercial production, and adapt crops to these areas. Commercial farmers tend to concentrate in the low zone due to better land and uniform conditions, suitable for large-scale, mechanized production.

In the low zone a fundamental difference exists between commercial farmers and peasants. Entrepreneurial farmers, whether they rent peasant land or operate their own land, specialize in potato production and obtain higher yields. Peasant farmers in the same zone grow potatoes for home consumption, and operate in highly diversified, risk-averting part-time farming systems. Potatoes are a more capital-intensive crop and those farmers with the backing of capital specialize in their production. In the same area, smaller peasant farmers who have non-agricultural sources of cash, restrict potato production for home consumption and only occasionally sell surplus.

In the intermediate zone, commercial farms are virtually absent. Peasants who market crops produce potatoes or barley since these are the only two crops that grow well in these areas. If they have other sources of cash, such as herding, then the crops grown will be for home consumption only. Hence, if peasant farmers in the intermediate zone have access to puna grassland, their agriculture will be for home consumption. If they have no puna lands, they have no other choice, but to produce crops for the market.

In summary, market-destined potato production is carried out by commercial enterprises in the low zone and peasant farmers of the intermediate zone. Whether peasants have access to other sources of cash depends on the type of community they belong to. The Mantaro Valley has a large number of

Peru's officially recognized indigenous communities which organize and structure intersonal articulation. Access of peasant farmers to different zones is regulated by the community, as is the group effort to gain control over new areas. Intermediate zone communities are constantly organizing themselves and dividing up the land into separate production areas which are allotted to members. At present potato production zones are being carved out of land that was previously used exclusively for pasture.

One of the most significant results of the study has been to demonstrate the hitherto neglected importance of the intermediate zone for potato production. As has been shown, this zone produces as many potatoes as the low zone. Peasant farming strategies prevail here, since commercial farming methods are poorly adaptive to the ecological conditions. Most farmers producers in Peru and Bolivia cultivate potatoes in conditions similar to those of the intermediate zone, and consequently this zone merits CIP's attention.

The following specific points need further research and classification before sound recommendations can be made to farmers.

A. Fertilizers and Pesticides

Except for high zone bitter potatoes, in all areas surveyed, potatoes are fertilized with a combination of animal manure and chemical fertilizers. The amounts and technical applications differ widely. In the commercial areas, fertilization is heaviest and applied with more know how. In peasant production, chemical fertilizer is applied more haphazardly. The same applies for the application of fungicides and pesticides. Many farmers express concern and bewilderment about the causes of potato diseases as well as which products should be applied, when, where and how. This aspect requires special research and emphasis, not only because peasants may be losing products, even though they are spending money but also in consideration of the contaminating aspects that result from the unguided application of chemical products.

The rationale for fertilization differs between peasant and commercial producers. Commercial farmers fertilize each time they sow a crop. Peasant farmers, particularly the poorer ones, fertilize their fields once for the complete rotation cycle only. In all the areas surveyed, potatoes lead off the rotation cycle and are - within the farmers' knowledge and means- fertilized adequately. The following crops of Andean tubers, legumes and grains are not fertilized. A rotation cycle is also a fertilization cycle. This implies that extension recommendations about the quantity and quality of fertilizer to apply should relate to three or four year cropping cycles, not a single crop of potatoes.

B. Fallowing

The usual rationale for fallowing is that it allows the soil to regain vital nutrients, and if these can be supplied by means of fertilizer, then fallowing becomes unnecessary. However, in the case of potatoes, fallowing and crop rotation are crucial to prevent the build-up of nematodes or potato disease carrying micro-organisms. In the higher areas farmers fertilize and fallow, indicating that other biological processes necessary to plant growth, are taking place during the fallow period.

As we have seen, fallowing years diminish with decreasing altitude. Historically, fallowing has also diminished with population growth and the pressure to intensify land use. Research should be made on the technical and socioeconomic aspects of fallowing before recommendations are made for improving the existing systems.

C. Varieties of Potatoes

An altitudinal distribution of varieties by zones was observed. Using farmers' categories, from high to low, they range from "papa shiri" to "harinosas" to "blanca" to "común," ending with improved varieties in the low zones. Especially in the higher areas, peasants tend to grow several varieties in each field, while commercial farmers grow only one.

There is a widespread exchange of seeds between farmers in the valley. Improved varieties diffuse from the lower to the higher zones in a gradual process of exchange. The limits reached by improved varieties are established by a process of trial and error. A careful study of these patterns could be useful for improving the quality of planting material and the diffusion of new varieties.

This study was based on the premise that in order to understand how potatoes are produced, and how production might be improved, it is necessary to view the potato in relation to the other crops sharing its territory, and in relation to the persons growing the crop. The report describes the ways in which potatoes are cultivated by different social groups in diverse ecological environments. We have attempted to show how varied and complex agriculture is in the Mantaro Valley, and how this complexity can be understood in terms of underlying ecological and social forces. It is hoped that both the approach and specific research results may prove useful to those concerned with understanding and improving agriculture in the Mantaro Valley and in the Andes.

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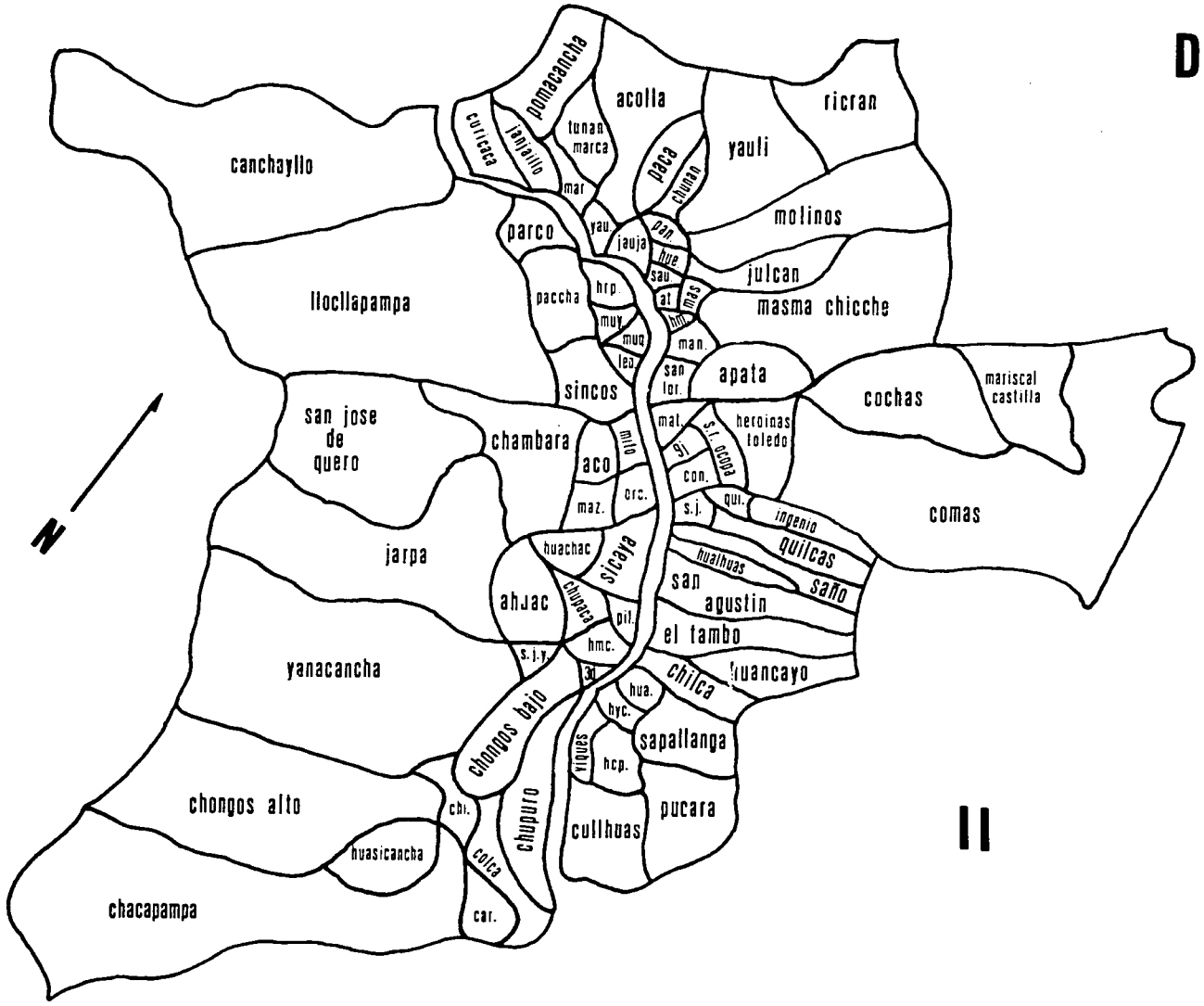

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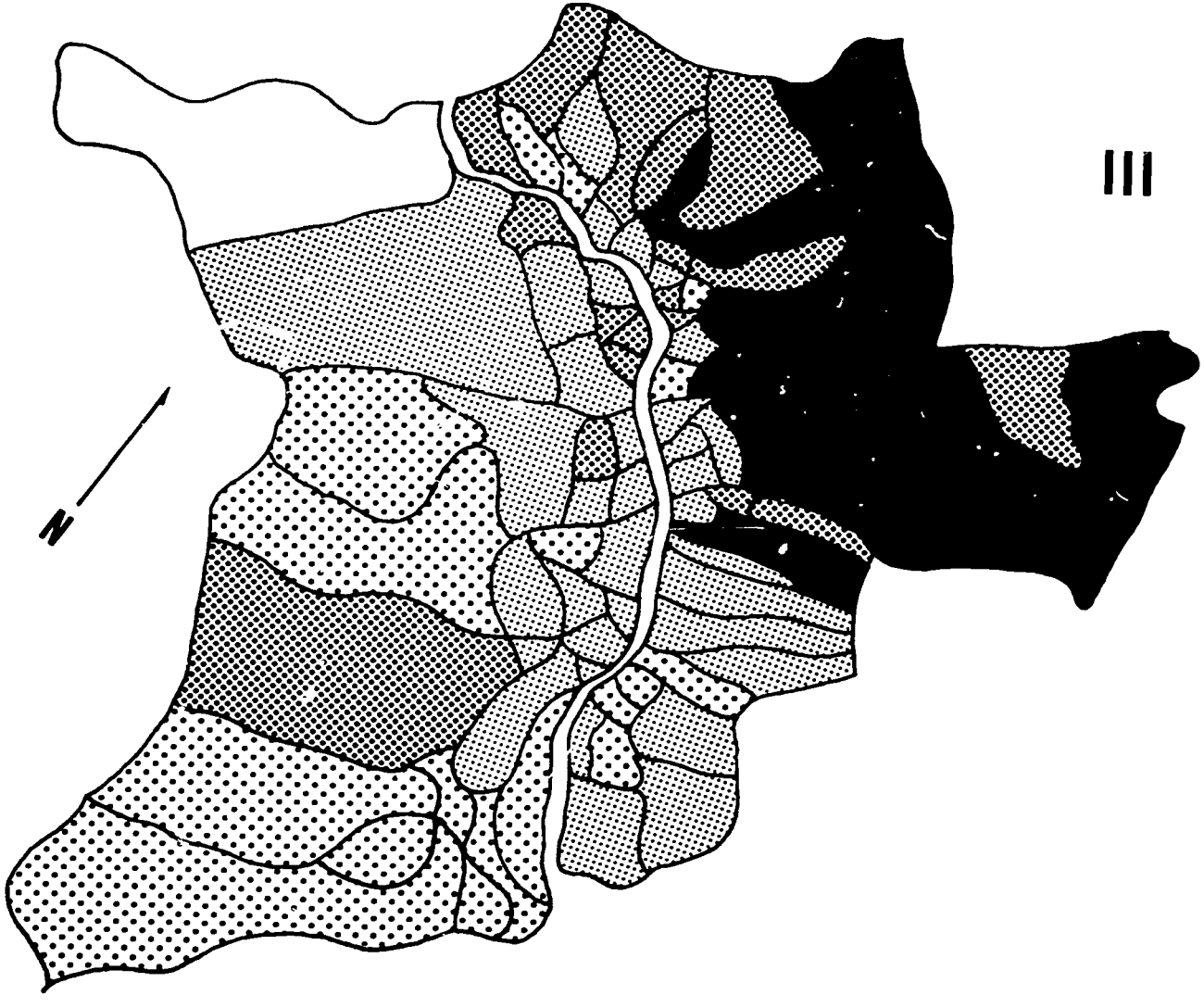
DISTRICTS / DISTRITOS

3d.	tres de diciembre
9j.	nueve de julio
at.	ataura
car.	carhuacallanga
con.	concepcion
chi.	chicche
hcp.	huacrapuquio
hm.	huamali
hmc.	huamancaca chico
hrp.	huaripampa
hua.	huancan
hue.	huertas
hyc.	huayucachi
leo.	leonor ordonez
man.	el mantaro
mar.	marco
mas.	masma
mat.	matahuasi
maz.	manzanares
muq.	muqui
muy.	muquiyauyo
orc.	orcotuna
pan.	pancan
pil.	pilcomayo
qui.	quichuay
sau.	sausa
s.j.	san jeronimo de tunan
s.j.y.	san juan de yscos
yau.	yauyos

R. Shea



POTATO

Percentage of Cultivated Surface Area.

40+

30-39

20-29

10-19

0-9

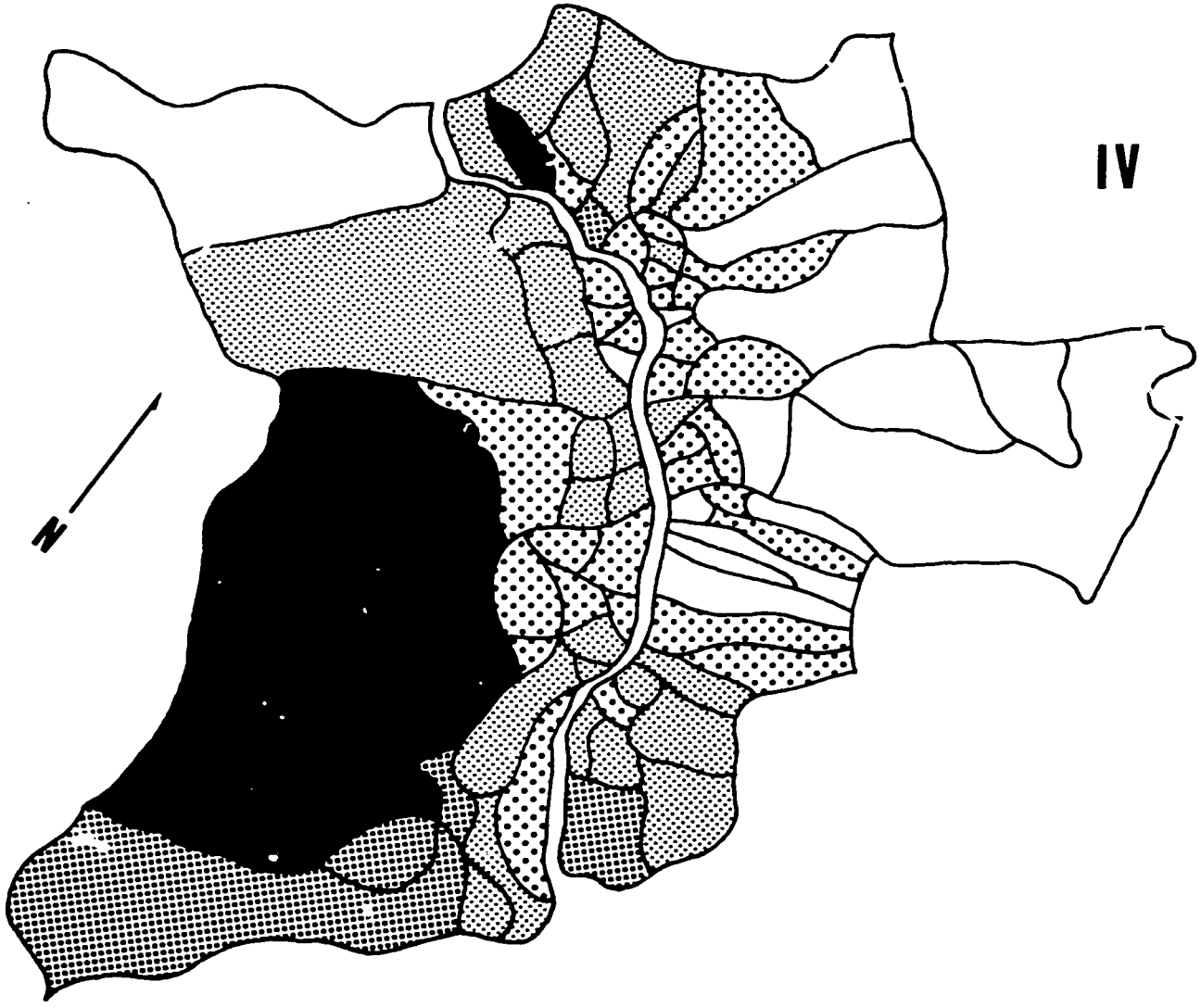
Porcentaje de la Superficie Cultivada.

PAPA

R. Shea

Source / Fuente : II Censo Nacional Agrario, 1972

Scale / Escala : 1:750,000



BARLEY

Percentage of Cultivated Surface Area.

- 40+
- 30 - 39
- 20 - 29
- 10 - 19
- 0 - 9

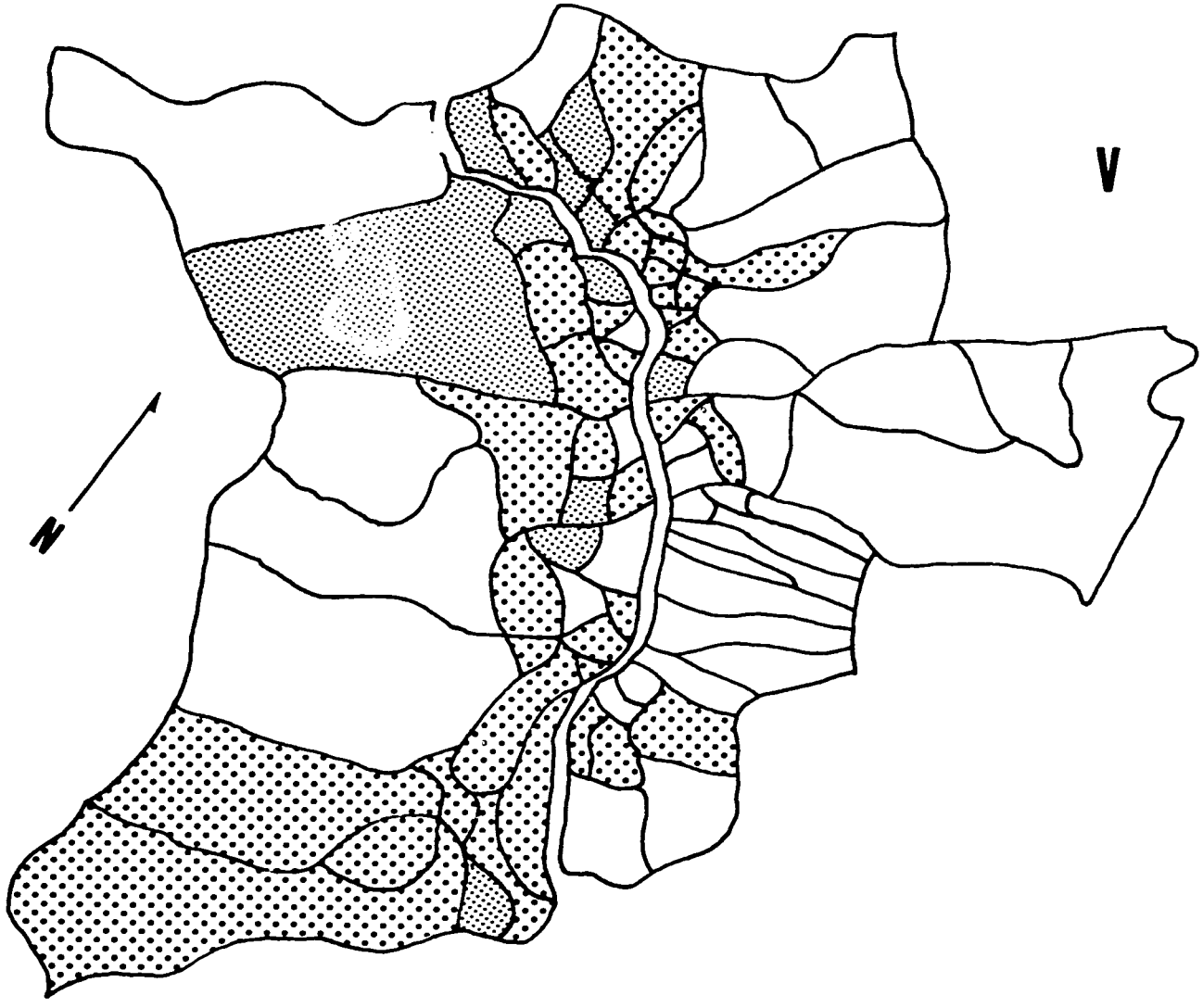
Porcentaje de la Superficie Cultivada.

CEBADA

Source / Fuente: II Censo Nacional Agrario, 1972

Scale / Escala: 1 : 750 000

R. Shea



WHEAT

Percentage of Cultivated Surface Area.

- 40+
- 30 - 39
- 20 - 29
- 10 - 19
- 0 - 9

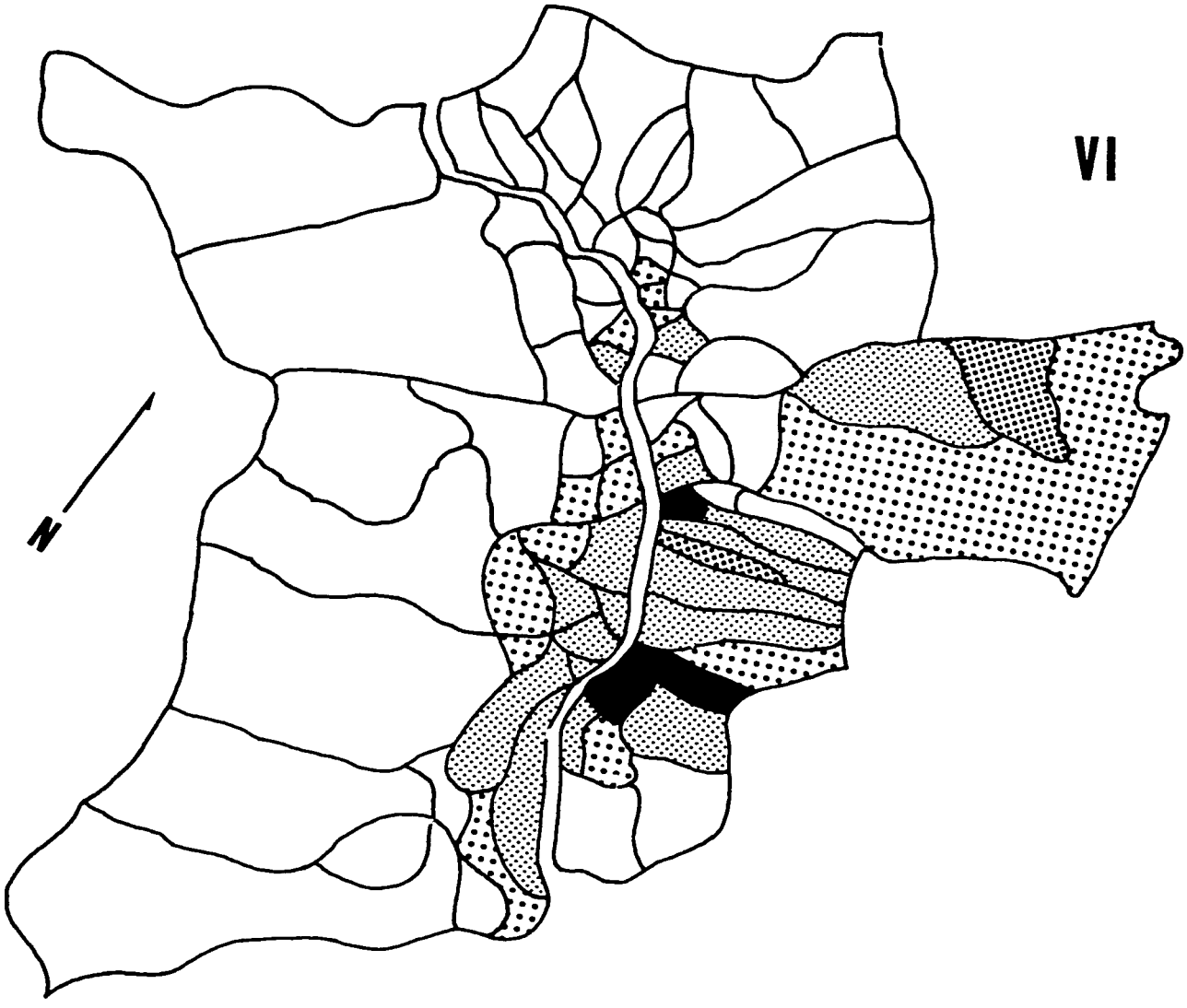
Porcentaje de la Superficie Cultivada.

TRIGO

R. Shea

Source / Fuente: II Censo Nacional Agro - Pecuario, 1972

Scale / Escala: 1 : 750 000



CORN

Percentage of cultivated Surface Area.

40+

30-39

20-29

10-19

0-9

Porcentaje de la Superficie Cultivada.

MAIZ

R. Shea

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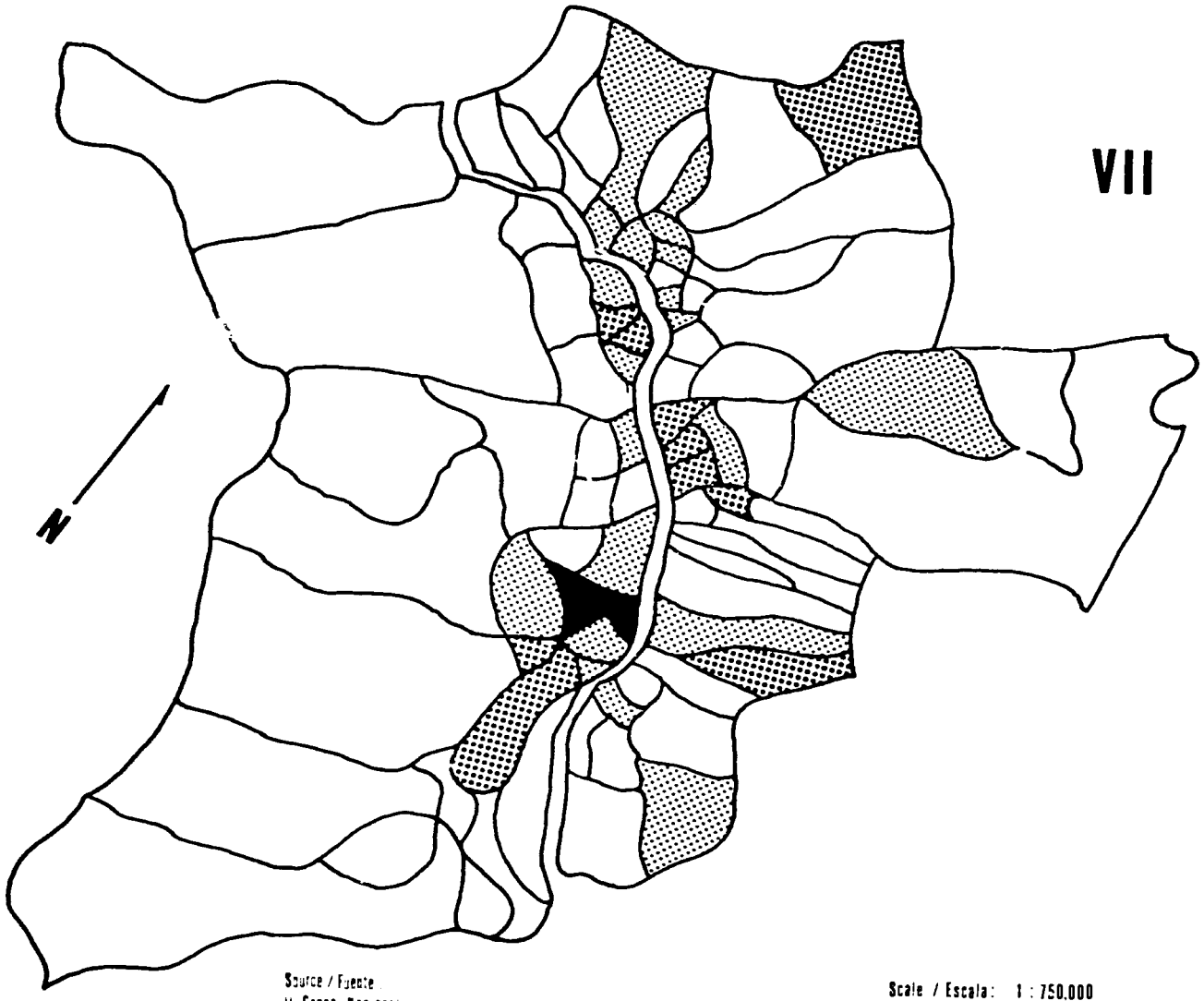


HORTICULTURE

Percentage of Cultivated Surface Area

10+

5-9

1-4

0

Porcentaje de la Superficie Cultivada.

HORTICULTURA

Source / Fuente
II Censo Nacional
Agro - Pecuario. 1972

Scale / Escala: 1 : 750.000

R. Shea
7

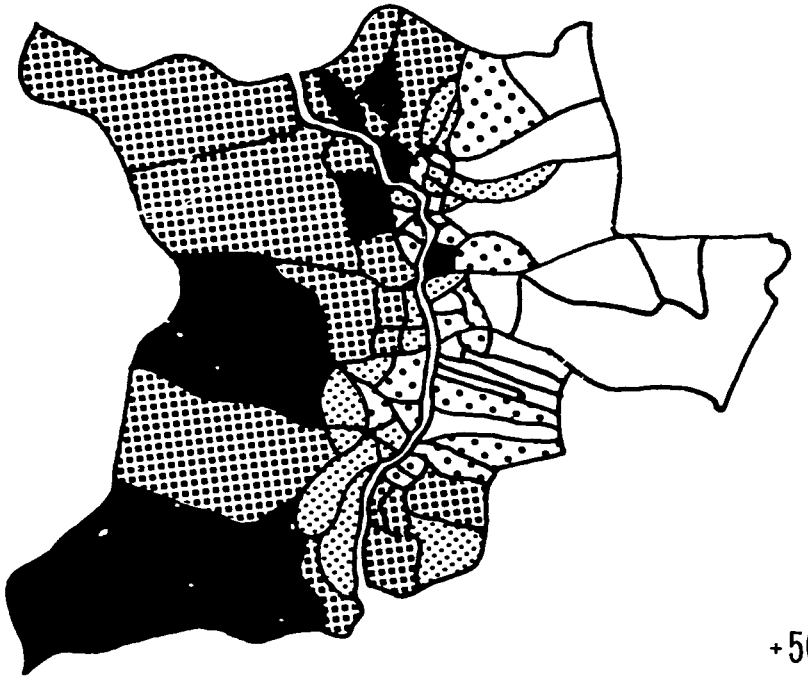
COMPARATIVE CONCENTRATIONS

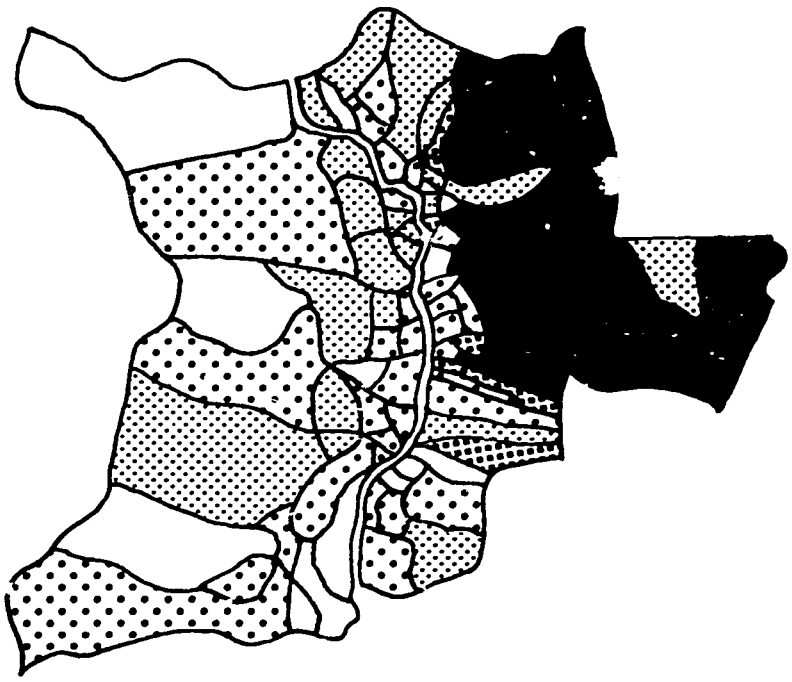
european grains

Percentage of Cultivated Surface Area

tubers

VIII





+50

40-49

30-39

20-29

0-19

granos europeos

tuberculos

R. Shea

CONCENTRACIONES COMPARATIVAS

Source / Fuente: II Censo Nacional Agrario, 1972

Scale / Escala: 1 : 1'000,000

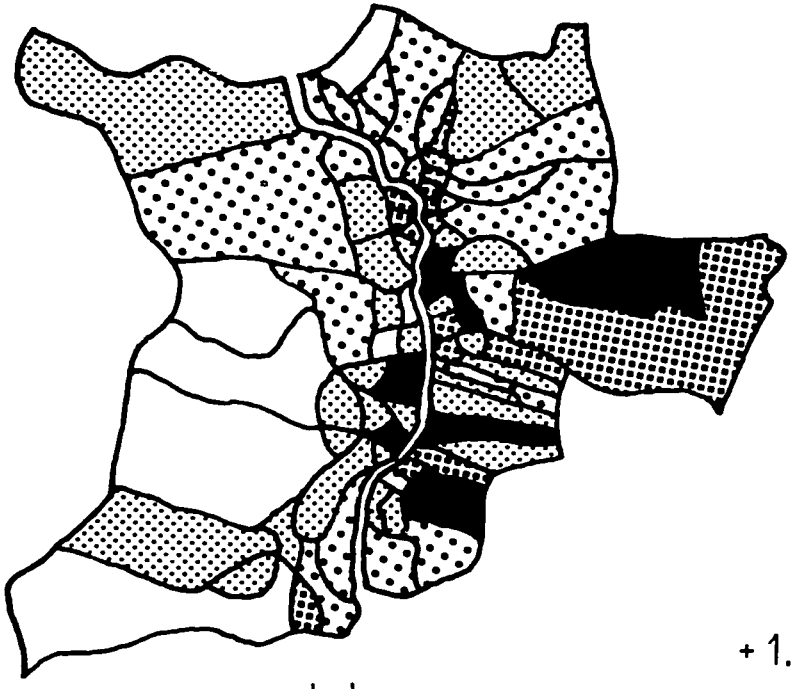
COMPARATIVE YIELDS

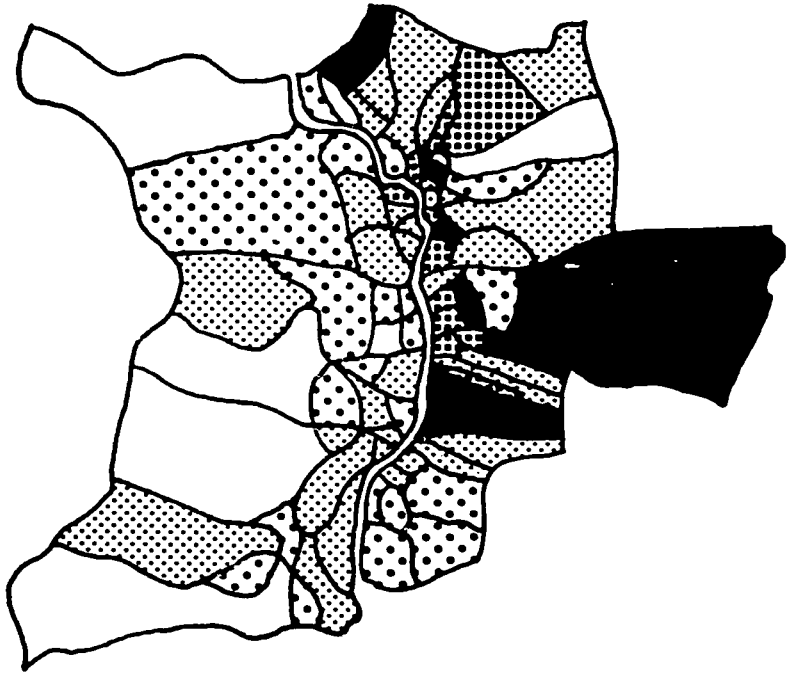
barley

Metric Tons per Hectare

IX

potato





+ 1.1	4.0 +
0.9 - 1.0	3.0 - 3.9
0.7 - 0.8	2.0 - 2.9
0.4 - 0.6	1.0 - 1.9
0.0 - 0.3	0.0 - 0.9

cebada

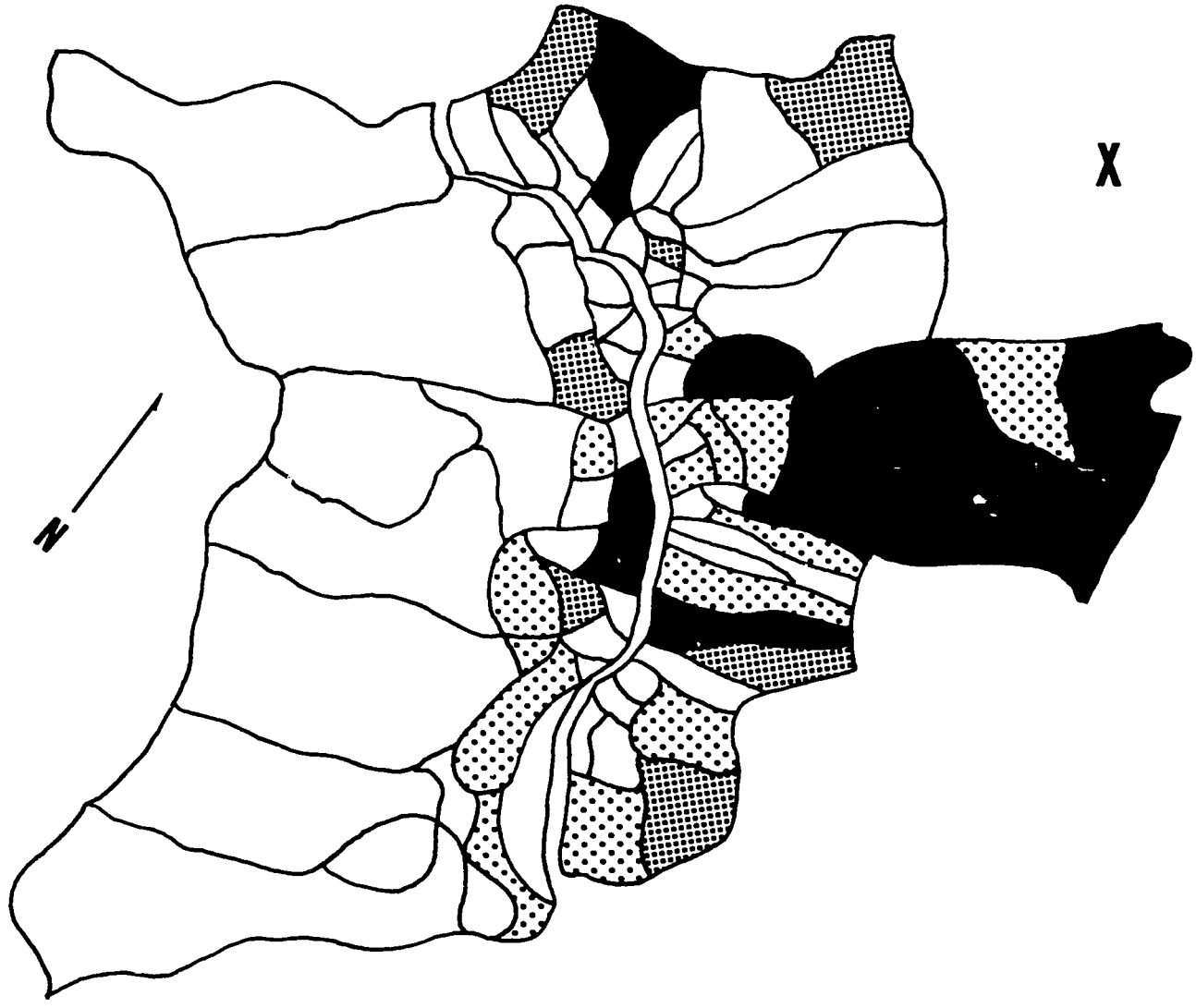
papa

R. Shea

RENDIMIENTOS COMPARATIVOS

Source / Fuente: II Censo Nacional Agrario, 1972

Scale / Escala: 1 : 1'000,000



POTATO PRODUCTION

District Poduction in Metric Tons.

1200 +

800 - 1199

400 - 799

0 - 399

Producción Distrital en Toneladas Métricas.

PRODUCCION DE PAPA

R. Shea

Source / Fuente : II Censo Nacional Agrario.1972

Scale / Escala: 1 : 750.000

COVER

The cover is a painting by Yolanda Carlessi, which in the words of the artist, expresses an evocation for contact with nature. The intense light, mountains and fields symbolize man's work in a highland valley and his relationship to the land. Technique used on the original: Tempera.

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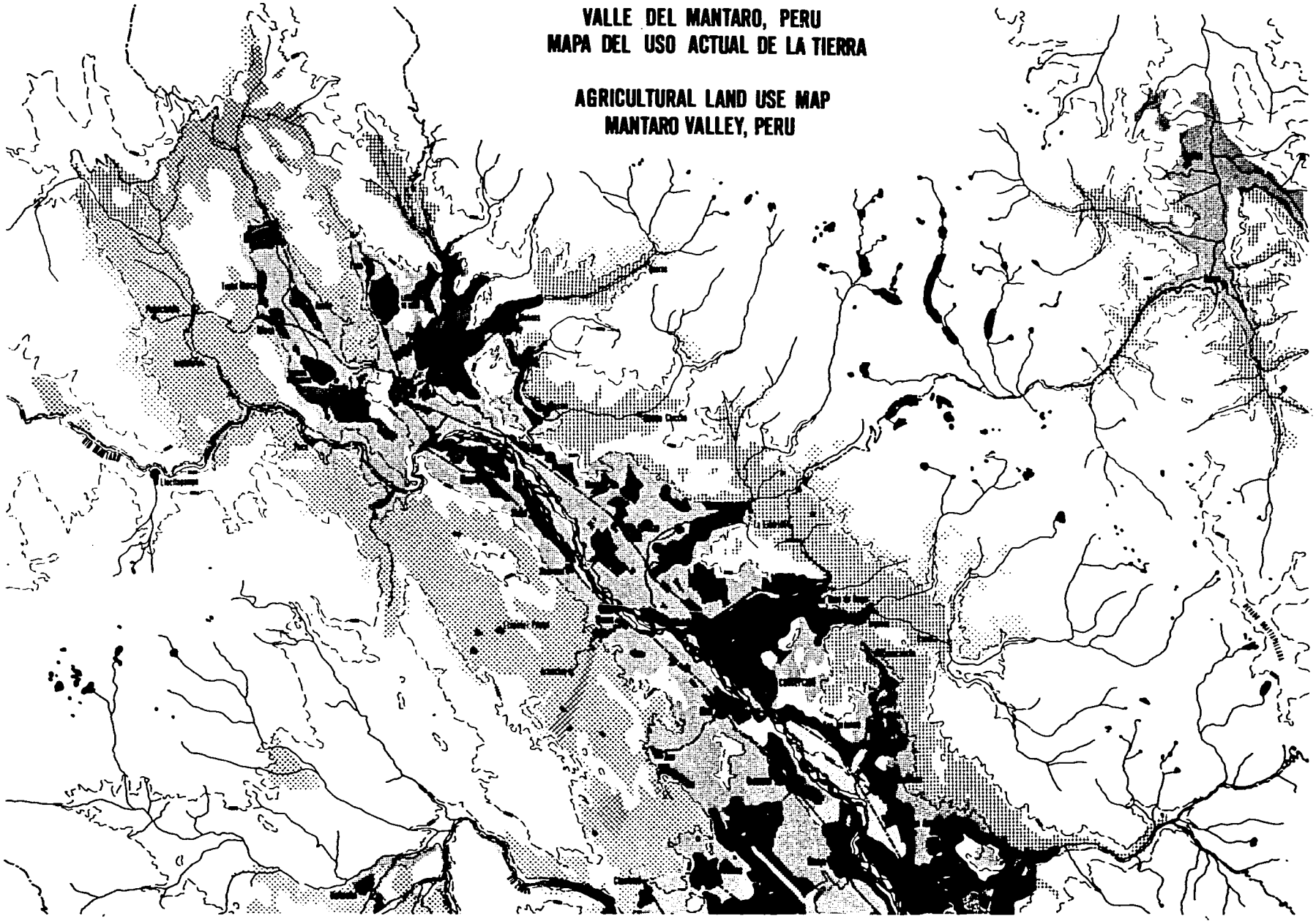
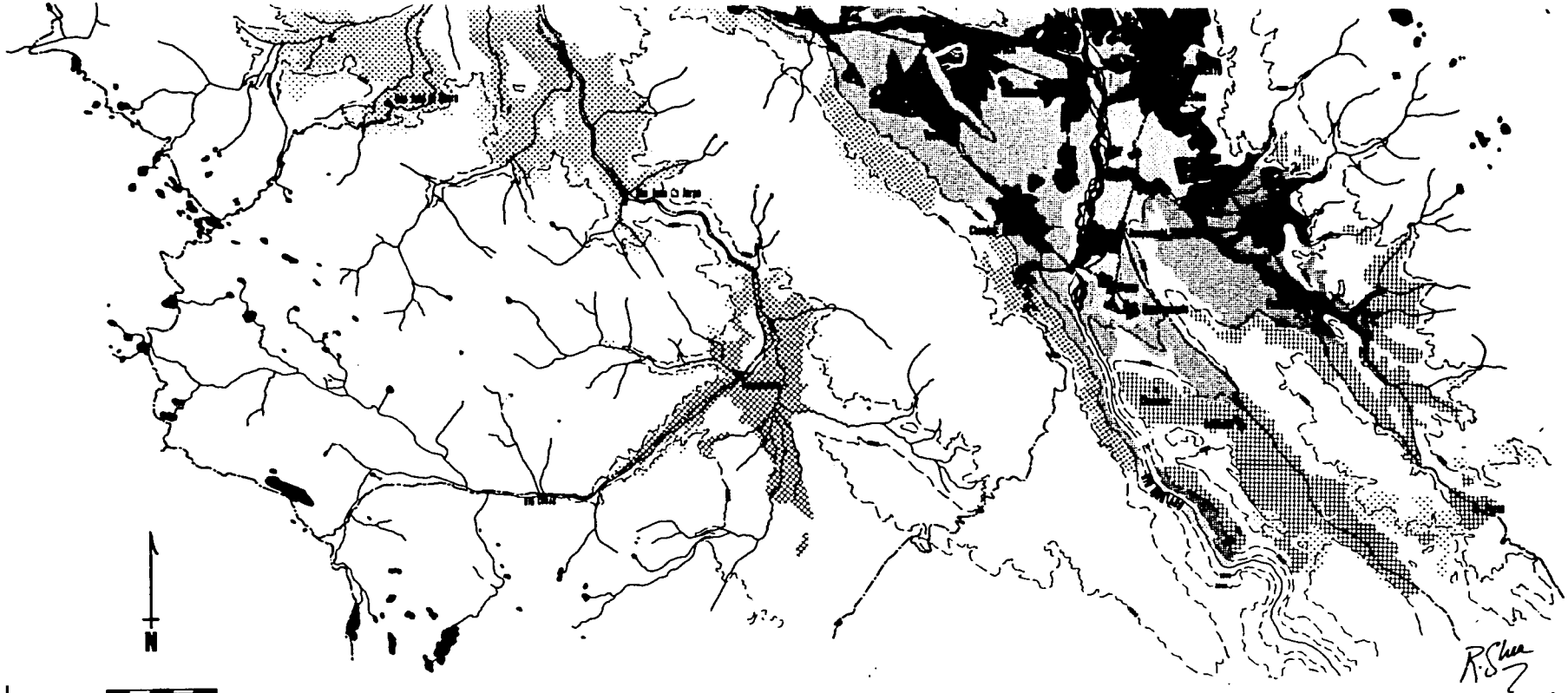

VALLE DEL MANTARO, PERU
MAPA DEL USO ACTUAL DE LA TIERRA
AGRICULTURAL LAND USE MAP
MANTARO VALLEY, PERU



altitude lines
curvas de nivel

rivers
rios

roads
caminos

population centers
centros poblados

graphics by R. Shea.
map developed by E. Mayer and R. Shea, 1977.

SYMBOLS									SIMBOLOS
SUB-ZONES	P D M L1	P I L2	P D L3	C I L4	C D L5	P D T I1	P D G I2	P D H1	SUB-ZONAS
ALTITUDES	3000 3550					3550 3950		3950 4250	ALTURAS
AGRO-LIFE ZONES	LOW-BAJA					INTERMEDIATE INTERMEDIO		HIGH ALTA	ZONAS AGRO-ECOLOGICAS

P - peasant C - commercial D - dry I - irrigated M - corn dominant T - tuber dominant G - grain dominant Altitudes expressed in metres above sea level