SOME FACTORS AFFECTING LAND USE IN CHINCHERO, PERU

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AUTHOR'S BIOGRAPHY

The author was born on December 31, 1934 near Chicago, Illinois, U.S.A. Upon finishing his high school training at the Glenbard Community High School in Illinois, he entered the University of New Mexico in Albuquerque, New Mexico where he was awarded the degree of Bachelor of Arts, in June 1960, with a major in Inter-American Affairs.

Having been granted an Inter-American Cultural Convention scholarship to study in Costa Rica, he was admitted to the Graduate School of the Inter-American Institute of Agricultural Sciences in March of 1961. He enrolled as a joint student in the departments of Renewable Resources and Economics and Extension.

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CHAPTER I

INTRODUCTION

In recent years the conditions of underdevelopment and overpopulation prevailing in the Peruvian Sierra have been of increasing concern to the Peruvian government as well as to several international institutions working in social and economic development in that country. Much attention has been focused upon the rural Indian dwellers, most of whom live in comparative economic and cultural isolation, are ignorant of Spanish, the official language, lack formal education and lead a subsistence existence, largely independent of the national economy.

Various proposals have been set forth aimed at increasing the productivity of this sector of the population and reducing the pressures of population on the land resources in the Sierra. These proposals range from land redistribution to planned resettlement of surplus rural population in urban areas. Regardless of the methods finally adopted, the education of the rural Indian is believed to be one pre-requisite to his becoming a more productive member of Peruvian society.

In order to arrive at means of improving public education in areas of the Sierra where Indians are numerically predominant, the Division of Modern Languages of Cornell University (Ithaca, N. Y., U.S.A.) conceived and formalized in 1962, the <u>Peru-Cornell Experimental Program in Applied Linguistics</u>, a cooperative project with the Peruvian Ministry of Education*.

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* hereafter to be referred to as the Program

The immediate objective of the Program is to develop effective methods for the formal instruction of Spanish to Quechua-speaking Indians. The attainment of this objective will assist in the transmission of technological and other cultural knowledge which is essential to the more complete integration of the Indian sector of the population into the national economic and social life. The long range objectives of the Program are to contribute to the improvement of the living conditions of the rural Indians in the southern and central Peruvian Sierra.

The district of Chinchero, near Cuzco, was selected as the first center for the Program's experimental linguistic studies. The majority of the inhabitants of Chinchero are Quechua-speaking Indian agriculturalists. To provide a foundation for the activities of the program in Chinchero, a series of basic environmental and socio-economic studies were undertaken. The research reported in this thesis constitutes one such study of the series. Its purpose is to provide and interpret information on the natural environment of the Chinchero district and to describe the manner in which its Indian inhabitants have adapted themselves to this environment. The information obtained should contribute toward a better understanding of the agrarian life of the Chinchero Indians and a more complete utilization of the physical and human resources of the area.

Certain environmental, cultural, and institutional factors which affect land use were studied. These were:

1. The natural environmental setting, that is: climate, geology, land relief and frainage, vegetating and soils.
2. Present agrarian technology.
3. Land tenure and tenancy types.
4. Property size and distribution

These particular factors were selected for study because they were presumed to independently affect both present and future land use in the area. Moreover, they were presumed to have interrelationships which, if discovered, would permit a more complete understanding of the problems inherent to the utilization of the land resources in Chinchero.

Various problems of land use in the southern Sierra such as minifundium, subsistence level agriculture, and low agricultural productivity, to name a few, have interrelationships with environmental, cultural, economic, and institutional factors operative in that region. The relative scarcity of specific information on the relationships between these problems and the factors inherent to them prohibited the formulation of an inquiry into certain land use problems with the objective of determining the relative influences of the several functioning and related factors once these had been isolated. As a result the factorial approach to this investigation was adopted.

The various factors selected for study were considered independently before a search for their relationships to land use problems in the district was attempted. This procedure was believed to be more consistent with the need for establishing a foundation of basic information to which certain socio-economic and cultural factors not taken into account in this study could be compared. Furthermore, since an appreciation of the importance of the individual factors studied was thought to be facilitated by treating them separately, the utility of the present investigation as a tool in land use planning was considered to be enhanced.

CHAPTER II

REVIEW OF LITERATURE

Land Use Studies

The study of land use involves a comprehensive inquiry into the natural land resources, their geographical patterns, and their utilization by man. Such a study is applicable to rural regions. Survey type or observational field techniques are ordinarily employed for collecting a broad spectrum of data which is subsequently synthesized. More proscribed mapping surveys may be undertaken with the principal purpose of recording present land uses and their geographic distribution without a consideration of the environmental and cultural setting. A world land use classification system was developed during the last decade by the International Geographic Union and is being applied at present to land use surveys of this type (11). Such surveys are of limited value to planning rural development however.

Land use surveys usually have certain practical and specific objectives. They may be designed to provide information needed for scientific land taxation, for agrarian reform, or for overall rural development. The necessary point of departure for any type of land use survey intended to be used as a basis for planning is a detailed study of the natural environment, particularly the interrelated aspects of climate, topography and soils Water, forest, and mineral resources are often surveyed in relation to the environmental setting where they are pertinent to the economic or social development of a specific region.

West (39) identifies five different categories of land use studies, depending upon the number of factors taken into account and the objectives

of the studies. These categories range from purely basic environmental studies (climate, soils, vegetation, etc.) to land use capability surveys and studies for planning more efficient farm management. The factors taken into account in the different categories of surveys are divided into five classes by West (39,pp. 47-49):

1. Physical factors (factors of the physical environment).
2. Biotic factors (diseases that affect plants and animals).
3. Economic factors (prices, credit facilities, marketing).
4. Institutional factors (tenure, taxes, price controls).
5. Cultural factors (population characteristics, technological and educational levels, etc.).

Properly executed studies of the physical and biotic factors as described by West would provide information for determining land use capability and "optimal land use". The formulation of more specific proposals for improving land use would be possible were the study of physical and biotic factors complemented by a consideration of economic, institutional and cultural factors.

Jones (13) distinguishes between the determination of optimal and practical land use. The first is an appraisal of the most intensive possible sustained use of a given soil under the natural environmental conditions that pertain. The second recognizes the existence of factors limiting land use which are "of the people" rather than "of the land". Limiting factors "of the people" (economic, cultural, institutional) may be so overriding in their influence that they render practical land use techniques widely divergent from techniques for attaining optimal land use as determined by purely technical considerations.

Land use research methods are essentially geographic. The Rural Land Classification Program undertaken by the Insular Government of Puerto Rico

in 1950-51 is an example of a recent land use survey using advanced geographic methods for collecting and interpreting data. That program was designed to provide very detailed information for rural economic planning on the island. Data on actual land use, natural land types, crop types and yields, population distribution and settlement patterns, and rural commercial and industrial operations were obtained by direct field observations and interviews with rural dwellers. Observational data obtained empirically by professional geographers were recorded on aerial photographs and later transcribed to large-scale planimetric sheets. Field mapping units related to land capability were based essentially on such natural land characteristics as soils associations, erosion, slope, stoniness and drainage. Reliable climatic data, excellent topographic sheets and a soils survey previously conducted on the island facilitated field mapping and subsequent evaluation of the information obtained in the survey. The recorded Puerto Rican experience (17) was of considerable value to the planning and execution of the present study.

Previous Research in the Region

Although no land use studies have been made in Peru which synthesize all the factors related to land use, numerous regional and local studies dealing with related and basic aspects have been published. Of particular importance is a series of studies carried out in 1958 for the Southern Peru Regional Development Project (Plan Regional para el Desarrollo del Sur del Peru), hereafter to be referred to as the PRDSP reports (21). Also relevant are the anthropological studies of the Andean region published in the Handbook of South American Indians (32).

Bowman's geographic reconnaissance along the 73rd Meridian in Peru in 1916 (2) includes descriptions of land forms and interpretations of diastrophism and geologic erosion in the Chinchero area, although no specific mention is made of the district. Kalafatovich (14) described and established the age of the Cretaceous rocks in the region and Paredes (18) studied and mapped the calcareous rocks of the southern half of the district of Chinchero. The soils of the high Andean valleys are given a regional treatment by Drosdoff (3), while Zamora (42) reconnoitered and mapped the soils series of the district of Maras adjacent to Chinchero.

Weberbauer's phytogeographical work on Peru (38) includes information on the taxonomy and altitudinal limits of the flora as well as descriptions of the introduced and endemic cultivated crops in the Cuzco region. Tosi (34, 35) recently published a general ecologic map and study of natural life zones in Peru. In that study the natural vegetation is classified and described in relation to climatic variation. Topography, soils, and actual and potential land use are appraised in general terms for each natural life zone as depicted on a map scale of 1:1,000,000. The climatic conditions and their effects on agriculture in the Southern Sierra are also described in a PRDSP report (23).

Land use practices and patterns in Quechua Indian communities are described in detail by Mishkin (16); he states that agricultural practices are tradition-oriented and characterized by an intricate division of labor in the Cuzco region. Certain features of the Quechua Indian communities during the early colonial period which bear upon present agricultural practices in the Indian communities are set forth by Rowe (28). A case study of present agricultural practices in the Indian communities near Sicuani appear in a PRDSP report (27); Sicuani is situated in the same climatic life zone as Chinchero.

The problem of over-population in the Sierra is treated by Dyer (4) who estimates the total population of the Quechua region* in Peru to be approximately 3,395,000 in 1958. He regards sixty percent of the total to be Indians. According to Dyer, the average annual growth rate of the Quechua Region between 1940 and 1958 was 1.67 percent. The average annual growth rate for the whole republic was 2.6 percent for the same period. Dyer attributes the lower growth rate in the Quechua region to out-migration and a lower birth rate, perhaps due to high infant mortality.

An exhaustive analysis and interpretation of the 1940 census was made by Ford (7). The Indians of the Sierra are considered in relation to land distribution, tenure systems and the contribution of the Indian agriculturalists to the national economy. Ford considers population pressures in the Peruvian Sierra to be a critical problem confronting the social and economic development of the whole republic

The causes for low agricultural productivity in the Southern Peruvian Sierra are summarized in one of the PRDSP reports (22). These are: unfavorable natural environmental conditions, excessively small farm sizes and fragmentation of holdings, lack of roads, inequitable distribution of land among large and small landholders, low technological levels and low nutritional levels. According to the report, there were about 390,000 small landholders in the Southern Peruvian Sierra in 1958; most of these were Indians possessing family farms with an average of 0.9 hectares** of cultivated land divided up into 3 or 4 plots and as many as 25 plots. Due to unfavorable climatic

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* Dyer defines the Quechua region as being located between 8,200 and 11,500 feet (2480 and 3480 meters)(4, p. 338).

** One hectare equals 2.47 acres.

conditions, the Southern Sierra is estimated to suffer crop failure equal to the loss of one complete crop every seven years (22, p. 8). The report describes the Indians as using traditional labor intensive agricultural techniques, such as plowing by hand. The population which is "excess" at certain times of the year is needed at other times; this is due to the sharp seasonal fluctuation of labor requirements and the low efficiency of the labor expended.

CHAPTER III

MATERIALS AND METHODS

The present study was undertaken between March 15 and August 30, 1962. A reconnaissance of the field area was made in early April and actual field research was carried out from May to the end of August. During this period the investigator lived both in Chinchero and Cuzco. A total of about two and one-half months were spent in residence in Chinchero. The field area was travelled by foot, horseback and vehicle.

Mapping Materials and Methods

Upon arriving in Peru mapping materials were obtained in Lima. As field and other data were collected the materials were utilized in the construction of a reference map, landform map and maps of slope classes, geology, and soils. The principal mapping tools were aerial photographs. The National Aerial Photogrammetric Service (a branch of the Peruvian Air Force) flew and photographed the region in June and July of 1956*. Individual 9- by 9-inch aerial photographs at a scale of 1:14,000 provided complete stereoscopic coverage of the district. Controlled photomozaics of the area at a scale of 1:20,000 were utilized as the base on which all maps were traced as well as for general photo-interpretation.

No corrections were made for variations in scale on the photomozaics. Ground checks indicated that at 3720 meters above sea level the scale of the

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* Project No. 8485 - C, Cuzco-Quillabamba zone, sheet numbers: 1, 150E600N, 1, 150E608N, 1, 160E600N, 1, 160E608N. Undertaken in 1956-57 for the Cuzco Commission for Reconstruction and Industrial Development.

aerial photos was accurate. Since relatively large areas of the district in the east and north are above 3800 meters, areal measurements including these areas are slightly exaggerated. Most of the cultivated areas in the district are between 3700 and 3800 meters and errors in areal measurements due to scale were considered to cancel themselves.

Because the aerial photographs were taken at the time of year when almost all of the crops had been harvested, they were of no use in identifying agricultural land use and crop types. Distinction could be made, however, between cultivated land and grazing areas. Also geology, land forms and certain soil features such as outcrops, presence of alkaline salts, wet spots, and erosion could be more clearly discerned in the absence of a crop or natural vegetative cover. Certain cultural features could also be distinguished. Indian community lands and field divisions could be identified by the presence of terraces and field patterns. Seen on the aerial photos, community lands showed a patchwork of very small even-sized fields which ranged in shape from squares to narrow rectangles. Haciendas (private farms) had larger uneven-sized fields and large areas with no clear field boundaries.

Additional mapping aids included 1:200,000 topographic sheets prepared by the Military Geographic Institute (of the Peruvian Army) in 1943; these served as references for place names and certain elevations. A crop type map constructed on a scale of 1:5,000 in 1961 by Abner Montalvo, a Peruvian scholar associated with the linguistic program, covered a large part of the district and was helpful in mapping agricultural land use. Also utilized was a 1:20,000 geologic map of the southern portion of the district showing limestone outcrops and locations of other calcareous rocks as well as major fault zones (18). Both Montalvo's crop

type map and the above-mentioned geologic map were based on 1:20,000 photomozaics identical to those which were utilized in the present study.

The first map completed in the course of this study was the slope class map (Plate 2). Such a map was necessary to the construction of the soils and landform maps as well as to the planning of field work. The topographic sheets were not sufficiently large in scale to enable the determination of slope classes and the slope class map was made using an ordinary stereoscope and the individual 9- by 9-inch aerial photographs (stereo pairs). In the field slope classes were measured with an Abney hand level and located on the aerial photos. These classes were compared to the vertical exaggeration of the stereoscopic images of the same slopes seen under the stereoscope. After some practice, gradient could be estimated with sufficient accuracy and the slope classes delimited on the photos using the stereoscope. The boundaries were then transferred to the photomozaics and later traced off onto semi-transparent paper.

Field Research Methods

While in the field, observations were made on aerial photographs of the spatial distribution of soils, crop types, geology and landform characteristics. At diverse points, ecological and land use observations were annotated on 3- by 5-inch cards. The point of observation was numbered on the cards and located by the same number on the aerial photos for later use in map making.

The soils reconnaissance generally followed the procedures outlined in the USDA Soil Survey Manual (37). On the basis of field observations and a number of chemical and physical analyses, performed by the laboratory of the

Corporation for Reconstruction and Development in Cuzco, a classification of soils series was developed. With the aid of aerial photographs, the series were mapped. The traverse method was not used; observations were made in the field and soils samples were taken in places believed to be representative of the soil series and determined by photointerpretation and rapid ground checks. Boundaries between the series on the soils map (Plate 5) are therefore approximate.

Soil profiles were observed at gully and construction cuts; pits were not dug. Samples were taken with auger type instruments to a depth of 30 centimeters (12 inches) on moderately sloping, fallowed agricultural lands.

Information on land use practices and patterns and property size was obtained by both direct observation and informal conversations with Spanish-speaking Indian agriculturalists, personnel of the supervised agricultural credit program, local school teachers and the administrator of Hacienda Huaypo Grande, the largest private farm in the district. Property size and fragmentation data was also obtained from the applications of seventeen Indian agriculturalists who had used the agricultural credit program; their applications listed the total amount of land, the number of fragments, and the fragment sizes for individual farm units.

In the last stage of the field work a questionnaire was employed to obtain more specific information on land use practices, property size and distribution and land tenure. The agriculturalists interviewed were not considered to constitute a representative sample inasmuch as the interviews were possible only after obtaining the friendship and confidence of the interviewees. For two of the interviews it was necessary to use an interpreter and intermediary. The qualitative data obtained in these interviews are presented in the body of this report. A copy of the interview questionnaire appears in the appendix.

CHAPTER IV

CHINCHERO: A GENERAL VIEW

The district of Chinchero is located about fifteen kilometers northwest of the city of Cuzco at 13°17'South Latitude and 72°03'West Longitude. Elevations within the district vary from 3300 meters to 4500 meters but the settled areas are concentrated at 3700 to 3800 meters on an undulating plateau which covers roughly one-half the district. The plateau is bounded on the east and north by high mountainous ridges and on the south by the lower-level Anta River. To the west and northwest the plateau extends into the districts of Maras and Huayllabamba as far as the deep canyon cut by the Urubamba River.

Chinchero is one of the seven political districts comprising the Province of Urubamba in the Department of Cuzco*; it was legally created in 1905. The political seat and the principal settlement of the district is also named Chinchero**. The district covers an area of about 135 square kilometers (40 square miles); it comprises seven Indian communities and several haciendas, or privately owned farms. The Indian communities are subdivided into parcialidades, or neighborhoods.

Communication

The district is accessible by one all-weather branch road (See Reference Map, Plate 1), which departs from the Cuzco-Anta road south of Cachi-

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* The political divisions of the republic are, from smallest to largest: district, province, and department.

** Not to be confused with Chincheros in the Department of Andahuaylas.

mayo in the Anta River Valley, 16 kilometers west of Cuzco. The branch road proceeds north to the town of Chinchero, 15 kilometers distant at an elevation of 3720 meters, 300 meters higher than Cachimayo. There are also two fair-weather roads; one links the town of Chinchero with Chequerecc on the Anta-Urubamba road, and the other leaves the above mentioned branch road near Lake Piuray to follow the potable water aqueduct to Cuzco. The latter road connects the Cuzco-Anta road a few kilometers west of Cuzco at a place known as Arco Punco. Neither of the fair weather roads is regarded as passable by vehicles during the rainy months.

Numerous cattle trails and footpaths known as caminos de herradura criss-cross the district and connect population centers (these have not been indicated on the Reference Map). Some of these trails are old Incaic cobbled roads (Fig. 2) now badly eroded and in disrepair. Several trails pass over the ridges bounding the district on the east and down into the Cuzco Valley. A major trail crosses the ridges to the northeast and descends into the Calca Valley while another connects Chinchero with the Vilcanota Valley via the Urquillos Canyon (Fig. 22). These trails are frequently used by the Indians.

Chinchero is linked to Cuzco by telegraph via Urubamba, and there is a direct telephone line to Cuzco from the hydroelectric plant at Ccorimarca. This plant also has a private phone line to Chaca Punco, the intake point for its water supply on Lake Piuray. Two or three times a week large cattle trucks known as colectivos carry people to and from Cuzco.

Population

The Chinchero district is located in a relatively densely populated region centering in the Cuzco Valley. West of Cuzco there are numerous village type settlements inhabited by Quechua-speaking Indians. The district of Chinchero has several such settlements.

Almost all of the district's inhabitants are Quechua-speaking Indians. A small number of Spanish-speaking people of mixed Indian and Spanish origins reside in the town of Chinchero and work in the school, municipal offices or with the supervised agricultural credit program.

In 1961, there were 6385 people living in the district; average population density was about 210 persons per square kilometer. In 1940 the population of the district was 5790 (19). The average annual demographic growth rate between 1940 and 1961 was therefore only 0.4 percent. Over the same period, by comparison, the Province of Urubamba grew at a rate of 1.3 percent a year and the average annual growth rate for the entire republic was 2.6 percent (4).

The proportion of the population of school age (6 to 14 years) was 24 percent in 1961; only 15 percent of the total population could read and write Spanish, these being mostly males. The average family size, according to the 1940 census, was 4.8 persons.

Except for about 650 persons who lived in individual dwellings scattered about Hacienda Huaypo Grande, nearly all of the population was grouped in village type settlements of the several Indian communities. These Indian community members are referred to as comuneros*. The large village of

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* Comunero has no adequate translation to English. It refers to members of those Indian communities which still retain some communal characteristics (See Glossary). This and other frequently used Quechua or Spanish words will be underlined on first use only.

Table 1. Population in Chinchero in 1961, Distributed by Indian Communities, Haciendas, and Other Population Centers*.

Indian community or hacienda	Population	Men	Women	Totals
Cuper, Yanacona, Ayllupongo	Town of Chinchero	501	559	1,060
Ayllupongo	Huila Huila	148	193	341
	Huita Puquio	56	60	116
	Pongobamba	259	280	539
	Ch'uso	182	169	351
	Maichu	6	4	10
				1,158**
Yanacona		499	635	1,134**
Cuper	Cuper Estancia	244	281	525
	Puca Marca	83	104	187
				712**
Umasbamba	Umasbamba	83	82	165
	Ocotuan	62	87	149
	Ichucancha	32	41	73
		47	48	95
				482
Taucca	Taucca	47	57	104
	Ñujchupata	40	48	88
				192
Ccoricancha		133	156	289
Ayarmarca		123	111	234
Hacienda Huaypo Grande		300	288	688
Hacienda Simataucca		126	119	245
Others (Hda. Tamboraccay, hydroelectric plant personnel, etc.)				268
		Total Population		6,385

* Source: Records of the Rural School Center

Chinchero had about 1,000 inhabitants. There were apparently more people living in the village of Chinchero in the past judging from the number of tumbled down houses to be seen there. The townspeople stated that some former residents had moved onto haciendas in or near the district or farther away in the subtropical sections of the lower Urubamba Valley and its tributaries.

Population centers appeared to be located preferentially near sources of water, usually springs. Yanacona community was an exception, since there are no major springs within the area of the community lands. The Yanacona comuneros were distributed throughout the community in small clusters of houses.

The Indians lived in usually windowless, adobe houses. Although a few tiled roofs were seen, the most common roofing material was grass thatch, wood being too scarce or expensive for use in house construction (Fig. 1).

The most common diseases were pulmonary afflictions such as bronchitis and tuberculosis, and intestinal parasites (6). Generally speaking however, the Indians presented a healthy aspect. All the members of the family seemed to be accustomed to working hard, walking, climbing and carrying heavy loads. Except for an apparent dietary deficiency manifested in inflamed gums, the population did not appear to suffer from undernourishment or nutritional deficiencies. Many of the Indians were seen chewing coca, the leaf of a perennial shrub (Erythoxylon coca Lamarck) from which the narcotic alkaloids cocaine and tropacocaine are extracted. Coca leaves are chewed with alkaline substances such as the ashes of quinua stalks (Chenopodium quinua). Coca chewers experience stimulant reactions* and may become addicted to the habit of chewing.

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* For a discussion on the physiological affects of coca chewing, see:

Economy

The major occupation was agriculture. Both field crops and livestock were raised. The comuneros cultivated small plots of land in the community and grazed their animals on fallowed crop land or permanent pastures at higher elevations. Some also worked on the haciendas in partnership with resident tenants or for wages. The family worked as a unit; the children tended the animals and the men were engaged in cultivation. Women helped with planting and harvesting but occupied themselves otherwise in weaving and other household activities.

The principal crops raised were potatoes, broad beans and barley. Oats were raised for forage. Early potatoes were reportedly the best cash crop, but all tubers figured as important trade items, a large part of the crop being exchanged for corn grown in the lower and warmer Urubamba Valley. The interchange of corn for tubers was an important economic activity between the Chinchero residents and the valley agriculturalists.

Cattle and sheep were the most common domesticated animals. Although cattle were sold occasionally to buyers who resell them in Cuzco, they were kept principally for use as draft animals. Their sale appeared to be an important source of cash income, nevertheless. Sheep were also sold but were raised mainly to produce the wool needed for homespun garments.

The home weaving industry producing ponchos, blankets and other native garments for sale to tourists in Cuzco did not seem to have fully developed in the Chinchero area. This is an important activity in other Indian communities.

The Indians of the district appeared to buy little, yet the proximity of Chinchero to Cuzco must certainly have developed some consumer desires.

Several Indians were seen with transistor radios during the course of the field work and the colectivos which left for Cuzco were always filled to capacity with Indians and their bundles. According to conversations with local informants, however, the Indians produced or traded for practically everything they needed, with the notable exceptions of sugar cane alcohol and coca.

Institutions

The district had a mayor appointed by the departamental prefect, a municipal council, and a popularly elected governor. There was also a two-man civil guard attachment in the town of Chinchero. All of these persons exercised some form of authority in the district. Each Indian community had its own communal council and a personero. The personero is an influential leader, usually literate in the Spanish language, who represents the community's interests before the government's Bureau of Indian Affairs and who is supposed to safeguard the rights and privileges of the community.

The Catholic Church had a parish in the district and the main church is built over the Incaic ruins in the town of Chinchero. The church held weekly Masses, performed the usual religious ceremonies, and observed the Saint's days and other religious holidays.

Rural primary education in the district was administered by the Rural School Center (Nucleo Escolar Campesino). The School Center consisted of a co-educational Central School in the town of Chinchero (Fig. 3) which gave the six-year primary education course, and sectional schools (first and second grades) in the villages of Umasbamba, Cuper, Ccoricancha,

Huila Huila, and Ayarmarca. A new sectional school was being built in Olonis (Yanacona community) in 1962 on the initiative of the comuneros in that neighborhood.

The School Center administered all educational activities in the district and employed a team of specialists in agriculture, home economics, and literacy. The agricultural supervisor taught the students flower and vegetable gardening; he did not work with adults. Until August 1962, the rural schooling program in Chinchero had been aided and supervised by the SECPANE program (Peruvian-North American Cooperative Educational Service). This cooperative venture, which began in 1948 in Chinchero, is now entirely under the direction of the Peruvian Ministry of Education.

The Central School will be the location of the experimental studies in linguistics to be undertaken by the Peru-Cornell Experimental Program for Applied Linguistics in 1963.

The Corporation for Reconstruction and Development (CRIF) of Cuzco had several operations in Chinchero. CRIF operated a hydroelectric plant in Ccorimarca which furnished part of Cuzco's electricity needs. In the town of Chinchero CRIF planned and constructed a small tourist hotel which was completed in August, 1962. Electric lines were being strung from Ccorimarca to the hotel and they were also to provide some electricity for the inhabitants of the town of Chinchero.

CRIF also had a local branch of its supervised agricultural credit program, known locally as CREAS, in Chinchero. CREAS had a warehouse, offices, a workshop, staff living quarters, and a small metereological station just south of the Central School. Students from the Central School were taught wood- and metal-working in the workshop.

The supervised agricultural credit program was started in 1952 and originally provided the additional services of a resident home

economist and a medical doctor who made free weekly visits to attend the district's inhabitants. Both these services were discontinued around 1958 and the program's principal function was lending seed, fertilizer, fungicides, insecticides, and machinery. Planting and fertilization were supervised. There were two Quechua-speaking resident technicians and a non-resident agronomist supervisor in 1962. The supervisor was also in charge of the program's activities in the Anta Basin.

The CREAS program was originally established with the explicit aim of helping the small landholders. In the past two years, however, efforts had been directed toward establishing a market for the fertilizers soon to be produced at the plant now under construction in Cachimayo. More attention had been paid to the larger landholders in recent years on the presumption that they would be the principal purchasers of these chemical fertilizers.

CHAPTER V

THE NATURAL ENVIRONMENT

The natural environment is the primordial basis for an agricultural way of life. An understanding of the natural environment in Chinchero is pre-requisite to the determination of its agricultural problems and potential for it establishes a physical basis to which the human aspects and technical considerations related to the agricultural activities of the district can be compared.

Climate

The seasonal changes of weather in Chinchero are similar to those experienced throughout the inter-cordilleran plateau. High pressure conditions prevail from June to August; this is the cold dry season characterized by clear sunny days, cold nights, and early morning frosts. As the sun's angle increases in September and the inter-tropical convergence zone moves south, local low pressure systems develop which produce short but heavy convectional rains, usually in the afternoon. By December, generally unstable atmospheric conditions are accompanied by general cloudiness and maximum precipitation. The "rainy" season extends from December through March and diminished rainfall occurs until June. Temperature and rainfall data recorded in recent years by CREAS* indicate a mean annual rainfall of 843 millimeters ** and a mean annual temperature of 11.8ºC***.

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*A maximum-minimum thermometer and a pluviometer, set up in 1955, were located just south of the CREAS buildings at 3720 m. Data recorded was not complete and did not appear to be very reliable.

**Average for the years 1955-1959, 1961.

Total annual rainfall varies a good deal from year to year; in 1956, 585 millimeters were recorded and in 1961, 1143 millimeters fell. Monthly rainfall totals have not been registered in excess of 300 millimeters. Rain usually falls in cloudbursts which move south over Anta Quilca ridge; rain may be accompanied by hail. Fernandez Baca reports that snow falls on an average of twice in five years, sometimes during the months of June and August; as much as 3 centimeters may accumulate (6).

Due to high altitude atmospheric effects, daily temperatures may vary 20ºC between the warmest and coldest hour. Such diurnal variations are more common during the June to August dry season. During that season it is not unusual to encounter recorded daily absolute minima and maxima of -4ºC and +23ºC, respectively. Cloudiness between December and March decreases effective out-going radiation and diurnal temperature variations are less marked. Generally speaking, seasonal effects on temperatures are much less than on precipitation. Monthly variations from the annual mean maxima of 20ºC and the mean minima of 3.5ºC are seldom more than 3 or 4ºC. In fact, freezing temperatures may occur at any time of the year which can be quite harmful to young developing plants. Where topographic depressions occur, plants are susceptible to nighttime frost damage for cold air flows downhill at night and collects in these depressions. This is particularly the case in the Yanacona Pampa and the Pampa de Olonis (See Reference Map, Plate 1). Due to the generally low temperatures which characterize the climate of Chinchero, the cultivation of only the more cold-resistant crop species is possible.

No generalizations can be made with respect to evapotranspiration and moisture balance since complementary rainfall and temperature data were available for a three-year period only. During this period (1957-59), average annual water movements, calculated using the Holdridge nomogram (10),

indicated the potential evapotranspiration to have been 696 millimeters and the actual evapotranspiration to have been 497 millimeters. Average monthly water balance calculated using the Holdridge formulas (9, 10) and taking into account changes in soil water indicate the effectively dry months* to have extended from July to the middle of October; these months coincide with the months of greatest frost incidence. The effectively wet months** extend over an eight-and-one-half-month period from the middle of October to June.

The actual evapotranspiration calculated on a monthly basis was 585 millimeters, or 68 millimeters greater than the annual actual evapotranspiration calculated using the Holdridge nomogram. The difference is probably due to the fact the rainfall was well distributed and conditions of atmospheric humidity, taken into account in the nomogram, were not considered in the monthly water balance calculations. Atmospheric humidity during rainy months, if sufficient, would tend to reduce actual evapotranspiration (10, p. 6)(See Table 2***).

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* Those months, when temperature is not a limiting factor, during which the soil does not contain enough water for normal growth of existing vegetation, e.g. natural vegetation (10).

**Months during which soil contains sufficient water for normal plant growth.

***Explanatory notes for the items appearing in Table 2 are as follows: Item 1; biotemperatures were calculated by dividing the sum of positive daily mean temperatures by the number of days in the month. Item 2; potential evapotranspiration is a hypothetical value obtained by multiplying the mean monthly biotemperature by 0.16 times the number of days in the month, expressed in millimeters of rainfall equivalent. Item 4; potential evapotranspiration ratio is potential evapotranspiration divided by the average total annual precipitation; for the average year only. Item 5; average actual evapotranspiration is a calculated estimate of total water returned to the atmosphere by evaporation from the soil and vegetation and transpiration of a climatic climax vegetation on the zonal soil. Actual evapotranspiration is approximately equal to potential evapotranspiration in those months when rainfall, or rainfall plus soil moisture, equals the potential. Actual evapotranspiration will be roughly one-third less than amounts calculated for zonal soils with a grass or field crop cover. (Footnote continued on the next page)

The above calculations assume conditions of zonal soils on which a natural climatic climax vegetation is growing. Neither zonal soils nor climax vegetation exist in Chinchero, a circumstance which acts to diminish stored soil water as well as transpiration. On steeply sloping Lithosols field capacity is low; where these slopes have been overgrazed run-off has been accelerated. Judging from the advanced degree of erosion evident on even the moderately sloping agricultural soils, moisture infiltration is impeded and internal drainage is poor. Field capacity may also have been reduced. Where these soils occur most of the water surplus during the rainy season is lost as run-off; subsurface run-off may be considerable where dipping planes favor rapid infiltration into parent rock. Thus although there is an appreciable amount of moisture surplus from January to April much of it appears to run off directly to surface streams and into depressions. As a result conditions of soil drought occur more quickly after the end of the rainy season than would be the case on zonal soils with vegetative cover.

In terms of crop production, the fact that most of the excess moisture is not stored in the soil is not a serious problem. First, plants develop and mature during the months of moisture surplus. Second, the rainfall is well distributed according to the station data; this, in effect, gives the soil more chances to recharge its moisture. If the rainy season starts late, however, the initial development of germinated seeds can be endangered. Excess moisture is more likely to be the problem

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Items 6 and 7; calculations for both these items presume a storage capacity of 100 millimeters (four inches) of rainfall equivalents between pF4.2 and pR1.0 (field capacity at rooting depth). Item 9; it was presumed that fifty percent of the gravitational water reaches water table in the succeeding month.

Table 2. Thermal efficiency and monthly water balance of Chinchero soils calculated from short-term mean station data (1957-1959) using Holdridge formulas (9, 10) and the Thornthwaite method (33)*.

	Month of the Year												Year
	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	
1. Mean Biotemperature, ° C.	10.4	11.7	12.2	13.2	13.2	13.2	12.2	12.0	10.3	11.9	11.8	10.3	11.87
2. Potential Evapotranspiration, in mm.	52.0	58.5	58.5	66.1	63.5	66.1	61.1	54.3	51.5	57.2	59.0	49.5	696.6
3. Average Total Precipitation, in mm.	10.3	5.3	7.7	57.7	86.7	133.0	121.7	230.0	112.7	44.3	32.7	4.0	846.0
4. Potential Evapotranspiration Ratio	-	-	-	-	-	-	-	-	-	-	-	-	0.823
5. Average Actual Evapotranspiration	25.6	5.3	7.7	57.7	63.5	66.1	61.1	54.3	51.5	57.2	59.0	49.5	558.5
6. Soil Storage, in mm.	-15.3	nil	nil	nil	-23.2	-66.9	-9.9	0	100.0	-12.9	-26.3	-45.5	
7. In Soil Storage, in mm.	0	0	0	0	23.2	90.1	100.0	100.0	100.0	87.1	60.8	15.3	
8. Water Deficit, in mm.	26.4	53.2	50.8	8.4	0	0	0	0	0	0	0	0	138.8
9. Surface and Subsurface Run-off, in mm.	0	0	0	0	0	0	25.4	113.1	118.5	30.6	0	0	287.5
	D R Y				W E T								

* Calculations courtesy of J. A. Tosi, Jr.

together with untimely frosts and hail storms. If the developing plants survive these hazards and the usual low nighttime temperatures, they will receive sufficient insolation and radiant energy for photosynthesis. The months of moisture deficit do affect the grazing areas, however, and from June to October natural grass pasturage becomes progressively poorer and more limited in area.

Vegetation

Natural vegetation in the Chinchero district has been drastically altered by man. Centuries of agricultural and pastoral activities accompanied by general deforestation have resulted in the virtually total disappearance of the original forests presumed to have existed there. Except for scattered groups of eucalyptus (Eucalyptus sp.) recently introduced from Australia, the landscape is treeless. The mountainous ridges to the north and east present a panorama of bare slopes on which only grass grows (Figs. 16, 27). The upland slopes and the fluvio-glacial fans are utilized in their entirety for cultivation and for grazing when the fields are fallowed.

The Ecologic Zone. Chinchero is shown to be within the Tropical Montane Moist Forest plant formation* or natural life zone, close to the upper boundary of the Lower Montane altitudinal belt, on the ecologic map drawn by Tosi (32). Tosi bases his map on Holdridge's classification of World Plant Formations. In essence Holdridge's classification synthesizes the broad general relationships between climate and natural vegetation. The

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* A plant formation is defined as "a uniformly weighted division of the earth's climate which supports a distinct set of plant associations. A plant association is a dominant community of plants which in its mature natural state, has a physiognomy distinct from that of all other plant associations"(10, p. 2).

climatic elements related to vegetation in this system are mean annual biotemperature, total annual precipitation, and the ratio of potential evapotranspiration* to precipitation.

The Montane Moist Forest life zone has climatic conditions permitting the growth in the climatic climax association of a low (10 to 15 meters) moderately dense woodland (35). In the Peruvian Sierra this zone is now one of the most heavily populated agricultural areas and the low forest that once existed (5, 35) has been removed by man. Although the total annual rainfall ranges only from 500 to 1000 millimeters, there is an appreciable moisture surplus since relatively low temperatures effectively reduce potential evapotranspiration at this altitude. As has been pointed out, a favorable atmospheric moisture balance tends to be off-set over much of the Chinchero district by unfavorable edaphic conditions conducive to excessive surface run-off.

Sub-alpine temperature conditions, as delimited by Tosi should not occur at mean annual temperatures higher than 6ºC. Such a temperature falls between 4100 and 4200 meters elevation in Chinchero, despite the fact that a short term recorded annual biotemperature of 11.8ºC at 3720 meters in Chinchero would indicate a higher altitudinal limit for the 6ºC isotherm in the region. Since the natural vegetation has been altered so much by grazing, and perhaps by burning, an accurate determination from vegetation alone is not possible. Tosi mentions that the upper altitudinal limit of cultivated crops coincides approximately with the lower limits of the Sub-alpine zone (35, p. 113). In Chinchero potatoes are cultivated up to 4000 meters.

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* Potential evapotranspiration is "the amount of water which could be evapotranspired under optimal conditions of soil moisture and vegetation on a zonal soil in a zonal climate"(10, p. 1).

Natural Vegetation

The residual natural vegetation consists principally of annual grasses and perennial bunchgrasses, shrubs and low trees (up to 6 meters), and sedges and rushes in wet spots and ponds. Cacti and thorny shrubs grow on over-grazed areas and eroded slopes, particularly those with a northeast exposure, to as high as 3900 meters (Fig. 23). The upper limits for trees and large shrubs is at 3950 meters. This is likely to be a man-made limit for the Queuña (Polylepis sp.) has been found above 4000 meters in glacial cirques in the Cuzco region (15).

Only around settlements are specimens of mature native trees encountered. Around houses and along pathways and old Incaic roads, the Queuña, the Quishuar (Buddleia sp.), the Sauce (Sambucus peruviana), and the Chachacuma (Escallonia sp.) have been preserved. More common are the hedge-forming Motuy (Cassia sp.), Ch'ilca and Tayanca (Baccharis spp.), Quisca (Berberis sp.), Cantuta (Cantu sp.) and Llaulli (Barnadesis sp.). All of these woody species are sources of firewood and sprout vigorously following cutting (Figs. 1, 2).

Hedge-forming shrubs and natural grasses are left to grow on those terrace walls which are not fortified with stones (Fig. 24). This conservation measure is commonly employed on Indian community lands but rarely on hacienda lands where fields are larger and seldom terraced.

Only one place in the district retains vegetation sufficiently undisturbed to merit mention. This site is on the very steep, south-facing slopes of the Urquillos Canyon opposite Antasacca Hill (Figs. 22, 23). Here a growth of herbaceous and woody species attains heights of up to five meters on rocky soils. With a southern exposure, hence fewer hours of direct insolation, this site is probably more humid than any other well-drained part of the district. In several places ground water is

provided by small springs. The elevation is between 3400 and 3600 meters. The most abundant species on the site are of the Compositae. The genus *Baccharis* is represented by numerous species. Other shrubs belong to the Verbenaceae, Rosaceae, and Berberidaceae families. Herbaceous forms of the Euphorbiaceae, Labiatae, and Scrophulariaceae families were seen; conspicuous was the red-flowering Cantuta, the national flower of Peru.

Grasses grow luxuriantly on this site; *Stipa* being especially abundant. *Stipa ichu* is cut here for use in hatching houses. Maguey (*Agave americana*) is also present; this introduced plant appears to have its upper altitudinal limits at about 3600 meters in the area. No cacti or thorny shrubs were seen, nor were those native tree species noted about settlements seen. The latter have been selectively cut for firewood. "Chacahcuma" is preferred for making charcoal.

The rest of the district has only grass vegetation. The Fescue tribe is represented by *Festuca* spp., *Bromus* spp. and *Distichilis* sp., the latter being a saltgrass which grows on alkaline flats. In moist areas *Poa candamoaria* grows in association with *Rumex* sp., stunted Juncaceae (perhaps *Distichia muscoides*), and, in places, *Distichilis*. Of the Timothy tribe, *Calamagrostis* spp., along with *Stipa* sp., are common on the upland plateau and surrounding hills. At higher elevations *Muhlenbergia* sp. and *Aciachne pulvinata* are common, the latter forming typical prickly cushions and occurring principally in high sub-alpine valleys and cirques above 4100 meters.

Dominant grasses were not identified and the more palatable species were probably not seen due to heavy grazing in all places. Samples had to be taken from hedge rows or sites inaccessible to grazing stocks.

In the seasonal lakes and marshy spots, rushes and sedges predominate over grasses. *Juncus* sp. and, in places, several species of

Cyperaceae were seen. These areas are called totorales and are grazed heavily along the shores in the dry months, and where inaccessible to the animals, are cut to provide forage.

Eucalyptus Plantations

In the early part of the century the first eucalyptus were planted in Chinchero. The largest trees standing today were planted by the original owners of the hydroelectric plant in Ccorimarca at 3500 meters. These trees are now 25 to 35 meters high and measure 50 to 60 centimeters in diameter at breast height. This example was followed by sporadic plantings in the settlements of Pongobamba, Chinchero, and Ch'uso on the higher upland plateau, but it was not until 1948 that a large number of trees began to be planted.

In 1948, the School Center began distributing *Eucalyptus globulus* seedlings to the comuneros. Seeds furnished by SECPANE were germinated in beds prepared by the School Center and seedling trees were later given to the comuneros. Since 1948, a total of 33,000 seedlings have been distributed and eucalyptus trees are now a permanent feature of the landscape around settlements. No eucalyptus have been planted on Hacienda Huaypo Grande, but the other small haciendas in the southeast part of the district have a few trees.

Recently the local forest service office in Cuzco has made seeds available of *Eucalyptus globulus*, *Cupressus macrocarpa*, *Pinus insigne*, *Casuarina equistifolia*, and Q'olle, an endemic tree (*Escallonia* ?).

Except for a few small plantations having a total area of perhaps three hectares, all of the eucalyptus have been planted on deep soils near houses where they can be cared for and watered or irrigated. A common practice is to plant the seedlings inside ruined, roofless adobe houses

where they are safe from the domestic animals. Irrigation is necessary to help the young trees survive frosts. During the first three years after transplanting, it has been found necessary to protect the terminal bud from freezing by covering it with a sack during the cold months. This applies to sites above 3700 meters. At the Central School a few young species of _Cupressus macrocarpa_ are completely encased in adobe shelters during the June to August season.

Eucalyptus grow best where they are irrigated or where the subsoil is moist throughout the year as on the fluvio-glacial fans near Pongobamba. Such conditions exist only on the best agricultural soils of the district (Figs. 17, 18). Outside these areas, sites with optimal conditions are rare. Eucalyptus plantings therefore compete with field crops for the best agricultural soils in the district.

Regeneration of Grasses

About three years ago a small eucalyptus plantation was established at 3600 meters on the upper slopes of the east side of Ccorimarca Draw opposite the hydroelectric plant. The plantation was fenced to keep out the grazing stock. Previous to being fenced off the area was heavily grazed and the dominant grass had become Kikuyu (_Pennisetum clandestimum_), an exotic grass introduced from Africa. Native grasses were regenerating vigorously and had begun to dominate the Kikuyu. This regeneration contradicts the local belief that Kikuyu grass, once established, will eliminate all native grasses. The real reason is obviously that kikuyu grass survives the abuses of over-grazing much better than do the native grasses. Kikuyu may be more vigorous at lower and warmer elevations, however.

Kikuyu is good forage and an excellent sod-former and it would not be unwanted by the farmers except for the fact that it invades their

cultivated fields and is difficult to eradicate there. This problem had not become serious in the district since Kikuyu does not grow well at elevations above 3650 meters. Scattered patches were seen along the north shore of Lake Piuray, however, indicating that locally the micro-climate is modified by the lake's waters.

The vegetation of the district has been seriously altered and degraded by over-grazing, deforestation and the general pressures of dense population. Its value as a natural, renewable resource has been reduced to a minimum. It is possible that if the eucalyptus had not been introduced, there would be no woody species remaining today. Wood is the only fuel resource in the area and it is so scarce that animal manure is dried out to be used for fuel*. Nevertheless native shrubs and trees have been preserved around settled areas. Perhaps the most serious consequence of the removal of the natural vegetative cover has been the diminishing of soil productivity by depriving the soil of the beneficial structural and chemical effects derived from organic matter; denudation has also increased erosion.

Geology

The chief physiographic features of the area are a) the gently undulating upland plateau which has formed over Cretaceous rocks, and b) the mountainous ridges to the east and north formed of older, more resistant rocks, possibly of the Jurassic or Triassic.

The upland plateau is situated at elevations between 3650 and 3800 meters. It extends westward from about the middle of the district into

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* Animal manure may be a preferred fuel, however. This was not determined.

the neighboring districts of Maras and Huayllabamba. This surface had reached near peneplanation prior to the upwarping that raised it to its present elevation (2). It is a major feature of the landscape in areas west of Chinchero also.

The Cretaceous plateau bedrock consists of hard limestones and soft shales of Cenomanian (Middle Cretaceous) age, locally known as the Yuncaypata formation (14). Between Cccorimarca Draw and the mountains in the southeast portion of the district, the Cretaceous rocks overlie red and violet shales and clays containing small fragments of reddish sandstone, thin layers of calcareous material, siderite, and biotite flakes. These clays also underlie the Yuncaypata rocks on the western half of Antasacca Hill and were apparently formed near the shores of the Cretaceous seas.

The limestones occur over the shales in the Yuncaypata formation in Chinchero, however they have been weathered away in many places. They outcrop in the southern half of the area and east and north of the town of Chinchero. These limestones may be quarried to be used in the manufacture of nitrogenous fertilizer to be undertaken in Cachimayo.

The older rocks forming the mountainous ridges are light reddish-grey sandstones interbedded with shales ranging in color from grey to yellow. They emerge from the Cretaceous rocks to form the east-west trending Anta Quilca ridge and the north-south trending Ccorcor ridge. These ridges form the political boundaries of the district on the north and east. Ridge tops vary in elevation from 4000 to 4400 meters.

The beds of the ridges dip generally to the north. Along Ccorcor ridge they dip 25 to 30 degrees (Fig. 17) and on Anta Quilca ridge they dip 50 to 60 degrees or more (Fig. 23). An anticlinal fold whose

east-west axis runs through Taucca marks the limit north of which the beds dip more steeply.

From the western tip of Anta Quilca ridge to the northeast corner of the district above Taucca, these sandstones and shales have been gouged out by glaciers into a series of parallel U-shaped valleys with cirques at valley heads (Fig. 10). Permanent and seasonal lakes occupy the cirque bottoms at elevations above 4200 meters. These valleys open into the Urquillos Canyon which begins near Cuper and drops 1000 meters in less than 12 kilometers to empty into the Vilcanota River (Fig. 22). This east-west canyon separates the upland plateau from Anta Quilca ridge.

The eastern half of Antasacca Hill and a series of low hills extending east to Taucca are comprised of sandstones and shales dipping 20 to 30 degrees to the northeast. These rocks are softer than the Anta Quilca sandstones and shales and they may be the so-called Permian "red beds", although Permian rocks in the Cuzco region generally contain volcanic brecchias (14). These softer sandstones and shales are red in color and from a distance appear to have a violet hue. They lie uncomformably over the Anta Quilca rocks north of Cuper and they are dissected by the upper stretchs of Urquillos Canyon.

During the Pleistocene a large part of the upland plateau was occupied by lakes. An old lake bed can be traced west of the town of Chinchero, extending southward toward Olonis. It is now known as Yanacona Pampa and the Pampa de Olonis (Fig. 7). Another old lake bed called Piuray Pampa extends west of Lake Piuray to Huila Huila (Fig. 20); it is no doubt an earlier and higher level of the present lake and it probably extended westward also. A smaller lake bed plain extends northeast of Lake Huaypo.

The Pleistocene lakes have dried up due to climatic changes or have been drained as a result of geologically recent faulting or upwarping. The stream waters that once fed the lakes were apparently heavily charged with calcium salts which allowed the development of calcareous aquatic organisms. These produced the calcareous muds over the lake beds that now comprise the subsoils of the old lake bed plains.

Fluvio-glacial sediments washed down from Ccocor ridge and its side canyons during the late Pleistocene extend westward south of Lake Piuray to form a fan on which the towns of Pongobamba, Ch'uso and Ccoricancha are located (Figs. 13, 17).

Peat deposits occur at several places at the edge of the fluvio-glacial fan west of Ch'uso and at various spots in Ccorimarca Draw and the Tangabamba Creek valley. This peat is mined and used as fuel for burning limestone to produce construction lime (See Plate 3).

Apart from the present uses made of peat and limestones and the possible use of limestone in the manufacture of fertilizers, the mineral resources of the district present no forseeable possibilities for commercial exploitation. Although small quantities of secondary copper minerals such as cuprite occur sporadically in the sandstones of the mountainous ridges, they do not constitute exploitable ore bodies.

Landforms and Drainage

Landforms are an expression of geology and geomorphological processes, principally surface and stream erosion and tectonic activity. In the present study distinctive types of landforms were classified as natural land types and mapped (Plate 5). Criteria used were: a) gradient and type of slope (whether simple or complex), b) degree and class of erosion, and c) geomorphological processes giving rise to a particular landform.

A consideration of soils was not included in the criteria however the distribution of the soils series, which were mapped separately, corresponds closely to the patterns of natural land type distribution. Seven natural land types were distinguished over the Chinchero area:

1. Mature Upland Slopes
2. Dissected Upland Slopes (high level)
3. Dissected Upland Slopes (low level)
4. Old Lake Beds
5. Fluvio-Glacial Fans
6. Canyons
7. Mountainous Country

Mature Upland Slopes

The mature upland slopes take in the smoothest topography of the upland plateau. The landscape is characterized by broad undulating, unbroken slopes with 5 to 20 percent gradient lying at elevations between 3700 and 3800 meters. These slopes are that part of the upland plateau which has not been dissected by stream action and which exhibits the topography of a near peneplaned surface. They have formed over the Yuncaypata shales and there are no limestones outcropping anywhere. Numerous swales and depressions on this old erosional surface contain seasonal lakes and ponds; Quellhuacocha is the largest of these (Figs. 10, 12).

Dissected Upland Slopes (high level)

A string of low hills running from the northwest to the southeast rises 200 meters above the mature upland slopes and separates these from the Urquillos Canyon. These hills are cut by numerous gullies, some which have springs. Where limestones outcrop, on the west side of Antasacca Hill and on the hill north of Yanacona Pampa, complex slopes of 20 to 60 percent gradient are characteristic. East toward Cuper, the hills are formed over softer sandstones and shales which have eroded into a somewhat less rugged topography but which nevertheless has slope gradients up to 60 percent and is cut by small gullies. Toward Taucca the hills have been rounded off somewhat by glacial action. Near Chinchero and Puca Marca, sediments washed to the bases of the hills have spread out as colluvial and alluvial fans onto the mature upland slopes and along the northern margin of Lake Piuray (Figs. 9, 16, 25, 28).

Dissected Upland Slopes (low level)

South of Lake Piuray between the fluvio-glacial fan and Ccorimarca Draw, the Cretaceous rocks of the upland plateau have been extremely faulted and dissected by streams. Isolated blocks of the upland plateau rise 100 to 150 meters above steeply sloping stream and gully cuts. Slopes are complex, ranging in gradient from 20 to 60 percent. West of Ccorimarca Draw, Tangabamba Creek and its small tributaries are cutting headward into the mature upland slopes. Slopes are complex, ranging from 20 to 40 percent in gradient, and limestone outcrops occur.

Stream patterns are quite erratic due to the great amount of geologically recent tectonic activity which has taken place in this portion of the district. Streams follow fault zones or cut through less resistant rocks exposed by faulting. The local base level for these streams which drain the southern portion of the district is at 3300 meters, the elevation of the Anta River into which the streams feed. Lake Piuray is drained by the stream running through Ccorimarca Draw which joins the Anta River near Cachimayo. (Figs. 19, 21, 29).

The western half of the upland plateau, including Yanacona Pampa and the Pampa de Olonis as well as most of the mature upland slopes, is drained by streams which empty into Lake Huaypo at 3600 meters. Stream gradients are gentler and where they are cutting into the mature upland slopes, smooth slopes of 15 to 35 percent gradient occur. Limestone outcrops are present but occupy less area than to the south.

Old Lake Beds

The old lake beds are flat plains except in the eastern half of the Yanacona Pampa where a pits-and-mounds type micro-relief has developed. The plain east of Lake Piuray has been partially covered by fluvial gravels which were probably deposited during the late Pleistocene. As none of these plains has yet been reached by headward-cutting younger streams, they are all poorly drained. Where fluvial gravels occur however, internal drainage is improved.

Fluvio-Glacial Fans

Gravels of fluvio-glacial origin spread out in smoothly sloping fans with gradients up to 20 percent near the foothills of the eastern mountainous ridges. These sediments are dissected by several deep gullies which join the streams to the south. East of Lake Piuray these gravels form smaller fans which are partially covered by recent colluvial sediments close to the base of the foothills. The fluvio-glacial gravels appear to be excellent aquifers and small springs occur at numerous places at the edges of the fans (Figs. 13-15, 17).

Canyons

The Urquillos Canyon and parts of Ccorimarca Draw are characterized by precipitous slopes which attain 100 percent gradients

(Figs. 22, 23). Both of these canyons follow major fault zones. Where the Ccorimarca Draw opens up south of the hydroelectric plant, its walls are less precipitous and have been mapped in the dissected upland slopes, low level landform type.

Mountainous Country

This landform includes the steep slopes of Anta Quilca and Ccorcor ridges and the steep hill near Lake Huaypo called Huainacaure. Slopes with gradients exceeding 60 percent are characteristic. The relief of the higher valleys on Anta Quilca ridge has been modified by glacial action and in the U-valleys gradients of 40 percent or less occur locally. The aretes between the U-valleys are very steeply sloping, in places rising almost vertically (Fig. 10).

Man Made Terraces

Inasmuch as terracing is actually a modification of micro-relief, terraced areas were not considered to constitute a discrete land type. However, the total terraced area which could be clearly seen on the aerial photographs, amounts to 1,470 hectares or about 9 percent of the district's total area. In view of this fact terraced areas have been mapped on the landform map. Those natural landforms whose micro-relief has been modified by terracing include the high level dissected upland slopes in their entirety (excepting areas of outcrops), portions of the mountainous country and the head of Urquillos Canyon near Cuper, and relatively small areas on the colluvial fans which cover the fluvio-glacial fans near the foothills of the Ccorcor ridge complex. The steep areas of Ccorimarca Draw mapped as canyon have also been partially terraced.

Soils

The unique combination of circumstances in Chinchero which pertain

to the chief soil-forming factors* make it difficult to envisage the zonal soil that once may have existed. Because of man's interference through deforestation, protracted tillage and grazing coupled with steep relief and the relatively short period of time over which the soil-forming factors have operated, zonal soils are today nowhere conspicuous in Chinchero. On the mature upland slopes, the one place where relief favors the evolution of a zonal soil, the vegetation has long since been removed, and sheet erosion has washed away much of the upper soil horizon. Here the shale parent rock has been deeply weathered yet existing profiles show practically no horizon development. Taking into account the alkalinity of the limestones that once covered these shales and which must have contributed to soil formation as they weathered away, the original soils on the mature upland slopes may have been similar to Brown Forest Soils. The development of a Tropical Podzol seems unlikely since parent rock is not acid.

The soils existing today in Chinchero have the features of Azonal and Intrazonal soils and Lithosols. Parent materials are a major factor influencing soil characteristics and in classifying the soils series of the area, parent materials constituted the principal criterion.

The presentation of the soils series descriptions follows the standard description guide set forth in the USDA Soil Survey Manual (37). Where soil profiles are described, the capital letters "A", "B", "C", etc., refer to the different soil horizons as defined by pedologists. The term relief includes the characteristics of gradient (percentage values are used), length and shape of slope (whether simple or complex), and sometimes landform. Drainage refers to both internal and external drainage. Where vegetation is described, reference is made to the natural regenerating vegetation encountered on fallowed agricultural lands or natural vegetation

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relief

on permanently grazed areas. Inasmuch as the subjects of vegetation and land use are treated in detail elsewhere in the present study, they are mentioned only briefly in the series descriptions. Soils which would normally be classified as Lithosols or colluvial soils have been differentiated and described due to their significance as agricultural soils. Each series description includes a reference to the symbols of the series appearing on the soils series map (Plate 4).

The Soils Series of Chinchero

YANACONA SERIES (Yn and Yns): The Yanacona soils are compact clays developed over the deeply weathered Cretaceous shales and limestones of the upland plateau (Fig. 12). Their parent materials are slightly gravelly clays which have been weathered principally from the shales. The limestones leave no appreciable amounts of residual material on solution but in places were noted to yield dark reddish-brown friable clay. Over their greatest extent the Yanacona clays are characteristically light reddish-brown to light yellowish-brown in color. Limestones outcrop over at least half of their extent, principally in the southern portions of the upland plateau (the low level dissected upland slopes).

Soil Profile:

A - Absent

B - 0 to 18 inches. Light yellowish-brown to light reddish-brown compact clays; massive; no aggregates; in places columnar. Slightly gravelly. Acid in reaction.

C - 18- inches. Light yellowish-red gravelly clays; very compact. In the eastern limits of the series, these grade into slightly crumbly, gravelly clays which are very susceptible to gully erosion.

D - At variable depths below 5 feet, red, yellow, and brown shales; outcropping in severely eroded places. No limestones were observed below the D horizon.

Range in Characteristics:

In areas of limestone outcrops, both soils and parent material

are somewhat gravelly and slightly darker in color with carbonate concretions in the C horizon. Such areas have been mapped within the stony phase (Yns). In places the C horizon has been exposed by erosion.

Relief:

Gently sloping uplands (3 to 20 percent). Complex slopes of 20 to 40 % occur in areas of limestone outcrops and areas dissected by stream action.

Drainage:

External, poor to adequate, depending upon gradient. Internal poor.

Vegetation:

Sparse, natural grasses and scattered shrubs.

Land use:

Cultivated and grazed alternately.

Distribution:

Mature upland slopes, low level and high level dissected upland slopes. Total area: 5,666 hectares.

Remarks:

As a consequence of sheet and gully erosion aggravated in part by poor internal drainage and intensive cultivation and grazing, very little organic matter remains in these clays nor does it have a chance to accumulate.

CUPER SERIES (Cu and Cus): The Cuper series consists of sandy clay-loams and colluvial clays weathered from the reddish-grey sandstones and shales on the western half of Antasacca Hill and the hills extending eastward toward Taucca. These soils are superficial and the parent material is essentially the same as the surface horizon. On hilltops, very little soil has accumulated; soils are deepest at draw bottoms, at the base of slopes, and on terraces. The Cuper sandy clay-loams are more permeable than the Yanacona clays.

Soil Profile:

A & B - 0 to 12 inches. Reddish-grey to reddish-brown sandy clay-loam; crumbly when dry. Neutral in reaction.

C - Gravelly reddish-brown clay; compact. Depth variable but typically shallow.

D - At variable depth, sandstones and shales; outcropping on hilltops and topographic prominences.

Range in Characteristics:

On steeper slopes the Cuper soils are lithosolic (Cus) or colluvial. Soil depth varies greatly in relation to topography, erosive action and terracing.

Relief:

Steeply sloping, 40 to 60 percent or more. Complex slopes over at least one half of the series' extent.

Drainage:

External drainage adequate to excessive. Internal drainage good.

Vegetation:

Native grasses and shrubs on terrace walls.

Land Use:

Cultivated and grazed alternately.

Distribution:

High level dissected upland slopes east of Puca Marca. Total area: 776 hectares.

Remarks:

These soils are considered productive and although 95 percent of their extent has gradients of 60 percent or more, they have been almost completely terraced, notably on the north side of Antasacca Hill and at the head of Urquillos Canyon. Terraces at gully bottoms are susceptible to land slip if they are too large.

MAHUAYPAMPA SERIES (Mah): The Mahuaypampa soils have been described by Zamora (42). They cover only a small area in the eastern corner of the district near Chequerecc and extend westward into the neighboring

districts of Maras and Huayllabamba. They have developed over soft Cretaceous (?) limestones. Near Chequerecc they present well-defined layers of carbonates at depths below 10 inches. They differ from the Yanacona clays in their higher percentage of silt, greater friability, and typically more alkaline reaction.

Soil Profile (after Zamora):

0 to 6 inches: Clay to clay loam; dark reddish-brown when humid; compact. Calcareous with lime concretions. Superficial gravel.

5 to 25 inches: Dark reddish-brown clay; compact; large amounts of carbonates.

Range in Characteristics:

None in Chinchero.

Relief:

Undulating to moderately sloping upland slopes.

Drainage:

Adequate both internally and externally.

Vegetation:

Sparse, natural grasses.

Land Use:

Cropped and grazed.

Distribution:

Reduced area (115 hectares) near Chequerecc on the lands of Hacienda Hauypo Grande.

PIURAY SERIES (Pi, Pic, and Pis): The Piuray soils are very poorly drained calcareous clays developed over the calcareous lacustrine muds of the former Pleistocene lakes. The clays are superficial and have a very high lime content. Where they are hydromorphic, they contain considerable amounts of organic matter. Near the shores of Lake Piuray,

they have a gleyed horizon of black, humic silty clay. Near Lake Huaypo, the lake deposits are somewhat sandy and are overlaid by a gleyed horizon of greyish-brown sandy clay-loam. The Piuray clays of the Yanacona plain are inundated during the months of maximum rainfall and surface run-off.

Soil Profile:

A_0- Carbonate precipitates

A - 0 to 7 inches. Light grey clay, moderately high in organic matter, friable when dry, neutral to alkaline; lime concretions distributed throughout the horizon.

G - 7 to 12 inches. Black silty clay-loams or grey sandy clay; neutral to alkaline in reaction. Plastic when humid.

C - 12 to 48 inches; maximum depth variable. White calcareous mud with abundant skeletons of aquatic organisms. In places sandy.

Range in Characteristics:

At the margins of the <u>old lake bed</u> plains, additions of alluvium originating from nearby <u>upland</u> slopes cause the soils to be siltier in texture and darker in color. Such areas have been mapped as the silty phase of this series (symbol Pis). In places the A horizon directly overlies the lacustrine deposits and the gleyed horizon is absent. Surface deposits of carbonates may be so abundant as to give a calcium solonchak appearance; these areas have been mapped as the calcareous phase (symbol Pic).

Relief:

Continuous flat plains; 0 to 3 percent.

Drainage:

Poor to very poor both externally and internally. Artificial drainage has been attempted in some areas.

Vegetation:

<u>Juncus</u>, <u>Distichilis</u>, <u>Stipa</u>, <u>Poa</u>, <u>Rumex</u>.

Land Use:

The silty phase is cultivated; the calcareous phase and areas subject to inundation are grazed permanently.

Distribution:

Old Lake Bed plains. Total area 800 hectares

Remarks:

The white colored parent material is used locally for white-washing adobes. Tilling operations may bring the extremely calcareous lacustrine deposits to the surface. Chemical use of the lacustrine mud has been contemplated, specifically to lower the proportion of nitrogen in the manufacturing of nitrogenous fertilizers to be undertaken in Cachimayo.

PONGOBAMBA SERIES (Po and Pos): The Pongobamba soils are well-drained stony clays developed over the fluvio-glacial sediments washed down from the mountainous ridges to the east. They are characteristically superficial and in reality are colluvial (Azonal) soils having no distinct profile development.

Soil Profile:

A - 0 to 15 inches. Light reddish-brown to light reddish-grey clay; compact. Neutral to acid in reaction. Variable organic matter content. Considerable superficial gravel in places.

B - Absent

C - 15 inches to a maximum of 15 feet. Fluvio-glacial gravels derived from sandstones and shales; horizons of brown clays at depths below ten feet.

Range in Characteristics:

The topsoil grades from excessively stony (Stony phase; symbol, Pos) to free of stones (symbol, Po), depending upon proximity to the foothills. On the plain extending eastward from Lake Piuray the texture of the topsoil is sandy clay-loam.

Relief:

Unbroken slopes; 0 to 20 percent.

Drainage:

Well-drained internally and externally.

Vegetation:

Native grasses. Introduced eucalyptus grow very well on these soils.

Land Use:

Cultivated and grazed alternately.

Distribution:

Occurrence coincides with that of fluvio-glacial sediments. The colluvial soils of Caparay and nearby colluvial fans covering the fluvio-glacial sediments are mapped in this series since they have the same parent materials. Total area: 735 hectares.

CHINCHERO SERIES (Ch): These soils have developed over the gravelly clays washed down from the Cretaceous limestones and shales of the hills near the town of Chinchero. Although they are derived from the same parent materials as the Yanacona clays, they have a siltier texture inasmuch as they are essentially deposits of alluvium. The parent materials contain layers of gravel at varying depths in the lower horizons. The upper horizon characteristics are dependent more upon depositional processes than on weathering processes.

Soil Profile:

A - 0 to 6 inches. Dark brown to dark reddish-brown when moist; heavy clay loam; crumbly with aggregates. Neutral to slightly alkaline.

B - 6 to 18 inches. Dark reddish-brown to dark greyish-brown when moist; massive clay, columnar. May have carbonate concretions.

C - 18 inches to a maximum of 6 feet. Massive clays with several horizons of gravel.

Range in Characteristics:

Texture of the surface soil varies from silty loam to clay-loam. North of Yanacona Pampa, the soil color is lighter and texture is heavier, mainly due to the lack of continuous cultivation and irrigation water.

Relief:

Unbroken slopes, mostly flat but may slope up to 5 percent.

Drainage:

External drainage adequate to good. Internal drainage adequate.

Vegetation:

Sparse, native grasses and shrubs. Eucalyptus grow well in irrigated areas.

Land Use:

Continuously cultivated where irrigated; alternately cultivated and grazed where not irrigated.

Distribution:

Alluvial fans near Chinchero and Puca Marca. Soils on Hacienda Huaypo have been mapped in this series on the basis of aerial photograph interpretation.

Remarks:

The tilth of these soils appears to be improved wherever they have been in continuous cultivation under irrigation.

ANTA QUILCA SERIES (An): These colluvial soils are friable organic clay-loams, weathered from the sandstones and shales of the northern mountainous ridges. They are the only soils in the district with a good natural aggregate structure and friable consistency. The Anta Quilca soils have been mapped only above 3900 meters where soils take on a black color due to the slow rate of organic matter decomposition.

These soils are cultivated both above and below 3900 meters however at lower elevations slopes are much steeper, area of outcrops are greater and pockets of soil are relatively scarce. On Ccorcor ridge where the beds dip less steeply, weathering has not been rapid and soils are so thin that they cannot be cultivated. Although the Anta Quilca soils are considered to be productive, they require long periods of fallow after one crop in order to recover their natural fertility. The total mapped area of the series is 513 hectares.

LITHOSOLS (Li): In this series are grouped all the soils which are too thin or too steep to be cultivated. The glacial drift of the higher valleys has been mapped in this series. These shallow soils are often stony and their natural vegetation consists principally of grasses which are intensively grazed.

The boundaries between the Anta Quilca series and the Lithosols are somewhat arbitrary for there are undoubtedly small pockets of soils in topographic depressions on the mountainous slopes which are deep enough to be cultivated but are so inaccessible that they are left in grass.

Fertility Levels of the Chinchero Soils

According to the chemical analyses made of the samples (See Table 3), almost all of the soils in the district are deficient in organic matter, total nitrogen, and available potassium and phosphorus. The Piuray soils contain large amounts of calcium carbonates which limit their potential as agricultural soils. The only sample which was high in available potassium was taken from a permanently cultivated garden plot belonging to the Central School; fertilizers had been applied to this plot. The only well-drained soil with a high organic matter content was sampled at 3860 meters elevation. At that elevation organic matter decomposition is comparatively slow.

Soils Limitations

The majority of the series have at least one seriously limiting characteristic which relegates them to the category of marginally productive agricultural soils. Only the Chinchero series is comparatively free of seriously limiting factors such as excessive slope gradient, poor structure, marked acidity or alkalinity, poor drainage, shallowness and low moisture retention, or erosion, one or more of which characterize to some degree the rest of the soils series.

Some of these limitations have been partially corrected by good soil management. Excessive slope has been remedied by terracing over large areas; this in turn has deepened the soils and checked erosion. Undesirable stones have been removed where practicable. The tilth of some soils has

been improved through continuous cultivation, made possible by irrigation. However, such serious defects as poor drainage, acidity, alkalinity, low fertility levels, and poor structure have not been corrected by traditional soil management techniques.

Table 3. Results of chemical analysis of nineteen soil samples of the Chinchero area.

Sample No.*	Series** (symbol)	Organic Matter(%)	Total N (%)	pH	Available K_2O (kg./Ha.)	Available P_2O_5 (kg./Ha.)	$CaCO_3$ (%)
1.	Yn	2.52	0.12	6.9	145	17.25	0.27
2.	Yn	2.82	0.14	7.6	140	23.00	2.02
3.	Yn	3.56	0.17	5.4	130	28.75	0.13
8.	Yn	1.71	0.08	6.4	130	13.00	0.00
10.	Yn	2.18	0.11	5.8	100	11.50	0.00
16.	Yn	3.73	0.18	4.7	145	34.50	0.00
17.	Yn	2.28	0.11	5.8	100	35.00	0.00
18.	Yn	1.54	0.07	5.7	90	17.00	0.00
20.	Cu	1.34	0.06	7.1	135	17.25	0.00
19.	Mah	1.54	0.07	8.0	130	17.25	4.75
4.	Pi	8.67	0.43	7.9	148	46.00	33.00
5.	Pi	5.37	0.26	6.1	138	57.50	0.14
6.	Pi	4.53	0.22	8.4	288	28.70	70.50
11.	Pi	4.20	0.21	8.3	90	12.00	0.13
12.	Pi	4.57	0.22	8.1	90	23.00	35.82
13.	Po	6.42	0.32	6.9	95	17.25	0.12
14.	Po	1.95	0.09	7.0	143	22.50	0.00
21.	Ch	2.42	0.12	7.5	392	52.00	0.00
15.	Li	7.12	0.35	5.4	140	23.00	0.00

* The locations of soil samples with their respective numbers appear on the soil map.

** The symbols used in the table are the same as those used on the soil map.

CHAPTER VI

CULTURAL AND INSTITUTIONAL FACTORS

Of the several cultural factors bearing upon land use in the district, only present agrarian technology, or land use practices, was studied. Soil, crop, and animal husbandry and range management were investigated. Within the realm of institutional factors, tenure, tenancy types, and property size and distribution were investigated.

The information obtained concerning these cultural and institutional factors was then considered in context with the natural environment in order to arrive at a classification of agricultural land use types. These land use types were then mapped in order to graphically show present land use patterns in the district.

Land Use Practices

Land use practices in Chinchero were geared to a subsistence level of living. They were adjusted, furthermore, to the several limitations imposed by the natural environment upon those traditional agricultural techniques which the inhabitants knew and were able to apply. Certain techniques were probably modified to accomodate the introduced Old World crops and animals, however, most practices were essentially traditional and pre-colonial in origin. Relatively small areas were farmed on a commercial basis by larger landholders or administrators; here more modern farming methods were employed.

Soil Management

The greatest extent of the agricultural soils in the district were rotated within a pattern of several years of cropping followed by a

period of fallow, during which time natural grass becomes established and the fallowed tracts are utilized as pasturage.

Initial ground-breaking after a period of fallow was accomplished with the traditional foot plow (chaquitaclla in Quechua, tirapié in Spanish). The foot plow is a spade-like instrument with a long handle and an iron point above which there is a foot rest. The user throws the full weight of his body onto the handle and the foot rest and breaks out a piece of sod. Several men using foot plows usually work in unison in a crew calles a masa. They are helped by women or men called rapadores who invert the pieces of sod and place them on strips of intact land left between the broken ground. A masa of two footplowers and one rapador can work one-half a topo* in one day; with another footplower and another rapador, three-quarters of a topo can be plowed in one day.

This manner of plowing has the effect of creating a double layer of topsoil with the grass and organic matter more or less concentrated at half the depth of the raised row (Fig. 11). A field prepared in this way is actually only half plowed and consists of built-up rows of sod about 18 inches wide separated by furrows about 12 inches wide and 12 inches deep. The furrows usually ran down-hill on sloping lands (Fig. 26).

Sod-breaking is done four to six months prior to planting non-irrigated potatoes, invariably the first crop after a period of fallow. The potatoes are planted in the built up rows. After harvesting the potatoes, the soil is somewhat looser; when the tubers are dug up earth is pushed into what formerly were the furrows. The next year's crop, some other endemic tuber, is then planted in the filled-up furrows.

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* One topo in the Cuzco area measures 80 by 40 meters or the equivalent of 0.32 hectares (0.8 acres).

In the third year, barley, wheat or rye is sown. By this time the soil is loose enough to permit the use of an oxen-drawn wooden plow. The soil is plowed until all the clods are broken. Hand-wielded wooden mallets called ccasunas are used to break up the larger clods.

After the third year's crop is harvested the ground is usually left in fallow. By the time it is ready to be cropped again, a fairly compact sod cover has developed which necessitates the use of the sharp-pointed foot plow once again to break ground. Where soils are continuously cultivated, oxen-drawn wooden plows are used exclusively.

Fertilization was practiced to a limited extent. Available manure, principally sheep dung, was applied and cooking fire ashes were scattered on the soil. Cattle dung was observed to be used principally as fuel. About fifty of the comuneros had taken advantage of the supervised agricultural credit program and they supplemented manure with chemical fertilizers. Both chemical and organic fertilizers were applied mainly to continuously cultivated plots where natural soil fertility is not restored by fallowing. On the basis of the soils analyses (Table 3) insufficient fertilizer is used and the practice of fallowing in itself is apparently not sufficient to raise fertility levels*.

Where soils were irrigated, tilth was better, partly because these areas were cultivated continuously. Water was conducted by ditches from springs or streams and irrigation was accomplished by flooding. The system by which the irrigation water was apportioned was not determined.

The most conspicuous feature of soil management was terracing, a well-developed technique in pre-colonial times. Terraces were observed on nearly all land with more than 20 percent gradient. On steeper slopes,

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* The number of years soils had been fallowed where samples were taken was not determined.

terraces were not perfectly flat but had a curved profile, seen in cross-section, with a slight hollow near the bottom side of the terrace. This concave profile is a result of plowing the soil in down-hill rows, the plowing being initiated at the upper side of the terrace. The comuneros believe that down-hill rows and furrows are necessary to assure proper drainage, for tuber crops especially. This belief, based on experience, appears to be logical for most of the soils are poorly drained clays and there is a definite surplus of rainfall during much of the growing season.

Terrace walls consisted mainly of dirt banks on which grass and shrubby vegetation is allowed to grow. On very steep slopes, individual terraces may have up to 25 percent slope (Fig. 30). Were they to be entirely flat there would undoubtedly be a good deal of land slippage, despite the practice of leaving vegetation on terrace walls.

Near Pongobamba, and notably at Caparay, the terraces on 40 percent slopes gradients were more nearly flat, possibly owing to the availability of stones for constructing terrace walls. Also since these soils were irrigated, flatter terraces were needed to prevent erosion. Although the Incaic terraces below the church in the town of Chinchero were the most perfect examples of terracing in the area, cultivation was not permitted for they were protected as archeological remains and constituted a tourist attraction. Local anthropologists believe that these Incaic terraces were used for experimenting with plant selection*.

Crop Husbandry

Cold-resistant crops grown in pre-Colombian times continued to be

* This opinion was expressed by Dr. Manuel Chavez Ballón, of the University of Cuzco.

the mainstay of the district's agriculture. Potatoes (*Solanum andigenum*), ocas (*Oxalis tuberosa*), ullucos, or papa lisa (*Ullucus tuberosum*), and añe (*Tropaeolum tuberosum*) were endemic tubers grown as field and garden plot crops. About two hundred varieties of potatoes were recognized by the comuneros; perhaps thirty varieties were cultivated. Tarhui (*Lupinus mutabilis*), a domesticated lupine which produces bitter white seeds, was grown in garden plots and to a lesser extent as a field crop; it had been largely replaced by the Old World broad bean or haba (*Vicia faba*) as a field crop. Quinua (*Chenopodium quinua*), a highly nutritive, endemic amaranth, was also grown as a garden crop. The major cereal crops were barley (*Hordeum vulgare*) and oats (*Avena sativa*). Barley was raised as a food crop and oats were cultivated as a forage crop; oats were grown principally on irrigated plots and provide off-season forage. Lesser cereals grown were wheat (*Triticum sativum*) and rye (*Secale cereale*), both as food crops. Rye straw was used for thatching. Small areas at lower elevations were devoted to the cultivation of corn (*Zea mays*).

In Chinchero the upper altitudinal limits of tubers are at approximately 4000 meters and for cereals they are at about 3990 meters; the local varieties of maize cannot be grown above 3350 meters.

The approximate vegetative periods for some of the crops grown in the district are as follows:

Potatoes (irrigated).........	150 days
Potatoes (dry land farming)..	180 days
Ocas.........................	200 days
Barley.......................	210 days
Broad beans..................	240 days
Quinua.......................	240 days
Rye, oats; ullucos...........	270 days

The period of time between planting and harvesting was determined in part by the necessity of having to tend at least three different crops each season: potatoes, some other tuber, and a cereal. Activities were therefore staggered. Cereals and quinua might be left standing after maturing while tubers were harvested and new ground was plowed. Because oats invade barley fields, the barley crop might not be reaped until August; by that time the oat seed would be dry enough to fall to the ground if the plants were shaken, while the barley would remain intact. Thus, when the barley was threshed it would not become contaminated with oats.

Cereals were reaped by hand, threshed by trampling under cattle hooves, and winnowed. Grain was not milled but soaked and cooked to make porridge. In the last century there was a water-driven mill working at the outlet of Lake Piuray. The mill had been dismantled and the mill stone served as a bridge for one of the drainage ditches crossing Piuray Pampa.

Broad beans were cut in April or May and stacked up to dry. After thoroughly drying they were threshed with wooden flails and the beans were picked from the broken pods by hand; tarhui was processed in the same manner. Broad beans and corn were boiled and eaten whole, in a dish which is called mote.

Smaller potatoes were alternately dried and frozen to produce chuño, a dehydrated product which keeps without spoilage for five months or more. Seed potatoes were stored in a cool place out-of-doors with a cover of ichu grass (Stipa ichu)(Fig. 6).

Planting for dry land farming of tubers was done in the months of September and October, for grains in November and December. The small amount of corn produced in the district was planted in September under irrigation. Hilling the tubers, called lampa, was done twice in the growing season, about 45 to 75 days after planting. Wild mustard or

nabo (Brassica campestris) were seen to be growing abundantly in potato fields at harvest time, however.

The major climatic hazards were frosts, especially those occurring in February and March; November frosts damage irrigated crops. Hailstorms occasionally damaged developing plants by striking off the flowers or grain. Excessive rainfall damaged crops on poorly drained soils. In the 1961-1962 season tuber yields were low for this reason.

Plant pests were destructive in the district. Tubers are attacked by fungi, principally Phytopthora infestans. A fly larva (Premnotrypes solani) known as the gorgojo de los andes, attacks and strips the leaves of potato plants. A nematode of the genus Heterodora, which is parasitic on potato tubers, is especially damaging. Broad beans are attacked by a fungus which blackens the stalks. Barley and wheat are damaged by Ustilago hordeii, a fungus known locally as carbón. Very few of the agriculturalists used insecticides, fungicides or disinfected seed. Some of the comuneros had planted disinfected potato seed made available by the supervised agricultural credit program.

Typical yields produced by the comunero agriculturalists were as follows (after Yepez de la Rosa (41)):

Potatoes............	4000 to 5000 Kgs./Ha.
Ullucos.............	6000 Kgs./Ha.
Broad beans.........	800 " "
Barley..............	800 " "

CREAS estimates that when disinfected seed and fertilizer are used, yields of 14,000 Kgs./Ha. for potatoes and 1000 Kgs./Ha. for barley are possible.

Animal Husbandry

The animals raised in the district were: cattle, sheep, horses, llamas, burros, guinea pigs (cuyes), pigs and chickens. The guinea pigs and llamas

No special care was taken with respect to animal breeding, nutrition or sanitation. Cattle, horses, and sheep were kept in common corrals at night andwere put out to graze together. Except for oats, cereal straw and other crop wastes, the animals depended entirely upon natural forage.

Specific diseases afflicting animals were not determined. Sheep were described to die from what appears to be Enterotoxemia, a disease which causes sudden death of healthy, fat animals (20). They were also described as growing thin and dying. Several years ago almost all of the pigs in the district died in what apparently was an epidemic. Cattle suffered from tuberculosis and ticks were common on cattle and sheep.

The animals fulfilled specific functions within the subsistence economy. They were not raised on a commercial basis. Cattle were kept mainly for use as draft animals. When they were slaughtered it was primarily to obtain the hide for making rope; the meat was of secondary importance. Dairy products did not appear to be an important item in the diet of the comuneros. Cheese was made, however.

Llamas were used as beasts of burden as were horses and burros. Llamas had disappeared from the district except in the area east of Lake Piuray where there is access to high grazing areas. Pigs were raised for meat and lard and suckling pigs were slaughtered for special occasions such as religious holidays. One informant stated that before the aforementioned epidemic, Chinchero was one of the principal suckling pig producing areas for the Cuzco market.

Sheep were raised principally for their wool. Flocks usually included sheep with different colored wool. Native garments typically are of several different shades, however in Chinchero black is the dominant color in clothes.

When animals were slaughtered for their meat it was usually to celebrate some religious or other holiday (feast day). It should be noted that in the Sierra there are numerous holidays observed in the course of the year. During these holidays, or feast days, generous quantities of food and drink are consumed. In the Puno region 177 feast days are celebrated during the year (26). If this is any indication of the number celebrated in Chinchero, meat consumption may be higher than would be presumed. The exact number of feast days observed in Chinchero was not determined but informants stated that fewer holidays were celebrated than in the past.

Range Management

No evidence of pasture rotation or other techniques of grazing land management were apparent in the area. Permanent ranges were open to all stock however designated areas of open range correspond to the individual communities. In the western half of the district the communities of Yanacona and Ayllupongo had only fallowed fields, uncultivated flat plains or *pampas*, seasonal lakes, and scattered wet spots known as *huallares* which maintain green grass all year. If comuneros from Yanacona community wanted to graze their stock on the high permanent ranges to the east, they would need permission to do so from the communities that "own" these lands. On fallowed lands there was rotation, in a sense, because an individual comunero could graze his animals only on his particular plots of land.

During the dry months stock was grazed in the high ranges, on the *huallares*, and along the shores of seasonal lakes and ponds where rushes and algae provide forage. The rushes (totoras) and algae (llacho) are important forage sources. Chemical analyses of algae from Lake Titicaca, where they also are utilized as forage, show them to have percentages of mineral salts, proteins, and carbohydrates equal to or superior to those of alfalfa

(<u>Medicago</u> sp.). Alfalfa has higher oil and fiber content (24).

The pasture resources are insufficient in the district and overgrazing was apparent everywhere. In 1959, there were an estimated 9,500 sheep, 2000 cattle, 400 llamas (24), and perhaps a total of 500 horses and burros combined*. The animal population equalled roughly 3,800 animal units** in that year. The total grazed area of the district was measured as being 3,760 hectares; this figure is slightly exaggerated since some areas of permanent pasture fall above 3800 meters in elevation and are subject to scale distortion on the aerial photographs. The grazed area includes permanent ranges and one half of the cultivated land which is fallowed. There was thus approximately one hectare of pasture per animal unit. The average carrying capacity of the Sierra ranges is placed at two hectares per animal unit (24). Tosi, however, considers that in the Sub-alpine altitudinal belt optimum density is twelve hectares per animal unit (35, p. 130); parts of the district's permanently grazed pastures lie within the Sub-alpine zone. The total grazed area in Chinchero was therefore carrying somewhat more than double its capacity in 1959 and the proportion had probably not changed significantly in 1961.

It must be remembered that maximum use is made of crop wastes. Prior to harvesting tubers, all the animals except pigs are allowed into the fields to eat the plant tops. After harvesting the pigs and other animals are again put into the fields to scavenge for unpicked tubers. After grain harvests the stubble is grazed and the chaff and straw are saved for forage. Nothing is wasted.

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* Author's estimate of the horse and burro population.

**One animal unit is considered to equal one cow, five to six sheep, or two llamas.

Thus by supplementing natural forage with cultivated forage and crop wastes, the comuneros manage to maintain their animals. Nevertheless, some individuals had to resort to grazing their animals on hacienda lands with an exchange of pay or labor.

Tenure and Tenancy Types

Ford states that there are two basic types of land ownership in Peru. One type stems from the communal Indian society; the other stems from the individualistic society of the Spaniard (7). Examples of both existed in Chinchero, namely the privately owned haciendas and the Indian community lands. The dependency of the Indians on land for subsistence and the dependency of private land-owners on Indian labor had given rise to various forms of land tenure arrangements.

Five major categories of tenure types in Peru are identified by Ford (7):

1. Non-operating owners
2. Owner-operators
3. Non-owner operators
4. Farm laborers
5. Comuneros

Variations of each of these major types were found in Chinchero.

Non-operating owners

One type of non-operating owner is the religious institution. In Chinchero a monastic order, the Merceds, owns Hacienda Huaypo Grande. The order had never operated the hacienda; it was leased to an administrator who managed it.

Of a similar tenure status was the local parish in Chinchero which

out to the comuneros to help defray the parish's normal operating expenses. These lands, called mayordomías, were distributed throughout the Indian communities and were worked by comuneros called mayordomos, a term which also refers to hacienda overseers.

The mayordomo was appointed by the parish or elected by the comuneros for a period of eight years. During this time he cultivated his mayordomía and was expected to pay the costs of religious ceremonies entailed in the celebration of a certain saint's day. He also had to work one day a week for the parish and give a number of animals, usually sheep, to the parish every year.

The mayordomías, also known as saint's lands, were distributed throughout the several Indian communities as follows:

Ayllupongo	18	mayordomías
Yanacona	8	"
Cuper	8	"
Umasbamba	8	"
Ccoricancha	4	"

The total amount of cultivated land corresponding to these lands was approximately 14 hectares. The parish had no apparent legal title to these lands on the Indian communities. There has been a tendency in some land-scarce communities in the Sierra to demand the return of such lands to the comuneros (16) but in Chinchero such a move had not been made.

Owner-operators

In this category are included the private landowners who own the few small haciendas in the southern portion of the district. They managed their own farms but did not reside on them, leaving the day to day tasks in charge of an overseer, or mayordomo.

Non-owner operators

The administrator of Hacienda Huaypo Grande falls in this category. He administered the cultivation of a relatively small part of the hacienda, which corresponded to the most productive soils, and allowed the remainder to be cultivated by Indian tenant farmers. He seemed to manage the hacienda with a great deal of freedom and he was apparently not expected to raise or maintain high production on the greater part of the hacienda lands. The comuneros who cultivated the mayordomías also fall in this category.

Some of the comuneros entered into sharecropping arrangements with the tenant farmers of Hacienda Huaypo Grande and the other smaller haciendas. They paid for working part of the tenant's usufruct with half of the crop they produced. These comuneros are known as *piqueros*.

Farm laborers

The most common arrangement for paying farm laborers on haciendas is in land usufruct. The Indian tenant farmers on Hacienda Huaypo Grande were therefore actually farm laborers, known variously as *colonos*, *arrendatarios*, or *arrendiris*. On Hacienda Huaypo Grande the arrangement was that each colono must work a number of days each week on lands cultivated by the hacienda administrator. A token wage of 0.50 soles per day was paid (approximately US$0.02). In order to fulfill his work obligation and be able to work his usufruct, the colono had to resort to the same method of recruiting labor. He allowed sub-tenants known as *allegados* to farm part of his usufruct. The allegados then worked in the colono's place for the administrator. A colono could make an arrangement whereby he sent six men in one day, for instance, or one man a day for six days. Labor obligations incurred on the colonos' usufructs varied but were not less than six man-days per week.

The colonos also made arrangements with piqueros as mentioned above.

In 1961, there were 51 colonos, 200 allegados and an undetermined number of piqueros cultivating land on Hacienda Huaypo Grande, according to the hacienda overseer. Some of these colonos had "inherited" the privilege of working on the hacienda from their fathers. Most were former comuneros who no longer had sufficient land to cultivate in their communities. These people came from Chinchero and neighboring districts; about half were originally from Chinchero communities.

A colono who was interviewed on Hacienda Huaypo Grande shared an usufruct with another colono. The total work obligation was eight days per week. The interviewee's share amounted to 30 topos (almost 10 hectares) of non-irrigated land. Of this amount five topos were worked by five piqueros. The piqueros also helped the colono farm part of his usufruct as well as fulfill the labor obligation to the hacienda administrator. These associates of the colono were actually combination allegado-piqueros. The interviewee said that there was no difference between a piquero and an allegado. The interviewee identified himself as being from Huila Huila in Chinchero although he no longer had land in the community. He mentioned that his father had been a colono on Hacienda Huaypo Grande also, but on a different usufruct.

Comuneros

Comuneros are members of Indian communities. In Chinchero the comuneros still referred to their communities as ayllus. Under the classical ayllu system, the community lands were held in common and the families were assigned plots on the basis of family size. Rowe considers this to have had the purpose of affording equal opportunity and perhaps of regulating land rotation (28).

Today in Chinchero the Indian communities' agricultural lands are no longer commonly owned or equitably distributed. For all practical purposes

the land is privately owned by the individual comuneros. Apparently the land changes ownership only through the death of a comunero; he then wills his land to his wife, sons or daughters. No cases of comuneros trading or selling their lands were discovered. Under this inheritance system the land no longer corresponds to family size and some comuneros have more than twice the amount of land as others. Also cases occur in which a comunero may have land in two communities as a result of inter-community marriage.

However, some vestiges of the Inca ayllu system did remain. Communal land rotation patterns were followed (to be discussed in the section of land use patterns), permanent pastures were grazed communally, and reciprocal work patterns were practiced.

Two forms of reciprocal work arrangements existed; the _aine_ and the _minga_. Under the _aine_ arrangement personal services are lent with the expectation that they will be returned. This applies to plowing fields for example. _Minga_ is the mass lending of services to aid an individual in a specific task, such as making adobes, building a house, or planting. Those who work are asked to do so by the receiver and he provides them liberally with coca, _chicha_, a fermented drink made from corn, alcohol and food so that they will work "willingly". The receiver is expected to work under the same conditions at the request of his fellow comuneros.

For legal purposes the Indian communities are defined as "collective juridical persons under private law, constituted by the association of individuals linked together by the tradition of their uses and customs and by the common possession of lands"*. This is the definition given in Article I of the Statute of Indian Communities of Peru, promulgated by

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* Author's translation.

decree in June, 1961. In the case of Chinchero the reference to the common possession of lands applies only to the community as a whole.

According to the aforementioned 1961 statute, the official recognition of Indian communities is obligatory. In 1962, Yanacona community was working to fulfill the requisites, which include the election of a governing council, the taking of a census, and the mapping of the community lands. The communities of Umasbamba and Cuper had been inscribed with the government's Bureau of Indian Affairs of the Ministry of Labor since the late 1920's.

Whether legally inscribed and recognized or not, the Indian communities are protected by law. Law 8120 of 1935 states that Indian communities cannot rent or cede their lands to individuals not belonging to the community, e.g. private landowners. Article 210 of the 1933 Constitution states that Indian communities are not obliged to pay taxes.

Property Size, Fragmentation, and Distribution

Little data was available on property size and fragmentation. Although the 1962 agricultural census was designed to obtain this information, no results had been made public at the time of writing. Due to the long history of land disputes between Indian communities and private landholders and recent moves toward agrarian reform, the subject of property size was an extremely delicate one to be broached in conversations with either private landowners or comuneros.

For interviewing purposes property size was not asked, rather the length of time necessary to plow a piece of land was determined. The amount of land that could be worked in a unit of time with a wooden plow or foot plow had been determined. Average farm size was determined by making areal measurements. Data on property size, fragmentation and

fragment sizes were obtained from the applications of a number of CREAS creditors.

Average farm size

According to areal measurements, the average amount of cultivated land per comunero family was five hectares. This figure represents the total amount of all types of cultivated land in the Indian communities divided by 1100, the number of average size families (4.8 persons per family) for the entire Indian communtiy population, as of 1961.

Except in the case of Yanacona community, ratios could not be determined for the individual communities as the boundaries were only approximately located. The average number of cultivated hectares per Yanacona community family was 6.7; the Yanacona comuneros were considered to have more land than any other community.

On Hacienda Huaypo Grande 32.46 hectares per family was calculated. This did not include the 40 hectares that the hacienda administrator claimed to cultivate. Thus the figure calculated corresponds to the average amount of land available to the families who resided on the hacienda lands worked by the different categories of tenants.

The average amount of cultivated land per comunero family was more than double the amount calculated for the average southern Sierra small landholder, who is principally the Indian community dweller (22). In Yanacona community it was almost triple the average amount.

The average amount of cultivated land per resident tenant family on Hacienda Huaypo Grande seems inordinately high, even if the allegados and piqueros are taken into account. The amount would be even greater if the average were calculated with 51, the number of colono families given by the hacienda overseer, instead of 122, the number of families in residence according to the 1961 census.

The calculated figure for Hacienda Huaypo Grande may be inaccurate for several reasons. The administrator may have been cultivating more than the 40 hectares he claimed to work, there may have been more colonos than mentioned by the overseer or inferred from the census data, or the total permanently grazed area on the hacienda may be larger than was determined by aerial photo interpretation. A ground check of the entire hacienda was not made. The probable explanation is that the administrator was cultivating more than 40 hectares and he may have allowed large tracts to lie fallow.

Property size of seventeen CREAS creditors

The information contained on the applications for supervised agricultural credit included data on total property size, number of fragments, and the size of the fragments. Seventeen applications made between 1957 and 1961 were selected. Eight applicants were from Ayllupongo, three were from Umasbamba, five from Yanacona, and one was from Cuper. The applications were selected at random but an attempt was made to obtain applications from as many different communities as possible.

Statistical interpretation of the data was not feasible inasmuch as it was doubtful that all of the land owned by the applicants was disclosed. Also since the land is theoretically evaluated as collateral* the applicant may not have wanted to inscribe his entire holding. The sample also cannot be considered representative because those comuneros who applied for credit may have had larger or smaller properties than the average. Nevertheless, the data obtained is useful in indicating property size and degree of fragmentation. Fragment sizes are accurate for they were checked in the field by CREAS technicians.

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* According to the previously cited laws, this would be legally unsound.

Of the seventeen applicants only one listed a total property of more than 4.0 hectares. Twelve had 2.0 hectares or less and four had between 2.0 and 3.0 hectares. Farm units had an average of seven fragments. The smallest number of fragments was three; the largest number was thirteen. The farm units distributed by number of fragments are as follows:

Number of Fragments	Number of Farm Units
3 to 4	10
5 to 6	1
7 to 8	1
9 to 10	1
11 to 12	4
13	1

Those farms with the most fragments had a greater total area than those with fewer fragments. Farm units with eight fragments or more averaged 2.6 hectares in total size; farms with three to six fragments averaged 1.2 hectares in total size.

Fragments of individual farm units varied in size from 0.05 to 1.00 hectare. The total number of fragments of the seventeen farm units distributed by size follows:

Size of Fragment (in hectares)	Number	Size of Fragment (in hectares)	Number
0.05	2	0.6	-
0.1	41	0.7	1
0.2	30	0.8	1
0.3	19	0.9	3
0.4	11	1.0	2
0.5	6		

One of the applicants was interviewed. According to the data obtained in the interview, his holdings amounted to 2.89 hectares which were divided

into nine different fragments of non-irrigated land. He also owned a small plot of irrigated early potato land and rented 0.32 of a hectare from Hacienda Huaypo Grande. His application indicated that he possessed a total of 2.9 hectares divided into eleven fragments; no rented land or irrigated land was inscribed.

Another interviewee who was not a CREAS creditor owned a total of 3.0 hectares within Ayllupongo community which was divided into 19 fragments. His wife's father, who was from Cuper community, had just died and willed her a total of 4.0 hectares in seven different fragments. The interviewee was thus the owner or operator of 7.0 hectares divided into 25 fragments distributed in two communities!

The distribution of fragments of individual farm units is related to the land rotation system. Community lands which are not irrigated are divided into rotation sectors. Each comunero has at least one fragment in each of the rotation sectors of his community, provided he has inherited land in all the sectors. Thus the number of fragments of non-irrigated plots owned by a comunero is roughly equal to the number of rotation sectors in his community. In addition the comuneros usually have one or two parcels of irrigated land and a garden plot. This aspect is discussed in detail in the next section on land use patterns.

Aerial photographic interpretation of field sizes

Measurements of individual fields were made on aerial photographs. Field sizes on Indian community lands measured in this manner were from 0.12 to 0.16 hectare on the average. These were fields in dry land farming areas. Fields at the edge of Lake Piuray on the silty phase of the Piuray soils series had less total size and were longer and narrower, the long axis being at right angles to the lake shore. Apparent field sizes measured corresponded closely to the most frequent sizes of fragments of

Land Use Patterns

The land use patterns in Chinchero represent the spatial distribution of different types of land use and reflect the inter-relationships between technological levels, the natural environment, tenure types, social structure, and economic factors.

On the basis of the factors studied affecting land use, namely: the natural environment, tenure types, property size and distribution, and land use practices, a classification of present land use was developed within the classification framework of the International Geographic Union World Land Use Classification (11). The only major modification of the IGU classification was the division of cropland categories into irrigated and non-irrigated sub-categories.

Two major land use types exist in Chinchero: cropland and grazing land. Cropland can be reduced to two sub-types: irrigated cropland and non-irrigated cropland. Non-irrigated cropland accounts for the greatest extent of cultivated land in the district. On this sub-type the dominant aspect of land use is land and crop rotation. Variations are determined by tenure.

Each type of land use discussed below will include a reference to the corresponding symbol appearing on the land use map (Plate 6). A summary of the classification appears at the end of the discussion.

Settlements and Associated Non-Agricultural Lands

This type of land use could possibly refer to the town of Chinchero but as all of the townspeople maintain house garden plots which are irrigated, the town has been mapped as cropland.

Horticulture

Although horticultural land use has not been mapped in Chinchero, it is mentioned here to avoid confusion with other classifications of land use types. According to the IGU classification, wherever vegetables

are grown in rotation with ordinary farm crops, the area should be recorded as cropland. Because garden plots in Chinchero were used for both field and secondary crops, these plots have been recorded as cropland in Chinchero.

Tree Plantations (Symbol 3)

Two small plantations of eucalyptus have recently been established near the hydroelectric plant in Ccorimarca Draw. Trees planted around dwellings occupy a much greater total area but have not been mapped.

Continual and Rotational Cropping with Irrigation

Early potatoes (symbol 4a). Certain areas of the irrigated Indian community lands are dedicated solely to the production of early potatoes or maway in Quechua. These area produce one crop in November and sometimes a second crop in March. Maway lands are extremely productive in comparison to the other agricultural lands. They are the most intensively cultivated soils in the district and most of the available fertilizer is applied to these soils.

Perhaps the best maway lands are in Caparay, a well-terraced colluvial fan just east of Pongobamba. Its northeast exposure and proximity to the lake favor Caparay with one of the warmest micro-climates in the district.

Corn (symbol 4b). The cultivation of corn in Chinchero is limited to irrigated areas below 3550 or 3600 meters in elevation and this crop therefore occupies a very reduced area. At the bottom of Urquillos canyon about eight topos of corn were cultivated every year on terraced alluvial soils. The parish farmed four topos and the community of Cuper the other four. In Ccorimarca Draw the colonos of haciendas Huaypo Grande and Tamboraccay raised corn and early potatoes on small plots of irrigated land. Corn planted at higher elevations (above 3500 meters) in this region appeared very stunted.

Mixed field and garden crops (symbol 4c). Virtually all of the comuneros had irrigated plots that were continuously cultivated. These were usually located nearby the houses. Such plots were scattered throughout the town of Chinchero and other population centers. These plots were not managed according to community-oriented rotation patterns and were called canchones, a term which connotes the independent manner in which they are cultivated. Lesser crops such as tarhui, quinua, and onions were mixed with broad beans and other field crops (Fig. 5). Early potatoes can be grown on these irrigated canchones also. Both barley and oats may be cultivated to provide green forage during the dry months.

Continual and Rotational Cropping without Irrigation

Potatoes-broad beans-oats rotation (symbol 5a). In Yanacona community the silty alkaline soils along the margins of the flat plain are progressively being brought under cultivation by individual comuneros. Here individual plots were managed as canchones. On Piuray Pampa, west of

Lake Piuray, similar soils appeared to have been cultivated for many years and communal land rotation practices had developed. Due to bad drainage and susceptibility to frosts characterizing these structural depressions, the only crops that can be produced are potatoes, broad beans, and oats, which were rotated in that order in both areas. Potato yields were below average and excessive rainfall at times destroyed whole crops. Furrows dug in preparation for planting potatoes must be extra deep and calcareous lacustrine mud is brought to the surface in places as a result.

Land Rotation with Irrigation

Potatoes-broad beans-unimproved pasture rotation (symbol 6a). The calcareous clays washed down from the mature upland slopes northeast of Lake Huaypo were cultivated by the administrator of Hacienda Huaypo Grande. The rotation cycle was: first year, potatoes; second year, broad beans; one to two years of fallow. These soils were cultivated with machinery.

Mixed field and garden crops (symbol 6b). Irrigated lands were rotated near Pongobamba on the fluvio-glacial sediments. The land was cropped two years and fallowed four. Crops were mixed: potatoes, oats, tarhui, broad beans, and, where drainage is better near the foothills, ocas. During the fallowed years these lands maintain green grass all year on the flatter soils toward the lake.

Land Rotation without Irrigation

Cereals-unimproved pasture rotation (symbol 7a). On the undulating slopes north of Lake Huaypo and east of Chequerecc, the administrator of Hacienda Huaypo Grande cultivated barley and, to a lesser extent, wheat. The land was cropped every other year and fallowed in the interim.

Tubers-unimproved pasture rotation (symbol 7b). Community lands above 3900 meters were planted only in potatoes. Exact rotation cycles were not determined, however it appeared that these areas were fallowed six or more years after producing one crop. On Anta Quilca ridge this type of land was reserved for those comuneros from Cuper community who did not have sufficient land to plant in any one year. According to aerial photographic interpretation, Umasbamba and Taucca also possessed land cultivated in the manner above 3900 meters.

Field crops-unimproved pasture rotation (symbol 7c). The colonos who farmed hacienda lands practiced a sort of land rotation on their land usufructs. On Hacienda Huaypo Grande, the colonos cropped one half of their usufruct one year and the other half the following year. Thus one half of the usufruct was fallowed every year. Field crops produced were the same as those produced in the Indian communities, but the greatest extent of land appeared to be devoted to potato production. Few springs exist on land usufructs on Hacienda Huaypo Grande. In places, however, the colonos had dammed up arroyos to trap run-off during the rainy months. This water was later used to irrigate planted fields at the start of the growing season when rainfall may be insufficient.

Potatoes-ullucos/ocas/ane-barley/wheat/rye-unimproved pasture rotation (symbol 7d). In the Indian communities, crops and land on non-irrigated areas were rotated on a set pattern. A three year cropping cycle was used: first year, potatoes; second year, some other tuber (ullucos, ocas, añe); third year, cereals (barley, wheat, or rye; sometimes broad beans). The cropping cycle could be extended a year and broad beans cultivated after cereals; this was done in Ccoricancha community. After being cropped an area was fallowed for a period of three to seven years or more.

Non-irrigated lands were divided into rotation sectors called muyuiy in Quechua and turna or suerte in Spanish. Every community member had land in each sector and the several communities each had six or more sectors. When the sectors were cultivated only one type of crop was planted. Each sector produced consecutively, potatoes, some other tuber, and cereals, according to the aforementioned cropping cycle. All of these crops were harvested each season and for this to be possible, the sectors entered into the three-year cropping cycle on a staggered schedule.

If there are a total of six sectors in a community, three will be producing and three will be lying fallow in any given year. Where there are ten sectors, three will be producing and seven will be lying fallow. Each sector has a name and the rotation patterns are known to all of the comuneros and have been established by tradition. A schematic presentation of land and crop rotation patterns in Cuper community, where there were seven sectors, appears in Table 4.

The different sectors had approximately the same land quality. A sector would usually occupy a hillside or a sloping area with more or less homogenous characteristics. The different sectors varied in size from community to community but within the communities they were approximately even-sized.

In order for this system to work, each comunero must have at least one plot of land in each sector. The more sectors there are, the more fragmented will be the individual farm units. If a comunero does not have land in all the sectors, there will be years in which he will not be able to produce all three crops and he may have to work on an hacienda to compensate for this lack. As has been mentioned, the comuneros of Cuper community who lacked land in any one year could plant potatoes on Anta Quilca ridge. As a rule, when a comunero wills land to his heirs, he divides it up so that each heir will have a piece of land in each sector.

The number of rotation sectors in the different communities in Chinchero was:

Ayllupongo	6	sectors
Cuper	7	"
Yanacona	8	"
Ayarmarca	7	"
Ccoricancha	12	"
Umasbamba	?	
Taucca	?	

The comuneros knew where each of their plots were in the different sectors and boundaries were maintained. At plowing time all of the comuneros accomplished this task at the same time, especially on gently sloping non-terraced lands, where boundaries are kept only by plowing furrows at angles to those of adjacent plots. If a comunero plowed his plot late, he might find that his neighbor had plowed into his plot.

Table 4. Land and crop rotation patterns in Cuper Community; 1960-1966

Sector No.	1960	1961	1962	1963	1964	1965	1966
1.	Potatoes	Other tuber	Cereal	-*	-	-	-
2.	Other tuber	Cereal	-	-	-	-	Potatoes
3.	Cereal	-	-	-	-	Potatoes	Other tuber
4.	-	-	-	-	Potatoes	Other tuber	Cereal
5.	-	-	-	Potatoes	Other tuber	Cereal	-
6.	-	-	Potatoes	Other tuber	Cereal	-	-
7.	-	Potatoes	Other tuber	Cereal	-	-	-

* Hyphen indicates fallowed year.

When the sectors were fallowed, stock grazed on the regenerating grass. Grazing activities of a comunero's animals were strictly limited to his particular plot, although in practice the animals could not be confined to a small piece of land without hedgerows or some other barrier.

Unimproved Grazing Land

Principally grass (symbol 8a). These lands take in the high valleys and ridges to the east and north of the district. Fallowed agricultural lands were also included as were the permanent grazing areas on the Yanacona-Olonis plain. Fallowed agricultural lands have been mapped as cropland, however all those cropland types falling under the sub-categories of land rotation are periodically grazed.

Grass only on humid soils (symbol 8b). Despite the small total area occupied by this grazing land type, it is important because during the dry season it maintains green grass. Such areas are called huallares.

Grass with shrub vegetation (symbol 8c). This type of grazing land applies to the very steep lower slopes of Anta Quilca ridge. Here land is so steep that animals have difficulty grazing.

Marshy areas (symbol 8d). The principal seasonal lakes are included in this sub-category. The importance of these areas, known as totorales, during the dry season has been pointed out, especially with respect to the value of algae as forage.

Summary of the Land Use Classification

1. Settlements and Associated Non-agricultural Lands. - No application in Chinchinero due to the importance of garden plots.

2. Horticulture - No application.

3. Tree Plantations - Eucalyptus plantations.

CROPLAND

4. Continual and Rotational Cropping with Irrigation.

   4a. Early potatoes (maway)

   4b. Corn

   4c. Mixed field and garden crops

5. <u>Continual and Rotational Cropping without Irrigation</u>

5a. Potatoes - broad beans - oats rotation (canchón)	- poorly drained flat soils on old lake bed plains.

6. <u>Land Rotation with Irrigation</u>

6a. Potatoes - broad beans - unimproved pasture rotation	- cropped two years, fallowed one or two years
6b. Mixed field and garden crops	- irrigated areas near Pongobamba.

7. <u>Land Rotation without Irrigation</u>

7a. Cereals - unimproved pasture rotation	- chiefly barley; cropped one year, fallowed one year.
7b. Tubers - unimproved pasture rotation	- Community lands above 3900 meters. Cropped one year, fallowed six or more years.
7c. Field crops - unimproved pasture rotation	- hacienda lands worked by colonos.
7d. Potatoes - ulluco/ocas/ane - cereals - unimproved pasture rotation	- cropped three years, fallowed three or more years. Indian community rotation sectors.

<u>GRAZING LAND</u>

8. <u>Unimproved Grazing Land</u>

8a. Principally grass	- mountainous ridges, high valleys, fallowed fields, uncultivated flat plains.

8b.	Grass only; on humid soils	- <u>huallares</u>
8c.	Grass with shrub vegetation	- Urquillos Canyon and lower slopes of Anta Quilca ridge.
8d.	Marshy areas	- <u>totorales</u>

CHAPTER VII

SYNTHESIS AND DISCUSSION OF RELATIONSHIPS

Natural Environment

A distinction should be made between those factors of the environment which are alterable and those which are unalterable. Factors of climate, geology and topography are essentially unalterable and place ultimate limitations on land use at any technological and economic level. Alterable factors as those of soils and vegetation can be modified by man's occupation of the land as has been the case in Chinchero and probably throughout the Peruvian Sierra in similar areas.

Unalterable Factors

The low, year-round temperatures of the district impose severe limitations on agricultural production. Even with irrigation, specific crops adapted to the cold environment of this altitudinal belt are very limited in number and character. As defined by Tosi (32), the greatest extent of the district's lands lie within the Tropical Montane Moist Forest life zone. Here crops are restricted to cold resistant species and varieties which tolerate low nighttime temperatures and generally low thermal efficiency, in particular, small grains and tubers. Seasonal changes also act as a limiting factor in all crop production, although to a lesser extent. From July to September moisture deficits and freezing nighttime temperatures combine to prohibit field crop production. Because range capacity is also affected by these adverse seasonal changes, part of the crop production must be diverted to supplementary feeding of livestock during the dry, cold months.

The geologic and topographic conditions on the mountainous ridges make it impossible for weathering and soil formation to keep pace with

erosional processes. However, where rocks are softer and parent materials have been produced, despite steep slope, colluvial soils may be terraced and cultivated. In a different manner topography alone limits crop production wherever it causes cold air to drain into closed structural depressions making them susceptible to nighttime frosts. This is the case in the Yanacona-Olonis plain. Crop production on that site is also limited by poor soil drainage and alkalinity.

The availability of water is another factor placing certain limitations on crop production. Irrigated lands can be planted earlier and can produce forage crops all year. Providing they receive applications of fertilizers, they can be cultivated continuously. It is erroneous to conclude that irrigation alone permits continuous cultivation. In Chinchero it happens that those soils which are irrigated have, relatively, the greatest capacity for sustained production. These soils are principally colluvial or alluvial soils whose physical and chemical characteristics are superior to the greater part of the district's soils. They require fertilizer to maintain their productivity, however, and not all irrigated soils are continuously cultivated, probably due to the scarcity of fertilizer. Soils formed over parent materials by normal weathering processes (e.g. Yanacona series) also would require frequent additions of fertilizers if continuously cultivated, whether irrigated or not.

The reduced capacity of the area's soils for sustained cultivation is related to slow weathering processes as influenced by low temperatures. The soils lose their natural fertility fairly rapidly and require a number of years of fallow after cropping to recuperate. The availability of nitrogen, one of the most important plant nutrients, is related to the rate of organic matter decomposition, which is pregressively slower as elevations increase. At 3900 meters, for instance, the soils can be

cropped only once and then must be fallowed for six or more years. Overgrazing on fallowed fields acts to reduce the amount of organic matter available for mineralization and nitrification.

Cold temperatures and other climatic conditions place no apparent limitations on animal reproduction in the district. The necessity for warm woolen garments influences the choice of animals however and almost every comunero has some sheep.

Alterable factors

Soils and natural vegetation have undergone drastic changes in Chinchero. The original forest vegetation has been removed principally because most of the district's soils are capable of agricultural production. The removal of the natural vegetation together with overgrazing has had the effect of depriving the top soil of additions of organic matter. This has reduced total nitrogen content, diminished aggregate structure, tilth and permeability, and reduced field capacity. The most disastrous result has been the increase in the rate of geologic erosion which, in moderately sloping to steeply sloping areas, is fast under normal circumstances due to the rejuvenation of the erosion cycle as a consequence of regional uplift. Erosion of all types has washed away much of the area's soils. Terracing has compensated to a certain degree, the harmful effects of deforestation, but this has been a measure motivated principally by the scarcity of agricultural land, rather than the conscious desire to control erosion.

Resource management

Landownership and tenure are associated with resource management as related to conservation. Steeply sloping hacienda lands seldom have terraces and in some places have been eroded so severely that they are no longer productive. These areas on the haciendas are usually worked by the

colonos who do not conserve them as they would their own community lands. A striking example of this can be seen on the steep slopes of a side canyon which opens into Ccorimarca Draw. On one side of the canyon the slopes are cultivated by the comuneros from Ayarmarca who have worked the soil completely into terraces. On the other side of the canyon, on the lands of a hacienda, the steep slopes are practically converted into barrens since they have been cultivated without being terraced.

Another notable difference with respect to resource management as related to ownership is the occurrence of eucalyptus plantings. Every comunero has a few eucalyptus trees around his house. On Hacienda Huaypo Grande the absence of eucalyptus is conspicuous; the other smaller haciendas have few trees except for a small plantation recently established on one.

About the Indian settlements even native trees and shrubs have been preserved despite the fact that animal manure must be used for fuel.

Land Use Patterns; Origins and Relationships

The factors of the natural environment discussed above exert certain universal and straightforward influences on land use patterns and practices. Locally crop types are restricted to specific zones related to the altitudinal influences on thermal efficiency. Thus only potatoes can be cultivated above 3900 meters and the production of corn is negligible in the district. Chinchero is fortunate, however, in that much of its total area is characterized by undulating topography at elevations low enough to permit the production of small grains as well as tubers. At these elevations (3650 to 3750 meters) land use practices and patterns are influenced locally by such environmental conditions as the availability

of irrigation water, topographic conditions which increase frost incidence, and impeded surface run-off. However, over the greatest extent of the cultivated area in the district land use patterns are influenced mainly by the reduced capacity of the soils for sustained production as a result of climate. Different agricultural methods were employed as an adaption to this circumstance and as a result different land use patterns exist. Hence certain modifications in land use patterns related more directly to agrarian technology which was in turn related to tenure types.

The most outstanding feature of land use in the district was the practice of crop and land rotation on non-irrigated community lands. This practice probably originated prior to the political reign of the Incas and is likely one of the oldest agricultural practices in the Sierra.

The reasons for fallowing land for relatively long periods have been discussed; they relate to natural soil fertility. The practice of fallowing land was doubtless influential in developing the foot plow. The foot plow is essentially a ground-breaking instrument designed to penetrate sod. Its use is not necessary on loose, continuously cultivated soils. It was probably designed and perfected to fulfill the function of penetrating and breaking out sod which had developed over fallowed soils.

The practice of crop rotation, as distinguished from land rotation, seems to have originated from the relationship between certain endemic parasites and crops cultivated in the Andean area. In the case of tuber crops, in particular potatoes, continuous single-cropping favors the propagation and spread of the worm Heterodora which contaminates the soil with its larva-filled cysts. The only technique known to the early agriculturalists was to change to another crop and/or fallow the land and cultivate in another area until contamination had diminished. Today in Chinchero a second crop is planted after potatoes, usually one of the

other native tubers; these were described as not susceptible to attack from pests. After a third crop, which is now grain but in pre-Colombian times was probably quinua or tarhui, the soil had be to fallowed.

The necessity for fallowing combined with the danger of crop loss to parasites living in the soil, evidently led to the practice of having several fields located in different areas. Thus one field could always be producing while the others were lying fallow. This method of controlling parasites and allowing the soil to regain natural fertility obviously functions more effectively on Indian community lands when practiced communally, thereby localizing in one area contaminated ground and avoiding the danger of wide-spread contamination of agricultural soils. The origin of communal rotation sectors probably dates to the Incaic period when ayllu lands were communally owned and assigned each year according to family size. The location of the rotation sectors was probably determined by a central authority who planned the rotation schedules of the various sectors so as to initiate cropping on sectors distant from those where potatoes had just been harvested. Today in Chinchero potatoes are not planted adjacent to sectors where potatoes have just been harvested, although the rotation schedules are now followed according to tradition.

Since the majority of the present day comuneros do not have access to sufficient fertilizer or to insecticides or fungicides, the principles on which land and crop rotation were developed still apply. Although communal landownership no longer exists, the practices pertaining to communal land and crop rotation schedules and rotation sectors have been continued. Traditional work patterns such as the aine, as it applies to plowing and planting activities, are more conveniently followed since all the comuneros perform the same task in the same area. This inter-

relationship serves to reinforce both these vestiges of traditional communal agriculture and is no doubt fundamental to their retention.

The continuation of communal land and crop rotation practices is the principal cause of fragmentation and wide-spread distribution of individual properties. With the disappearance of communal landownership and the adoption of the Spanish inheritance system, property size is no longer equitable and fragmentation has been increased. Intercommunity marriages act to make this situation more acute.

Communal land and crop rotation is practiced throughout the Southern Sierra in Indian communities. Mishkin describes crop and land rotation practices similar to those in Chinchero as being common throughout the Department of Cuzco (16), although he makes no mention of rotation sectors. Brief mentions are made of rotation sectors in a PRDSP report (22). They are referred to as suertes in the Sicuani area where elevations are from 3750 meters to 3950 meters and the sectors are cultivated two years and fallowed four. Similar patterns are practiced in the Lake Titicaca region. At Llave sectors are called aynoca, an Aymara term, and the crop rotation cycle is potatoes, quinua, barley (for grain), barley (for forage), and three years of fallow (27). Tschopik mentions that in one village in the Aymara region, the rotation schedule is dictated by the headman of the village (36).

On haciendas agricultural practices differ from community practices only on those lands cultivated in cash crops by the administrators or the owner-operators. The colonos work their lands much in the same way as they would in the Indian communities but are not bound to keep crop and land rotation schedules.

Inasmuch as the colonos pay for their usufructs with labor, they have no obligation to raise production levels or commercialize farming

techniques. They employ labor-intensive methods and usually do not receive the best agricultural lands. A colono would find it difficult to pay for his usufruct in cash or in kind. As long as the pay is labor, however, the arrangement operates in favor of the continuation of a subsistence type of agriculture and to the disfavor of more productive cash crop farming.

Man-land Ratio and Food Needs

In all the Indian communities in Chinchero there was a total of 9,040 hectares of land. Of this total, 5,678 hectares were cultivated, 851 hectares of which were continuously cultivated, the remainder corresponding to rotation sector land. The average size comunero family thus had a total of 5.0 hectares of cultivated land. Of this amount, approximately 0.75 hectare was continuously cultivated, irrigated or non-irrigated, and the remaining 4.25 hectares was distributed in the various rotation sectors.

It appeared that more rotation sector land was fallowed than was cultivated. Of the 4.25 hectares, a total of 1.60 hectares was estimated to be under cultivation in any one year, the remainder being in fallow. The total amount of land being cultivated by a comunero in a year was thus 2.35 hectares, part of which was planted in forage crops. The question arises as to whether this average amount of land is sufficient to provide the food needs of an average size family of 4.8 persons. An approximate answer can be given by utilizing the Standard Nutritional Unit (SNU) proposed by Stamp (30) and comparing it to average production on community lands in terms of food value.

The SNU represents the annual per capita nutritional calory needs of "people of north-western European or of American height and weight and age composition" (30, p. 125), which Stamp considers to be 2,460 per day per person. By comparison, a PRDSP report on nutrition (25) places the per capita daily calory needs of inhabitants of Southern Peru (all-age average) at 2,300 calories. Adult Indian males in Puno were considered to require 2,700 calories per day. Stamp's SNU thus was considered to be sufficiently accurate to permit its application to the rough calculations presented below.

In order to utilize the SNU, typical yields of the different non-irrigated field crops usually produced every year were converted to SNU values per hectare and these values were compared to the average amount of land planted in the different crops. In rotation sectors three typical field crops (potatoes, ullucos, and barley) were considered to occupy equal area of the 1.60 hectares not in fallow. Of the continuously cultivated land, one-third was estimated to be planted in forage, and a weighted mean for broad beans, quinua, and potatoes was calculated for the SNU value of the remaining 0.50 hectare which is planted in mixed field and garden crops on this type of land (See Table 5).

Typical per hectare yields used were the same as those listed in the section on crop husbandry. Quinua was estimated to produce 800 kilograms per hectare. The calorific values of the different crops were taken from the above-mentioned PRDSP report on nutrition (24). The calculations made of consumable calories per crop yield allowed for approximately thirty percent loss due to spoilage, damage from pests, and frost damage.

According to the calculations made, a comunero produces food crops having a total calory value equal to 4.4 SNU, or sufficient food to provide the yearly calory needs of 4.4 persons. Average food production is

therefore insufficient, in terms of calory needs, for the average size family of 4.8 persons. It will be appreciated, however, that the calculations represent average values only and estimated values were of necessity used. Furthermore, the probability of higher yields on irrigated lands or more fertile soils was not taken into account. Yield estimates, however, were considered to be somewhat above average rather than minimum. The possibility also exists that meat, egg, milk, and cheese consumption is on a scale sufficient to compensate for indicated calory deficiencies. Nevertheless it appears that food production is somewhat less than, and at best just equal to, the calory needs for the average size family.

Table 5. Crop production on an average size Indian community farm unit converted into Standard Nutritional Units (SNU).

Crop	SNU per hectare (typical yields)	Amount of land planted (in Has.)	Production in SNU
Barley	1.70	0.53	0.90
Ullucos	2.25	0.53	1.19
Potatoes	2.50	0.53	1.32
Broad beans, Quinua, Potatoes	2.00*	0.50	1.00
		2.09	4.41

* The weighted mean.

Maximum population in the Indian communities has evidently been reached and somewhat surpassed, relative to the amount of food the comuneros

are able to produce. The present average of 5.0 hectares per family probably is a little less than the minimum amount required for an adequate subsistence existence using present agricultural techniques. Maximum population in Indian communities was probably attained at some time during the last twenty years, and perhaps before, as is indicated, in part, by the very low demographic growth rate between 1940 and 1961. Pressure on the land is also evidenced by the cultivation of virtually any soil that can produce a crop, regardless of the labor necessary to make it productive.

The animal population is also excessive in the district. The grazing lands belonging to the Indian communities support twice the number of animals that the average Sierra range is able to support. The result has been overgrazing and deterioration in range quality. This circumstance is of less consequence to food production than the unfavorable man-cultivated land ratio because animals do not seem to contribute much to the diet of the comuneros. Overgrazing on fallowed agricultural soils, however, results in less organic matter returned to the soils and increased erosion danger, thus nullifying to a certain degree the benefits of fallowing. Also a small part of the harvest must be used as forage.

Institutions Influencing Agricultural Development

Although the role of institutions in the agriculture of the district was not studied as an objective of this investigation, several observations should be made concerning the more pertinent aspects which were apparent.

The supervised agricultural credit program in Chinchero, CREAS, is directly involved in improving agricultural production in the Indian communities. As of 1962, only improved varieties of potato seed had been made available to the comuneros; these were disinfected and CREAS obliged the comuneros to purchase fertilizers as part of their loan. CREAS made one-year loans calculated on the basis of the total worth of the farm and the anticipated net income from the coming harvest. The number of borrowers from the Indian communities varied a good deal from year to year, but averaged around fifty farmers, out of a total of around 1100 Indian farmers.

CREAS was not an extension service and it had played a passive role in the dissemination of knowledge and techniques for increasing agricultural production. The technicians generally felt that the comuneros were very reticent and even reactionary to improved agricultural methods and the more intensive cultivation of the community lands. They stated that it was more rewarding to work with large landholders or hacienda administrators.

The agency which was directly involved in agricultural extension, the Agricultural Research and Development Service (SIPA), had not done any extension work in Chinchero nor was any contemplated, to the author's knowledge.

An institution which may possibly function actively as an extension agency in Chinchero is the Southern Peru Brewing Company in Cuzco, locally called the Companía Cervecera. This company has been supplying malting barley seed and supervising its cultivation in the Department of Cuzco for the last seven years. The company contracted farmers, delivered the seed, loaned threshing machines, and even made soil analyses to determine fertilizer needs. In 1961, the company's agronomists experimented with several

varieties of cold-resistant malt barley in Chinchero and obtained encouraging results. Since the company's principal problem was obtaining sufficient barley, it is likely that work will be done in Chinchero to stimulate the commercial production of this crop.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The physical environment in Chinchero places the following limitations on present agricultural production: low thermal efficiency, occasionally excessive rainfall, limited capacity of soils for sustained production without fertilization, very steep slopes over large areas (about two-thirds of the district), considerable areas susceptible to night frosts due to poor air drainage (about 500 hectares), and occasional frosts which occur over the entire district during the growing season.

2. The entire agricultural land use complex in Indian communities ultimately centers around the adaptations to environmental conditions evolved in response to the necessities of the subsistence way of life. These adaptations take the form of agricultural practices which are performed on both individual and communal levels and they constitute the basis for a relatively stable agricultural society. Land use practices on community rotation sectors are a cultural adaptation to the ecological relationship of the endemic parasitic worm, <u>Heterodora</u>, and its host plant, the potato, as well as the fairly rapid exhaustion and slow recuperation of natural soil fertility. The communal land and crop rotation practices which evolved in response to these conditions are now traditional and continue to be functional. Thus the adoption of private landownership in Indian communities has not modified land and crop rotation patterns and as a consequence the phenomena of property fragmentation and wide-spread distribution, as a result of inheritance patterns, have come about. Also the retention of land rotation sectors undoubtedly has a reciprocal fortifying relationship with traditional work patterns, namely the <u>aine</u> and

the minga. It can be justifiably concluded that the agricultural way of life followed in the Indian communities is essentially a case of environmental determinism.

3. On haciendas the tenure system of paying for farm labor with land usufruct is detrimental to the conservation and improvement of soils and to the development of more intensive and more productive agriculture. Also on the largest hacienda in the district, the tenancy arrangement between the administrator and the owner does not appear to be conducive to the realization of the agricultural potential of all of the hacienda lands, as is evidenced by the tenancy arrangements the administrator makes with the colonos.

4. The Indian community lands are slightly over-populated in terms of present agricultural production techniques. Average food production barely provides a subsistence level of living for the average comunero family. Population pressure has not reached sufficient severity, however, to disrupt traditional patterns of agricultural production owing to the fact that out-migration has apparently drained off some of the excess population. This might also be considered an indication of the rigidity of established production patterns. The animal population in the district is also excessive relative to the range carrying capacity. Consequently part of the agricultural production must be devoted to forage crops.

5. Land use patterns in the district are related to all of the factors studied, however in the order of their importance they are: a) climatic conditions as they affect plant life, b) local variations in topography and soils, c) availability of irrigation water, and d) tenure types, whose variations geographically coincide with variations in agricultural techniques.

Recommendations

Admittedly the agricultural production in the Indian communities could be raised by applying known technology. This measure, however, implies the development of commercial farming and the production of a cash crop surplus. The economic feasibility of raising production on this basis is confronted by serious problems.

In that the agricultural techniques and production methods used in the Indian communities are an integral part of a way of life which has developed over centuries in harmony with the natural environment, it does not appear recommendable that methods should be introduced which would radically modify established production techniques without first preparing the ground for a smooth transition. The replacement of traditional production methods with modern ones will have repercussions on the whole social and cultural complex and such a development will have to be geared to the capacity for social and cultural change in the Indian communities*.

Thus, consolidation of farm units in the near future is not recommended nor do methods of intensive cultivation appear to be recommendable if these are contrary to communal land and crop rotation practices. Such measures would upset or alter those communal aspects of agriculture

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* Social and cultural change in rural Quechua communities has been dealt with by investigators working in connection with the Cornell-Peru Project in Vicos and other communities in the Callejón de Huaylas (29, 31). Alers-Montalvo's recent study on this same theme (1) in Pucará is directed to both the scientific investigator and the change agent. It should be noted that agriculture in both Pucará and the Callejón de Huaylas is carried out for the most part in a slightly warmer ecologic zone (the Lower Montane altitudinal belt) and production patterns are somewhat different from those in Chinchero for that reason.

which appear favorable to the development of commercial cooperatives and would be accomplished with extreme difficulty at any rate due to the very definite ideas the Indian comuneros have of private landownership, on the one hand, and the rigidity of communal production patterns on the other hand, which apparently do not permit individual non-conformity.

The implication here is that labor-saving production techniques are virtually an impossibility on community lands until the comuneros are well enough acquainted with cash crop farming concepts to consent to necessary changes. In any case, labor-intensive methods are inevitable over the greater extent of the community lands, for they are steeply sloping and terraced. As the author sees it, labor-intensive techniques will have to be continued and incorporated into the early stages of any scheme designed to promote commercial farming.

The concept of private landownership, which can be presumed to be harmonious with the concept of individual gain, together with the existence of communal production methods seem to offer good possibilities for commercial cooperative agriculture. The danger exists, however, that cash crop farming, if successful on an individual basis, may bring about the disintegration of those traditional aspects of agricultural production whose retention and incorporation into cooperative agriculture are desirable.

In light of the aforementioned considerations, the following recommendations for further study can be made:

1. Means for assuring the retention of traditional agricultural production methods considered to be desirable and in keeping with commercial production methods should be studied. Social and cultural patterns in Indian communities should be studied with an eye to their positive influences on improved agricultural land use.

2. The economic possibilities of raising agricultural production in conjunction with cash crop farming on small plots using labor-intensive techniques should be thoroughly investigated.

3. Research on the possibilities of eventually developing commercial cooperative agriculture which would incorporate existing communal production methods should be conducted.

4. Traditional soil and crop management techniques should be studied in order to determine their scientific bases prior to the introduction of techniques which would basically alter these traditional practices. The ecologic validity of land rotation to combat soil parasites is a case in point. Another practice which possibly is scientifically sound is that of allowing wild mustard (Brassica campestris) to invade potato fields. Researchers have found that mustard roots excrete oils which counteract the stimulating effects of potato roots on the hatching out of Heterodora cysts (40).

5. Ways should be investigated for commercializing the district's animal production so as to permit a more rational and productive utilization of animal products as well as pasture resources.

With regards to the realization of the natural resource potential in the district, especially on the Indian community lands, certain recommendations are subject to the aforementioned considerations. Thus the implementation of means for improving the soils by such means as fertilization and different conservation techniques, where established production methods are followed would have to be tempered to the same social and economic conditions which influence means for increasing agricultural production. Not all of the resources fall within areas of traditional production patterns, however, and certain recommendations can be considered which would not be unduly complicated by existing patterns.

1. The possibilities of introducing marketable species of fish in Lake Piuray should be studied. At the present time, this body of water is not fished even for home consumption. Fish could possibly be sold on the Cuzco market.

2. The possibilities for reforestation of some of the area's soils should be considered. The very steeply sloping Lithosols on the north side of the Urquillos Canyon are not useful for cultivation and have limited value as grazing land. The presence of scattered bushes and low trees indicates their potential for supporting some forest regrowth. Species that could be established on these soils are *Alnus jorullensis*, *Eucalyptus* spp., and a number of native trees such as Chachacuma (*Escallonia* sp.) and Quishuar (*Buddleia* sp.).

Reforestation of the treeless mountainous ridges presents certain difficulties. Transplanted seedlings would have to be watered and protected from grazing animals. This would require the employment of several men full-time. The transporting of water for irrigation is especially problematical. Certain drought resistant native species could probably be established but they would also need protection from grazing animals. The value of these trees as marketable lumber is low. Except for eucalyptus, there is no fast-growing species which could be raised as a lucrative tree crop. To date no eucalyptus have been planted on these slopes, or on similar slopes in the region, but with proper care and watering they could probably be made to grow. Eucalyptus, however, would not grow as fast on the higher elevation lithosolic slopes as they do on the deep soils at lower elevations in the district.

3. The economic feasibility of converting the permanently grazed calcareous clays on the Yanacona-Olonis plain to cropland should be investigated. A possible crop for presently uncultivated areas on this plain

The recommendations presented concern only the Indian community lands and the areas within the private haciendas are excluded. Although some of the recommendations might apply to hacienda lands, the present systems of land tenure and tenancy impose a special set of conditions, all of which were not studied in the present investigation. Inasmuch as changes in production methods on hacienda lands imply changes in tenure arrangements, and these changes in turn would have repercussions on the general socio-economic complex of the region, the matter of increasing production on hacienda lands has not been analyzed. It is the author's considered opinion, however, that in light of the recent political trends in the southern Peruvian Sierra, the eradication of undesirable social and economic conditions associated with present tenure systems on haciendas ought to take priority in the near future over programs aimed at bettering conditions in the relatively stable Indian communities.

SUMMARY

Background

Reacting to the conditions of social and economic underdevelopment characterizing the rural regions of the Peruvian Sierra, the Peruvian government and several specialized international agencies have in recent years attempted to find ways of making this sector of Peru a more productive part of the national economic and social life. One program working on this problem is the Peru-Cornell Experimental Program in Applied Linguistics, being carried out jointly by the Peruvian Ministry of Education and the University of Cornell's Division of Modern Languages. The objectives of this program are to develop effective methods of teaching Spanish, the official language, to Quechua-speaking Indians, in order to make possible the transmission of cultural and technical knowledge requisite for ultimately ameliorating the social and economic conditions of the rural Sierra Indians.

The district of Chinchero was selected as the linguistic program's first experimental center and prior to initiating the program's activities, a series of basic environmental and socio-economic studies were undertaken, of which the investigation reported was one.

The problem of the investigation

In order to determine the manner in which the Indian inhabitants of Chinchero have adapted themselves to their environment and in order to provide tools for planning the eventual better utilization of the human and physical resources of the area, the natural environment and certain cultural and institutional factors affecting land use were investigated.

Field data collected between March and August of 1962 was obtained by means of direct field observations, informal conversations, and a number of qualitative type interviews. Aspects of the natural environ-

ment were incorporated into maps of geology, soils, landform and slope classes; a reference map was constructed from field observations of certain cultural and physical characteristics. Data on land use practices and tenure was synthesized for classifying and mapping land use types. Principal mapping materials used were 1:20,000 aerial photomozaics and individual 1:14,000 aerial photographs which provided stereoscopic coverage of the study area. All the data obtained was analyzed factorially and then synthesized to discover relationships and patterns.

Major findings of the investigation

Zonal climatic conditions typical of the Tropical Montane Moist Forest life zone exist in Chinchero. These conditions are: a slight annual moisture surplus relative to actual evapotranspiration, effectively dry and wet periods extending respectively for three and one half months and eight and one-half months, low thermal efficiency, freezing nighttime temperatures during the dry period, and occasional frosts during the wet period.

The vegetation, believed once to have been a low dense woodland, has virtually been totally removed. Consequent damaging effects on soils have resulted in a decrease in natural fertility and a partial deterioration of structure and texture. Erosion danger is high, even on moderate slopes, however terracing on Indian community lands has checked erosion over large areas. Almost all soils below 3900 meters are cultivated providing they are deep enough for shallow-rooted crops. In the Indian communities eucalyptus trees have been planted by almost all individuals near dwellings.

Agrarian techniques developed over centuries continue to be employed by the Indian agriculturalists in order to sustain a subsistence level existence. On community lands communal land and crop rotation

production methods are practiced in dry land farming areas. In such areas approximately one-half or more of the cultivated land is in pasture fallow in any one year. A nucleus of cold-resistant field crops are grown consisting mainly of small grains and tubers, most of which are endemic to the Andean region. Principal animals kept are cattle, for use as draft animals, and sheep, for their wool which is used for homespun garments.

Principal types of landownership in the district are private landholdings (haciendas) and Indian community lands. The latter are inalienable and protected by national law. The dependency of the private landholdings on Indian labor has brought about the arrangement of paying for land usufruct on haciendas with labor only. Indian community members hold the concept of private landownership and land changes hand by inheritance upon the owner's death.

Average property sizes in Indian communities as determined by comparing population figures to the measured amount of cultivated land are 5.0 hectares (approximately 12 acres), more than half of which are fallowed in any one year. Properties consist of seven or more fragments which vary in size but most frequently amount to 0.10 to 0.20 hectares (0.25 to 0.50 acres) and which roughly correspond in number and location to communal land rotation sectors.

The predominant feature of land use patterns in Indian communities is the existence of land and crop rotation sectors on non-irrigated lands. A three-year cropping cycle is followed by a three to seven or more year period of pasture fallow. This production pattern allows the soil to regain natural fertility and diminishes the risks of contamination of soil parasites affecting potato tubers.

Irrigated lands are continuously cultivated with some exceptions and certain non-irrigated plots are continuously planted in garden and

field crops. Continuously cultivated lands occupy only about one-tenth of the total cultivated area. All non-cultivated lands are permanently grazed except where too steep to be accessible.

Major conclusions

1. The physical environment places the following limitations on present agricultural production: low thermal efficiency, occasionally excessive rainfall, inability of soils to support continuous cultivation without fertilization, very steep slopes over large areas, considerable areas susceptible to night frosts due to poor air drainage, and occasional frosts during the growing season.

2. Land use patterns and practices in Indian communities center around adaptations to environmental conditions which have become deeply entrenched in agrarian technology and which have permeated the social and cultural characteristics of the agrarian way of life followed by the Indians.

3. Minifundium and property dispersal are a result of communal production methods and inheritance patterns.

4. Indian community lands are slightly over-populated in terms of present food production as indicated by consumable calories.

5. Land use patterns in the district are related to: a) climate, b) local variations in topography and soils, c) availability of irrigation water, and d) tenure types and agricultural techniques, whose variations coincide geographically.

Recommendations

The principal recommendations made were:

1. Desirable agricultural production methods presently employed in Indian communities should be retained and capitalized upon for

2. Programs aimed at raising production levels and intensifying cultivation of Indian community lands should be accomplished in the initial stages within existing patterns of property fragmentation and dispersal in order to retain those communal characteristics deemed favorable to the establishment of cooperative commercial agriculture.

Suggestions for Future Investigation

1. Economically feasible means for achieving commercial agricultural production should be studied which would incorporate labor-intensive methods and communal agricultural techniques.

2. Traditional soil and crop husbandry techniques in Indian communities should be studied to determine their scientific bases.

3. Social and cultural patterns and characteristics in Indian communities should be studied in their relation to proposals for introducing commercial agricultural production methods.

4. The possibilities of reforestation on presently uncultivated soils should be investigated.

5. The possibilities of converting certain areas of presently uncultivated soils on the Yanacona-Olonis plain into cropland should be studied.

6. The possible stocking of Lake Piuray with marketable species of fish should be investigated.

RESUMEN

Antecedentes

Reaccionando a las condiciones de subdesarrollo económico y social que caracterizan las regiones rurales de la Sierra peruana, el gobierno peruano y varias agencias internacionales especializadas han procurado en los últimos anos encontrar medios para convertir a este sector del país en una parte más productiva de la vida nacional económica y social. Un programa que está relacionado con estos esfuerzos es el Programa Experimental de Linguística Aplicada Perú-Cornell, que está llevando a cabo conjuntamente por el Ministerio de Educación peruano y la División de Lenguas Modernas de la Universidad de Cornell. Los objetivos del programa son desarrollar métodos efectivos para la ensenanza del español, la lengua oficial, para posibilitar la transmisión de conocimientos culturales y técnicos que son necesarios para el mejoramiento de las condiciones sociales y económicas del indio de la Sierra.

El distrito de Chinchero fué elegido para el primer centro experimental del programa linguístico y antes de iniciar las actividades del programa, se realizaron una serie de estudios básicos del medioambiente natural y de la situación socio-económica, de los cuales uno fué el presente estudio.

El problema de la investigación

Para determinar la manera en que se han adaptado los habitantes de Chinchero a su medioambiente y también para suministrar conocimientos básicos para la planificación de la mejor utilización de los recursos humanos y físicos del área, se investigaron ciertos factores culturales, institucionales y del medioambiente que afectan el uso de la tierra.

Se obtuvieron datos en el campo entre los meses de marzo y agosto

de 1962, valiéndose de observaciones empíricas, pláticas informales, y un número reducido de entrevistas con el objeto de obtener información qualitativa. Las características del medioambiente fueron incorporadas en mapas que cubren la geología, los suelos, las clases de pendientes de laderas y la configuración del terreno del area estudiada. Un mapa de referencia fué confeccionado a base de datos recolectados sobre ciertas características físicas y culturales. Fueron sintetizados los datos relacionados a prácticas del uso de la tierra y la tenencia a fin de clasificar los tipos del uso de la tierra y representar éstos en un mapa. Los principales materiales usados para la confección de estos mapas fueron foto-mosaícos a un escala de 1:20,000 y fotografías aéreas a una escala de 1:14,000. Estas posibilitaron un estudio estereoscópico del área estudiada. Todos los datos obtenidos fueron analizados individualmente y luego sintetizados a fin de encontrar interrelaciones y patrones generales.

Resultados principales de la investigación

En Chinchero existen condiciones climáticas típicas de la zona de vida Bosque Húmedo Montano Tropical. Estas condiciones son: un ligero sobrante anual de humedad con relación a la evapotranspiración real, períodos secos y húmedos que se extienden respectivamente por tres meses y medio y ocho meses y medio, bajas temperaturas, heladas nocturnas durante el período seco y heladas ocasionales durante el período húmedo.

La vegetación, que se cree ha sido en el pasado un bosque bajo semidenso, practicamente ha desaparecido bajo el impacto del hombre. Consecuentemente con ello efectos dañinos han dado como resultado una disminución de la fertilidad natural y una deterioración de la estructura y textura del suelo. El peligro de erosión es alto, aún en laderas de pendiente moderada, sin embargo terrazas construídas en tierras de

comunidades indígenas han controlado la erosión en grandes áreas. Casi todos los suelos a elevaciones menores de los 3900 metros son cultivados siempre que tengan una profundidad suficiente para cultivos de raíces superficiales. En sus comunidades casi todos los indígenas han plantado árboles de eucaliptos cerca de las habitaciones.

Técnicas agrícolas desarrolladas hace siglos son empleadas por los indígenas a fin de alcanzar un nivel de subsistencia. En terrenos de las comunidades indígenas bajo cultivo en secano se practica comunalmente una rotación de terrenos y cultivos. Aproximadamente una mitad o más de dichas áreas está en descanso en cualquier año. Las principales especies cultivadas son cereales de grano fino y tubérculos resistentes a los fríos, la mayor parte de los cuales son originarios de la región andina. La población animal está compuesta principalmente por ganado vacuno y ovinos; aquél es utilizado para labores agrícolas y los ovinos proveen lana para la ropa de los indígenas.

La posesión de la tierra está dividida en dos clases principales: haciendas privadas y conumidades indígenas. Estas son inalienables y protejidas por leyes nacionales. Hay una dependencia del propietario privado en la mano de obra indígena que ha creado el sistema de pago de arrendamiento con trabajo solamente. Los miembros de las comunidades indígenas tienen el concepto de propiedad privada dentro de la comunidad y las tierras cambian de dueño por herencia.

En las comunidades indígenas los tamaños promedios de las propiedades, determinados por comparar población con el área medida de terrenos cultivados, fueron 5.0 hectáreas (aproximadamente 12 acres) de las cuales un poco más de la mitad descansa en cualquier año. Estas propiedades tienen siete fragmentos o más que varían en tamaño pero por lo general son de 0.10 a 0.20 hectáreas en extensión. Corresponden

en número y localización con los sectores comunales de rotación de terrenos.

La característica más destacada del patrón de uso de la tierra en las comunidades indígenas es la existencia de sectores de rotación de terrenos y cultivos en áreas de cultivo en secano. Un período de tres años de cultivo es seguido por un período de tres a siete años de descanso. Este patrón de producción permite que los suelos recuperen su fertilidad natural y disminuye los riesgos de la contaminación de los suelos por parásitos que dañen los tubérculos de la papa.

Los terrenos bajo riego son cultivados continuamente con algunas excepciones y ciertos terrenos de cultivo en secano también se cultivan continuamente. Los terrenos continuamente cultivados ocupan solamente la décima parte de todo el área cultivada. Todo terreno que no se cultiva se utiliza para el pastoreo a menos que sea de pendiente demasiada inclinada.

Principales Conclusiones

1. El medioambiente físico impone las siguientes limitaciones a la producción agrícola actual: bajas temperaturas, incapacidad de los suelos para sostener una labor de cultivo contínuo sin la aplicación de fertilizantes, laderas de pendientes muy inclinadas sobre grandes áreas, áreas considerables susceptibles a heladas nocturnas debido al drenage deficiente del aire, y heladas ocasionales durante la estación de crecimiento de los cultivos.

2. Los patrones y prácticas del uso de la tierra en las comunidades indígenas tienen su orígen en adaptaciones a las condiciones medioambientales. Dichas adaptaciones son una parte importante de la tecnología agrícola y han interpenetrado en las características sociales y culturales

3. El minifundio y el esparcimiento de fragmentos de las propiedades en las comunidades indígenas son el resultado de los tradicionales métodos comunales de producción y el sistema de herencia.

4. Los terrenos de las comunidades indígenas están ligeramente sobrepoblados con relación a la actual producción de alimentos de acuerdo a su valor en calorías consumibles.

5. Los patrones del uso de la tierra en el distrito están relacionados con: a) clima, b) variaciones locales en topografía y suelos, c) disponibilidad de agua para riego, d) tipos de tenencia y técnicas agrícolas, los cuales coinciden geográficamente en sus variaciones.

Recomendaciones

Las principales recomendaciones son:

1. Los métodos de producción agrícola actualmente empleados en las comunidades indígenas que se estiman deseables deben de retenerse y aprovecharse para aumentar niveles de producción.

2. Programas con el fin de aumentar niveles de la producción como también intensificar la cultivación de terrenos de comunidades indígenas deben de realizarse en sus etapas iniciales dentro de los patrones existentes de la fragmentación y dispersión de propiedad, para retener aquellas características que se estimen favorables al establecimiento de agricultura comercial cooperativa.

Sugerencias para Futuras Investigaciones

1. Estudiar medios que son económicamente factibles para alcanzar una producción agrícola comercial que incorporen técnicas agrícolas comunales y que utilicen mano de obra intensiva.

2. Estudiar las técnicas tradicionales del manejo de cultivos y suelos en las comunidades indígenas para determinar sus fundamentos científicos.

3. Estudiar los patrones y características sociales y culturales en las comunidades indígenas con relación a propuestas de la introducción de agricultural comercial.

4. Investigar la posibilidad de reforestar suelos no cultivados.

5. Estudiar la posibilidad de hacer productivas ciertas áreas de la pampa Yanacona-Olonis que actualmente no se cultivan.

6. Estudiar la posibilidad de introducir en el lago Piuray especies de peces con valor comercial.

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APPENDIX

GLOSSARY

General

AINE or AYNE. (Qu.) An informal contract between individuals in Indian communities for the exchange of labor or services for agricultural or other tasks; mutual assistance.

ALLEGADO. (Sp.) A sub-tenant who pays for farming a part of a tenant's usufruct by helping him to fulfill his work obligation to the landlord.

ARRENDIRI. (Qu.) A quechuazation of Allegado; a tenant farmer.

ARRENDATARIO. (Sp.) A tenant farmer who pays for his usufruct in Chinchero by working a variable number of days per week on the lands farmed by his landlord or the administrator of the private farm.

CAMINO DE HERRADURA. (Sp.) A trail travelled by men and animals; usually not passable to vehicles.

CANCHON. (Sp.) A plot of agricultural land owned by an Indian community member, usually near the owner's dwelling, which is not farmed according to communal agricultural practices.

CARBON. (Sp.) A fungus, Ustilago hordeii, which is damaging to barley and wheat.

CCASUNA. (Qu.) A wooden mallet used for breaking up clods of earth in preparation for seeding.

CHAQUITACLLA. (Qu.) "Foot plow". A spade-like instrument used by Indian agriculturalists to break ground after periods of fallow; consists of a long wooden handle with a foot rest and an iron point.

CHICHA. (Qu.) A fermented beverage made from corn by the Indians.

CHUNO. (Qu.) Potatoes which have been alternately frozen and dried to produce a dehydrated product which preserves for four months or more.

COLECTIVO. (Sp.) A truck or car which carries people and goods for a fee.

COLONO. (Sp.) Resident tenant farmer.

COMUNERO. (Sp.) A member of an Indian community which has established boundaries around agricultural and grazing lands and whose members retain certain traditional social and cultural characteristics of communal life.

CUY. (Qu.) "Guinea pig"; kept in Indian dwellings and used as food on certain occasions.

GORGOJO DE LOS ANDES. (Sp.) A fly larva (Premnotrypes solani) which attacks and strips the leaves of potato plants.

HACIENDA. (Sp.) Any privately owned farm; in Chinchero these vary in size from 5000 hectares to 20 hectares.

HUALLAR. (Qu.) An area where there is sufficient soil moisture to maintain green grass all year.

LAMPA. (Qu.) The operation of hilling and weeding tubers.

LLACHO. (Qu.) Algae.

MASA. (Qu.) A group of three or four men who plow with foot plows.

MAWAY. (Qu.) A term which refers to early potatoes.

MAYORDOMO. (Sp.) The overseer of an hacienda or the rentor of parish agricultural lands within Indian communities.

MINGA. (Qu.) In the Indian communities, the mass lending of labor to an individual or for the realization of a community project.

MOTE. (Qu.) A dish of boiled whole corn and/or broad beans.

MUYUIY or MUYUY. (Qu.) A term referring to community dry land farming sectors which are fallowed after a period of cropping.

PAMPA. (Sp., Qu.?) Any area of relatively flat topography; variable in size from extensive plains to small flat areas on hillsides.

PARCIALIDAD. (Sp.) A neighborhood or cluster of houses within an Indian community.

PERSONERO. (Sp.) A popularly elected representative of an Indian community who protects the community's rights and privileges before the Bureau of Indian Affairs.

PIQUERO. (Sp.) A sub-tenant who pays for farming a piece of an Arrendatario's land with a portion of his crop.

RAPADOR. (Sp., Qu.?) Persons who work with a crew of footplowers and invert pieces of broken out sod onto strips of unplowed land.

TOPO. (Qu.) In the Cuzco region, a measurement of land 80 by 40 meters.

TOTORA. (Qu.) Rushes, usually a species of Juncus.

TOTORALES. (Qu.) A stand of rushes.

Common and Scientific Names of Plants in the Chinchero Area

ANE. (Qu.) Tropaeolum tuberosum; an endemic cultivated tuber.

CANTUTA. (Qu.) Cantu sp.; a red-flowering shrub of the Scrophulariaceae family found on hedge rows; used for firewood.

CHACHACUMA. (Qu.) Escallonia sp.; a native tree whose wood is preferred for making charcoal.

CH'ILCA. (Qu.) Baccharis sp.; a low shrub of the Compositae family, common along hedge rows; used for firewood.

HABA. (Sp.) Vicia faba; an introduced legume; broad bean or horse bean in English; cultivated as a field and garden plot crop.

ICHU. (Qu.) Stipa spp.; a needlegrass used for thatching and covering stored seed tubers.

KIKUYU. Pennisetum clandestinum; an introduced sod-forming grass endemic to Africa, found growing at elevations below 3700 meters, usually in areas of moist soils.

LLAULLI. (Qu.) Barnadesis sp.; a low thorny shrub found along hedge rows.

MOTUY. (Qu.) Cassia sp.; a leguminous shrub found along hedge rows.

OCA. (Qu.) Oxalis tuberosa; an endemic cultivated tuber.

PAPA LISA or LISA. (Sp.) Ullucus tuberosum; a cultivated endemic tuber.

QUEUNA. (Qu.) Polylepis sp.; a native tree of the Rosaceae family.

QUINUA. (Qu.) Chenopodium quinua; a cultivated amaranth native to the Andean zone; highly nutritive.

QUISCA. (Qu.) Berberis sp.; a hedge-forming low shrub, used for firewood.

QUISHUAR. (Qu.) Buddleia sp.; a native tree whose wood is used for construction and firewood.

SAUCE. (Qu.) Sambucus peruviana; a native tree used for firewood.

TARHUI. (Qu.) Lupinus mutabilis; a domesticated cultivated lupine endemic to the Andean zone whose white bitter seeds are eaten.

ULLUCO. (Qu.) Ullucus tuberosum; an endemic cultivated tuber; Papa lisa in Spanish.

COPY OF THE INTERVIEW QUESTIONNAIRE

Fecha ____________

1. Nombre del entrevistado ____________________________

2. Número personas en familia ______________

3. Comunidad __________________________

4. Animales

Clase	Número	Uso
vacas		
toros		
ovinos		
chanchos		
burros		
caballos		
cuyes		
llamas		
aves		

5. Métodos de cría ____

____

6. Dóndo pastorea animales? ____

____

7. Qué forraje usa? ____

8. Cuál es el mejor forraje? ____

9. Enfermedades de animales (clase de animal y enfermedad) ______________

____

____

10. Enfermedades de cultivos (clase de cultivo y enfermedad) _____________

____

____

11. Daños de cultivos causados por el clima: Heladas? __________

Cuándo? ___________. Granizo? _______________ Cuándo? ______________

Lluvias fuertes? __________________ Cuándo? ______________________

12. Qué combustibles usa? ____

13. Calendario Agrícola:

Cultivo	Sembrío	1a. Lampa	2a. Lampa	Cosecha
papas				
ullucos				
ocas				
cebada				
trigo				
habas				
avena				
quinua				
maiz				

14. Quién ayuda en labores agrícolas? ____________________________________

____

15. Usa fertilizantes? ______ Cuáles? ______________________________________

____

16. Qué hace para evitar erosión de los suelos? ___________________________

____

17. Ha plantado Eucalyptus? ____

18. Comentarios ____

____

____

____

____

19. Terrenos

a.	Tipo de terreno según manejo	Sectores de turna (muyuiy)	Maway	Canchon	Terrenos en hacienda
b.	Nombre del sector o parcela *				
c.	Cultivos producidos				
d.	Patrón de rotación del terreno				
e.	Riego o secano				
f.	Número de días necesarios para arar con yunta o masa				
g.	Tenencia (tipo)				
h.	Términos de arriendo				
i.	Extensión en hectáreas o topos				

* The names of the rotation sectors were learned for the communities in which the interviewees lived prior to the interview. The interviewee was thus asked if he had land in the various sectors as they were named off by the interviewer. This was the only way of assuring a complete inventory of the interviewee's lands.

Fig. 1 The town of Chinchero.

Fig. 2 An old Incaic road near Pongobamba.

Fig. 3 Buildings of the Central School in Chinchero; broad-beans growing in the foreground.

Fig. 4 Huita Puquio; Lake Piuray in background. Note barley and rye stacked for drying.

Fig. 5 A garden plot in Chinchero planted in quinua.

Fig. 6 Ichu (<u>Stipa ichu</u>) straw covering seed tubers.

Fig. 7 Left center, the town of Chinchero; middle center, eastern limit of Yanacona Pampa.

Fig. 8 A sink hole in region of limestone outcrops on dissected upland slopes, high level.

Fig. 9 An area of pasture fallow on dissected upland slopes, high level. Note weed, Astragulus garbancillo, has not been touched by grazing animals.

Fig. 10 Mature upland slopes, in foreground; Anta Quilca ridge in background showing glaciated topography.

Fig. 11 A field recently plowed with footplows. Note clipboard with 9- by 9 inch aerial photographs.

Fig. 12 A construction cut at Ccorimarca Draw showing deeply weathered shales over which mature upland slopes have developed.

Fig. 13 A view of the fluvio-glacial fan near Ch'uso. Note terracing near foothills and terraces at draw bottoms along the ridge.

Fig. 14 A gully cut in the fluvio-glacial sediments near Ayarmarca. Note size of figure at bottom of cut.

Fig. 15 A very stony phase of the Pongobamba series developed over the fluvio-glacial sediments; near Pongobamba.

Fig. 16 Puca Marca in the middle foreground; Pongobamba on the opposite shore on Lake Piuray with the Ccorcor ridge complex emerging to the left.

Fig. 17 A view showing several gullies cutting fluvio-glacial sediments.

Fig. 18 Pasture fallow on an irrigated plot; near Pongobamba.

Fig. 19 A view from the southern limits of the mature upland slopes looking toward Cachimayo.

Fig 20 Part of the old lake bed plain extending westward from Lake Piuray. Note white lacustrine sediments exposed by erosive action in the middle foreground.

Fig. 21 Severe gully erosion cutting headward into the mature upland slopes. Note fields plowed to the edge of the gully.

Fig. 22 Urquillos Canyon; Anta Quilca ridge rising to the right. The Vildanota Valley and Chicón Peak in the background.

Fig. 23 Looking across Urquillos Canyon from Antasacca Hill to Anta Quilca ridge. Note cacti along roadway.

Fig. 24 A communal rotation sector where potatoes are being harvested. Note vegetation left on terrace walls.

Fig. 25 A communal rotation sector planted in cereals above Puca Marca on high level, dissected upland slopes.

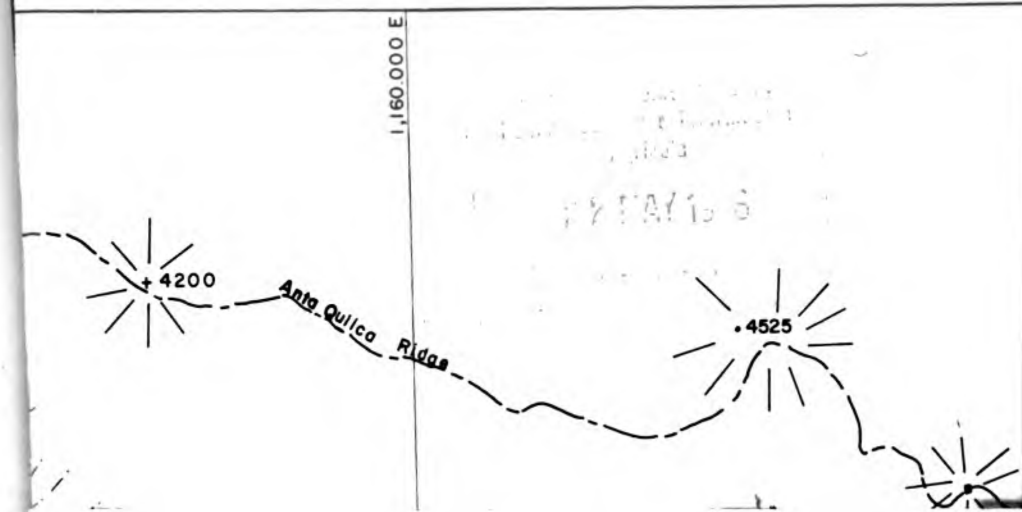
Fig. 26 A terraced area of the Cuper soils series. Note furrows running downhill.

Fig. 27 Permanently grazed Lithosols above Taucca at approximately 4000 meters.

Fig. 28 An area of limestone outcrops on the high level dissected upland slopes.

Fig. 29 Limestones outcropping on low level dissected upland slopes.

Fig. 30 An area of pasture fallow on a communal rotation sector. Note gradient of terraces in foreground.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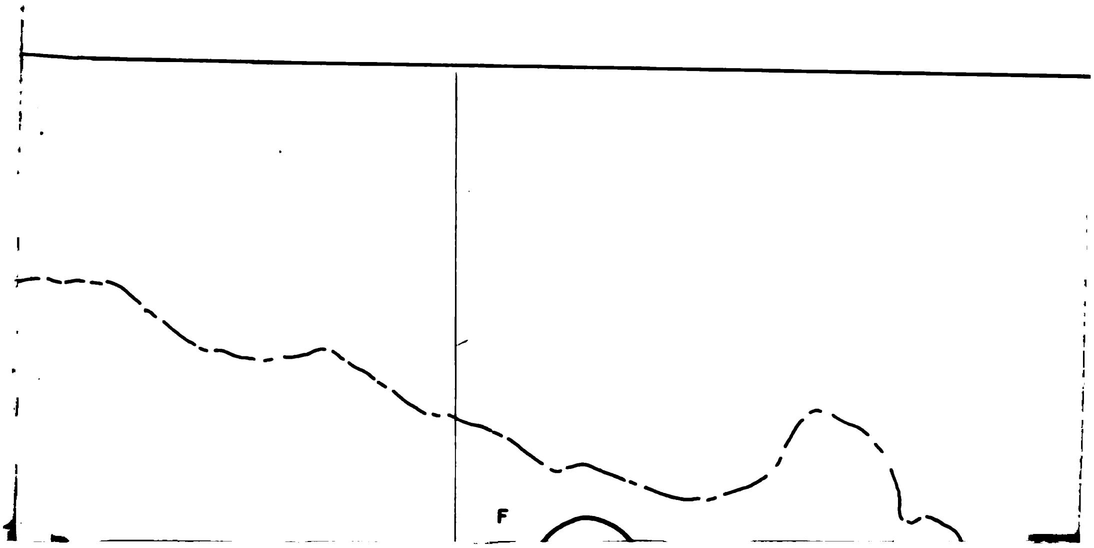
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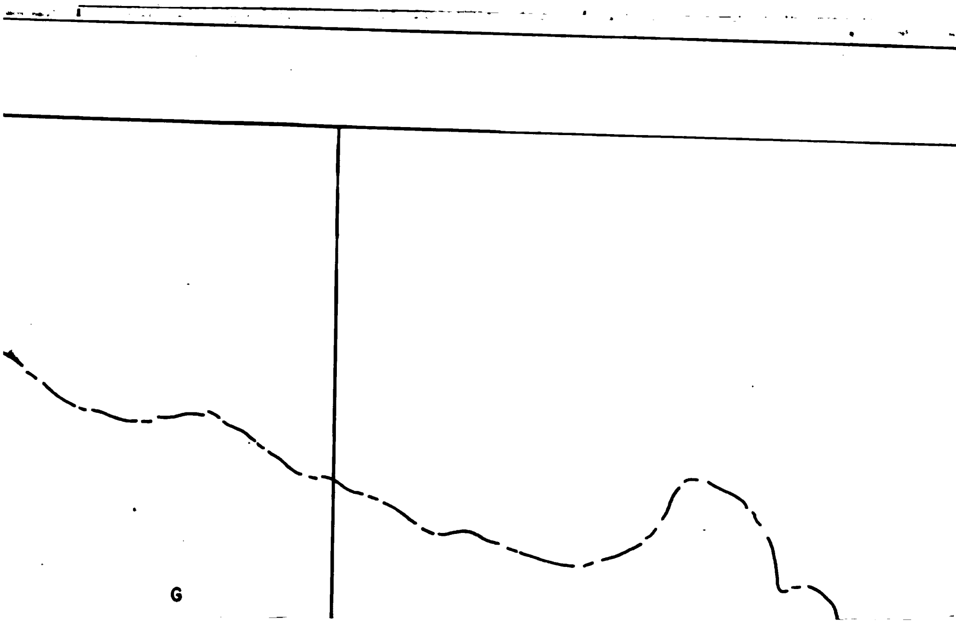
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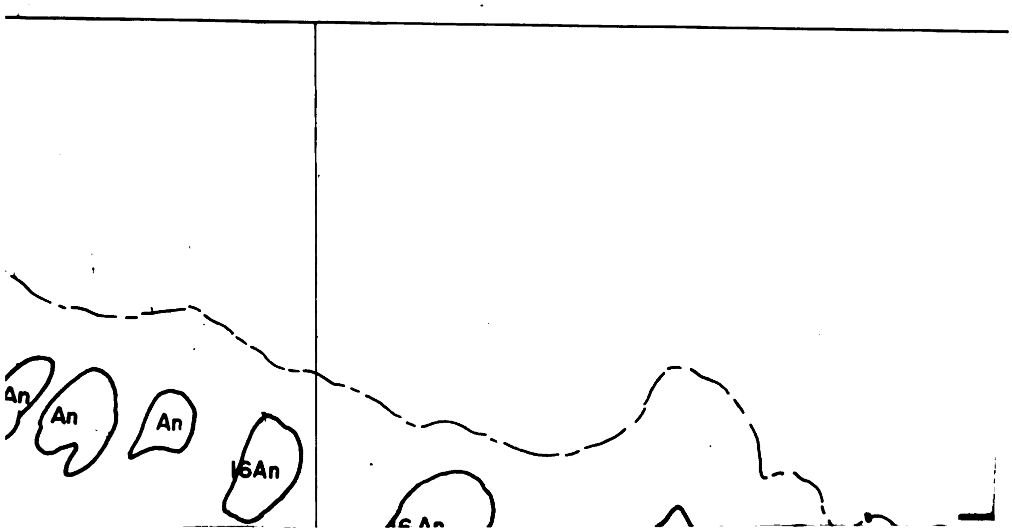

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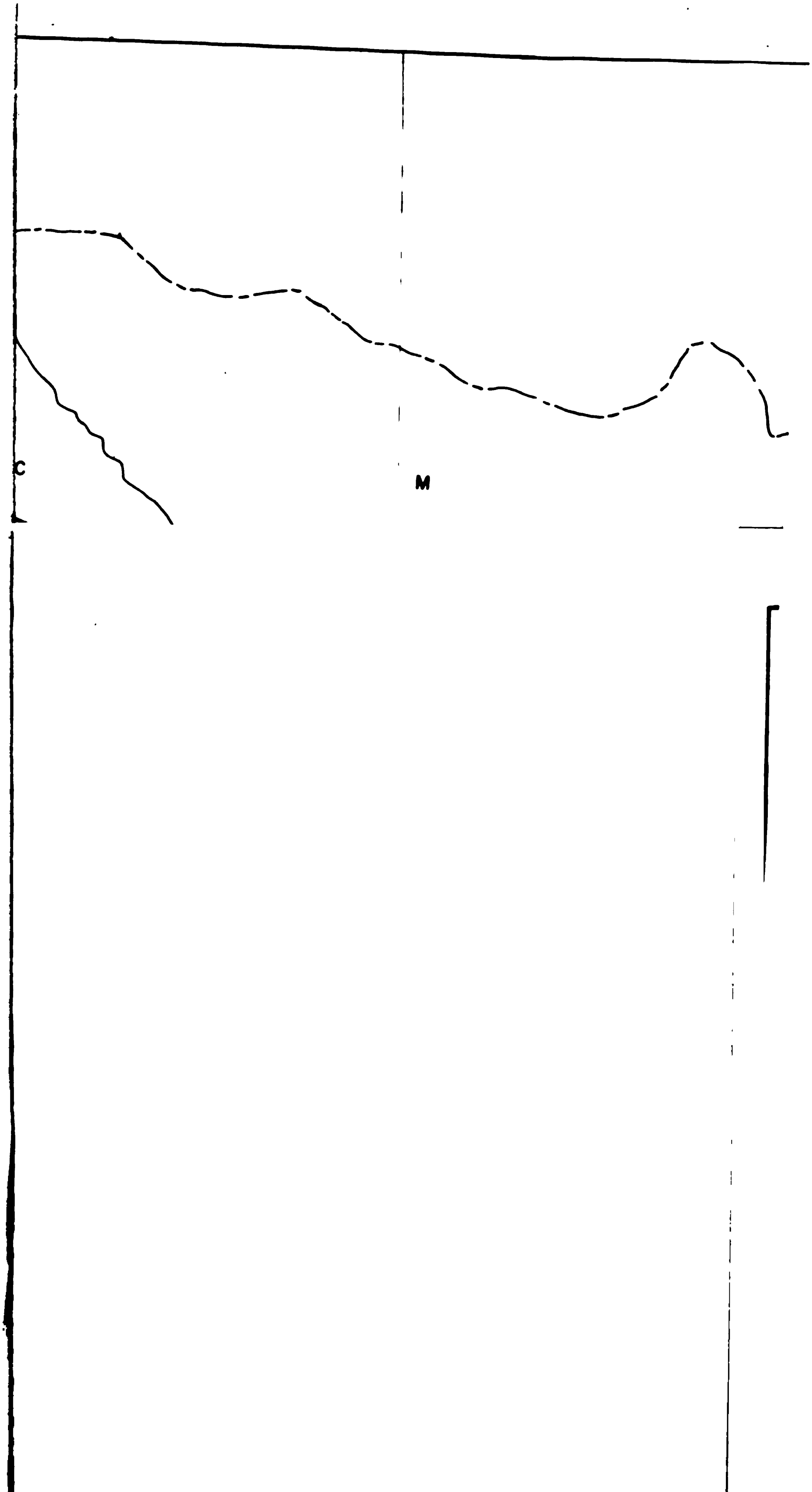
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