GEOGRAPHY OF THE LAKE TITICACA BASIN OF BOLIVIA

A Comparative Study of Great Landed Estates and Highland Indian Communities

By

Frank Lauer Keller

Thesis submitted to the Faculty of the Graduate School of the University of Maryland in partial fulfillment of the requirements for the degree of Doctor of Philosophy

1949

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FOREWORD

The field research on which this dissertation is based was accomplished between October 1944 and September 1946 while I was attached to the American Embassy in La Paz, Bolivia. The first year of residence was spent in field reconnaissance and library research in order to gain a deeper appreciation of the acute problems facing most altiplano inhabitants. During the second year, fourteen-page questionnaires were completed in the field on each of the 38 estates and 14 Indian communities treated in this study.

The author is very appreciative of the unstinted cooperation given by the Bolivian Ministry of Agriculture. In selecting specific estates and Indian communities for study, several specialists contributed their knowledge of highland agrarian organization. Moreover, the Director of Rural Economy, Ing. Jorge Alcazar Amputero, assigned four agricultural technicians to assist in the compilation and tabulation of raw data. The field technicians--Celso A. Reyes O., Luis F. Chavez, Hugo Rubin de Celis and Dalfredo Palacz A.--are to be highly commended for their untiring attention to minute detail and the intelligent application of their intimate knowledge of the local situation. Finally, the Minister of Agriculture, Jorge Zuazo Cuenca, insured successful completion of the field investigation by giving his official stamp of approval to the project.

I am deeply indebted also to Dr. Raymond E. Crist, my advisor, and the staff of the Department of Geography at the University of Maryland. At Professor Crist's suggestion, the institutional background of the prevailing agrarian organization was developed. His interest in the evolution of land tenure systems, and personal familiarity with the

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For as Geography without History

seemeth a carkasse without motion;

so History without Geography wandreth

as a Vagrant without a certaine habitation

--Captain John Smythe

The Generall Historie of the Bermudes.

SECTION I

THE CENTRAL ANDES

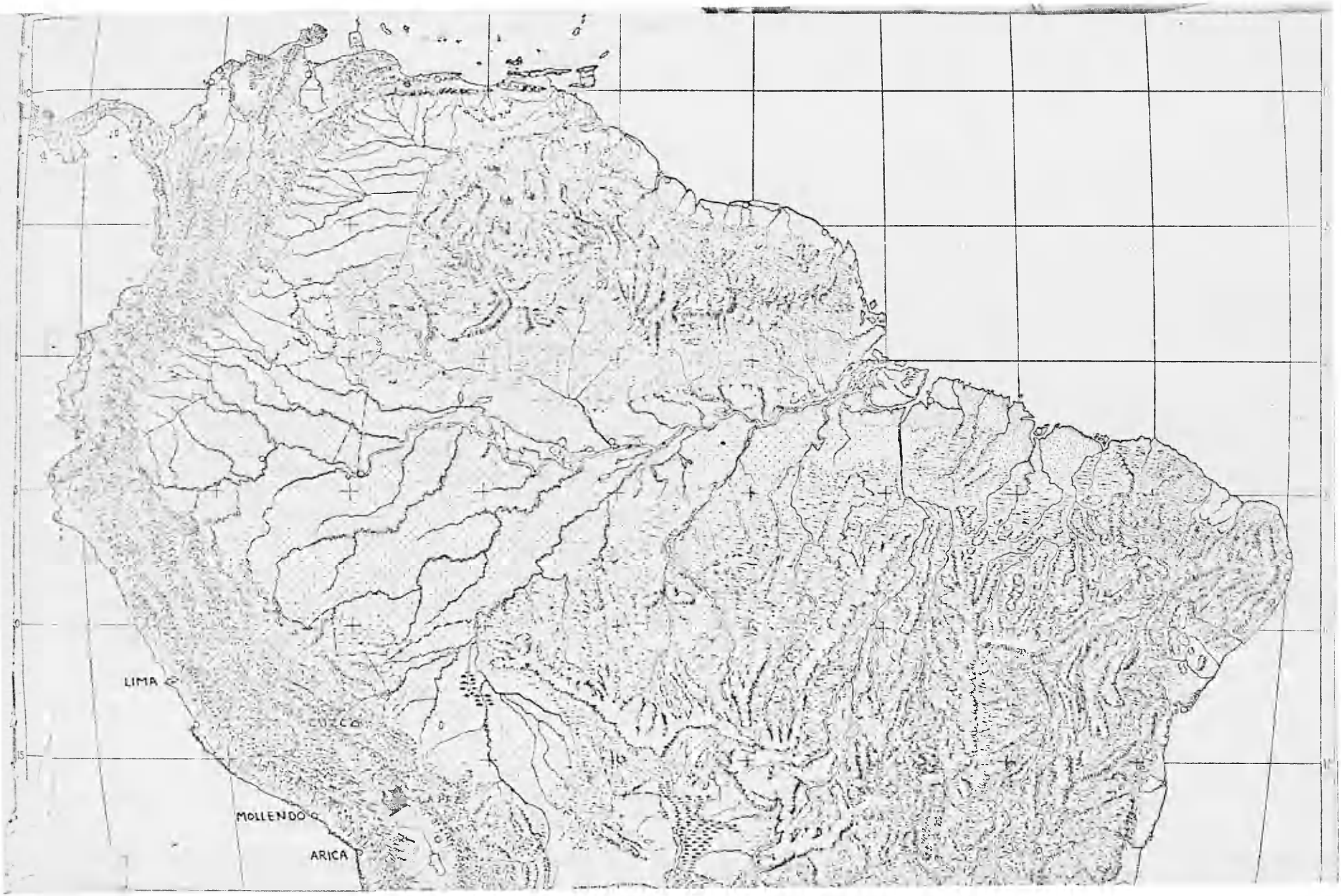
A General View

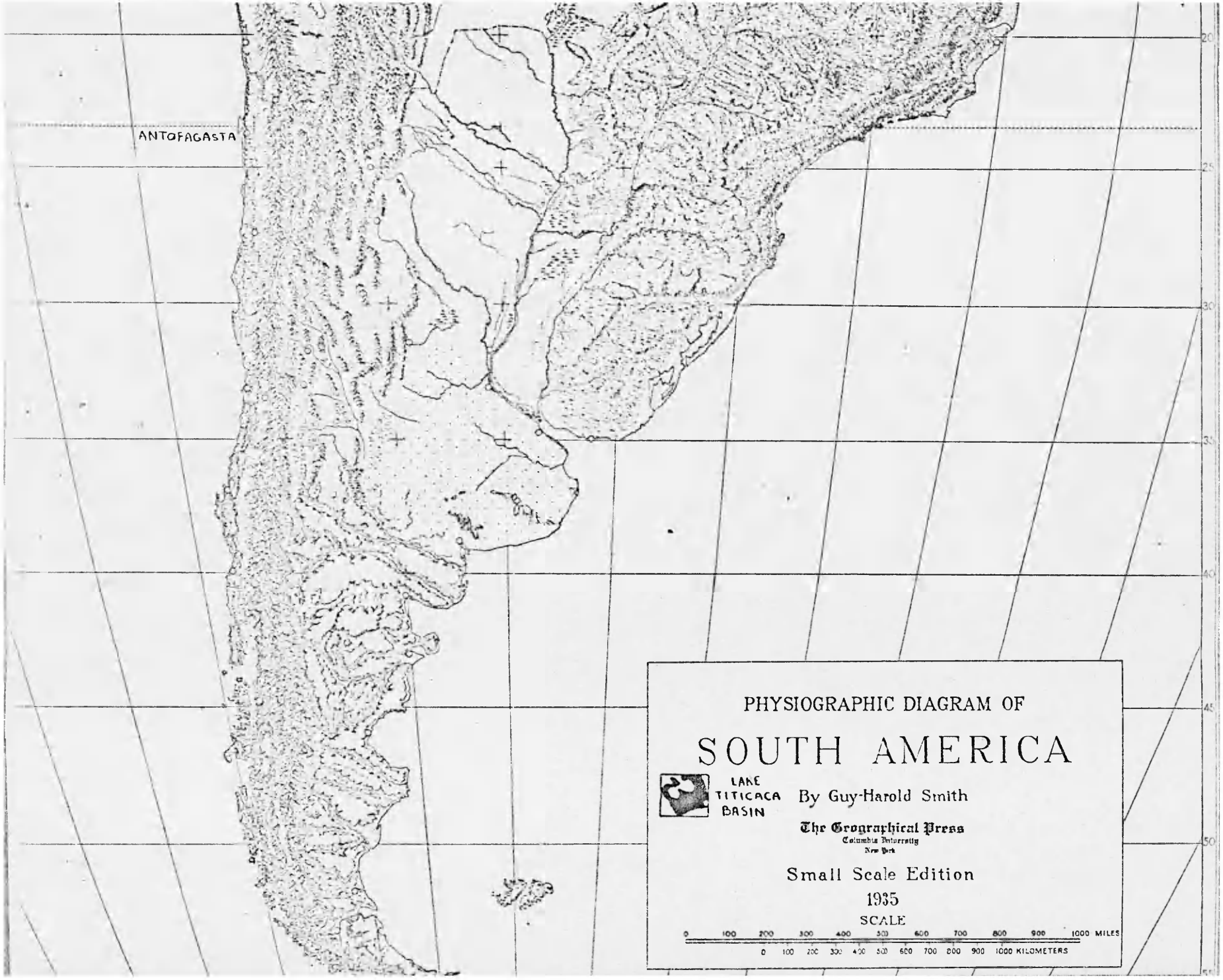
For a distance of five thousand miles along the western margin of the continent of South America the towering Andean mountain system forms a sinuous, unbroken chain varying from 100 to 400 miles in width. In Colombia the Andes comprise three parallel ranges, oriented in a general north-south direction, which merge into two relatively high, closely spaced crests in Ecuador and three lower, extended ranges in northern Peru. But this parallel arrangement is not present in southern Peru where the complex mountain knot lying immediately to the north of lofty Lake Titicaca introduces the Central Andean region. There are only two major north-south ranges in Bolivia plus a lower spur which cuts southeastward to create the maximum width of the Andes. Between the dry, inhospitable western range (Maritime Cordillera) and the majestic, snow-capped eastern range (Cordillera Real), the broad, flat two-mile high altiplano is cradled. This extensive plateau, containing the basin of Lake Titicaca near its northern terminus, constitutes the heartland of the Central Andes. Four hundred miles to the south the altiplano is pinched off by convergence of the eastern and western cordilleras, and a single, towering mountain crest continues poleward separating Chile from Argentina.

In structure regions the Andes can be roughly divided into three north-south regions--the Northern Andes, characterized by the massive

(wet highlands), the Central Andes, marked by the puna (dry highlands) and the Southern Andes, largely forested. The Central Andean region, consequently, includes all the mountainous area of Peru, except the extreme northern part, coastal Peru and the western cordillera as far south as northern Chile, the 100 mile wide altiplano, and the eastern cordillera of Bolivia and northwestern Argentina. Several peaks in this area extend above 21,000 feet in altitude and most passes are over 13,000 feet high. By modern transportation standards, based on railways and auto highways, these high mountain passes present many problems, but in terms of indigenous culture, based essentially on travel by foot or with llamas and alpacas, the mountain barriers are not insurmountable. In fact, within the highland area mobility is comparatively facile for the Indian, the chief limiting factor being distance (10, p.3).

The great physical relief of the Central Andes has given rise to three altitudinal zones which are important in terms of climate, vegetation and human habitation. In referring to this phenomenon, Isaiah Bowman has stated that "nowhere else on earth are greater physical contrasts compressed within such small spaces" (5, p.47). The lowest altitudinal zone, the tierra caliente (hot land) of the indigenous inhabitant, is best exemplified by the parched coastal desert and adjacent foothills along the Pacific Coast. The intermediate zone, tierra templada (temperate land), embodies the forested eastern mountain valleys (montaña of Peru and yungas of Bolivia). Containing some of the most spectacular mountain scenery in the world, these valleys, linking the high central plain with the flat eastern lowland, for many centuries have supplied the more densely populated highlands with semi-tropical produce. Incorporated in the uppermost level of this


LIMA
CUZCO
MOLLENDO
ARICA


ANTOFAGASTA
PHYSIOGRAPHIC DIAGRAM OF
SOUTH AMERICA
LAKE TITICACA BASIN
By Guy-Harold Smith
The Geographical Press
Columbia University
New York
Small Scale Edition
1935
SCALE
0 100 200 300 400 500 600 700 800 900 1000 MILES
0 100 200 300 400 500 600 700 800 900 1000 KILOMETERS

altitudinal scale is the tierra fria (cold land)--relatively densely inhabited intermontane pockets nestled in the altiplano; the puna, grazing lands of the alpaca and llama; and the Alpine-like Andean peaks. An analysis of archaeological materials from the Central Andes, nevertheless, indicates rather conclusively that the great relief and diversity of climate within the region did not always produce the sharp cultural divisions the contrasting natural environments would suggest (10, p.13).

For an unknown period the Central Andes have supported a sedentary Indian population engaged primarily in the cultivation of maize, potatoes and quinoa but dependent also on the more ancient pastoral pursuits of their less settled ancestors. The Peruvian coastal desert and the plateau region, especially the shores of historic Lake Titicaca, became the center in terms of Indian culture of the highest civilization in South America, fully comparable in achievement and intensity to the Maya of Central America and the Aztec of Mexico. Ancestors of the present day Aymará Indians living around the southern shore of Titicaca had developed at Tiahuanacu an advanced communal, theocratic state as early as the Third Century A. D. After reaching its apogee about the year 900, this civilization gradually declined until the Aymará succumbed to the Incas' superior military tactics during protracted campaigns after 1,000 A. D. By the time of the Spanish Conquest, all Indian tribes inhabiting the high plateau had fallen under the hegemony of the Incas whose empire extended along the Andes Mountains from Ecuador to central Chile. Throughout the Lake Titicaca Basin are to be seen the ruins of the Tiahuanacan Period as well as the partially destroyed aqueducts, abandoned agricultural terraces and crumbling stone roads of the more recent civilization of the Incas.

The central plateau and intricate folds of the associated mountain structures hold rich deposits of precious metals and strategic minerals. Although the mineral wealth of the Central Andes probably was of little value to the Indians in the earlier stages of their development, they exploited deposits of gold, silver and copper for the manufacture of tools, household utensils and ornaments as their culture developed. The Spanish conquistadores, pushing down from Panama and inland through Peru in search of "El Dorado", the mythical golden man, confiscated the accumulated wealth of the Incas, and exploited new mines such as "Cerro Rico" (rich hill) at Potosi, Bolivia, which has lived up to its name by producing a billion ounces of silver to date. The Aymará and Quechua Indians were subjected to forced labor in the mines (repartimientos and mitas) with practically no regard being given their former agricultural and pastoral pursuits. A great number perished from the pressure of unaccustomed labor and from diseases introduced by the white man, while the highly integrated agricultural economy which had evolved through the centuries was almost completely disrupted by rapacious overlords who were more interested in the extraction of precious metals. Mining activity fell off in the 18th Century, but today the Central Andes yield large quantities of minerals such as tin, zinc, lead, antimony, and tungsten which are of strategic importance to the outside world.

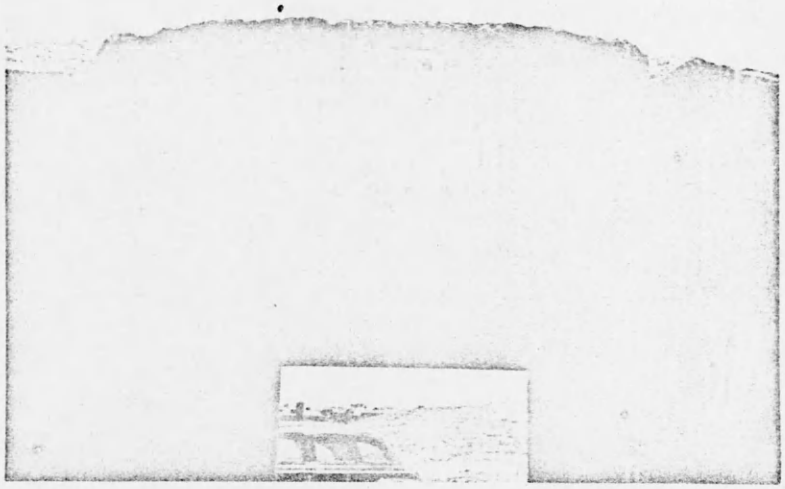
From very early times the social organization of the Andean Indians was based on the clan which, in the unit of Aymará society, was known as an ayllu. After the Indians became established as a sedentary agricultural people, the ayllu assumed greater importance as an agrarian unit than as a social bond. Land was held collectively by this body and was administered by the head man of the community who was responsi-

ble for its annual redistribution; but land continued to belong to the ayllu, and individuals who received yearly allotments were not permitted to alienate any portions of it. Thus true property in land was almost unknown among the Indians of this region before the arrival of the Spaniard whose cultural baggage included a system of private property in land known as the latifundia, or large landed estate, which he had inherited from the Romans. Although the majority of the conquistadores were victims of this stifling land regime in Spain, it was forcibly imposed on the Indians with the conquerors as overlords. The better agricultural lands of the ayllus, together with their Indian inhabitants, were incorporated into large private estates, and surviving Indian comunidades were relegated to less fertile land on the plateau or to isolated agricultural pockets in the mountains. The Indians did not accept the conditions imposed on them with complete apathy; Indian revolts were common, though generally futile, during the colonial period. Moreover, acts of violence by estate Indians against their masters have increased in recent years, an outward indication of the smouldering restlessness of the indigenous population. Thus, in the Central Andes two mutually antagonistic systems of land tenure confront each other--the communal holdings of community Indians and the private estates belonging to descendants of the conquerors--with the latter dominating the agricultural economy (11, p. 1).

The area encompassed by the Central Andes is an inordinately complex geographical region, yet it can be further subdivided into smaller, relatively homogeneous units. One such unit, the Lake Titicaca Basin, comprising the level land along the southern margin of the lake and its adjacent terraced slopes, has provided a

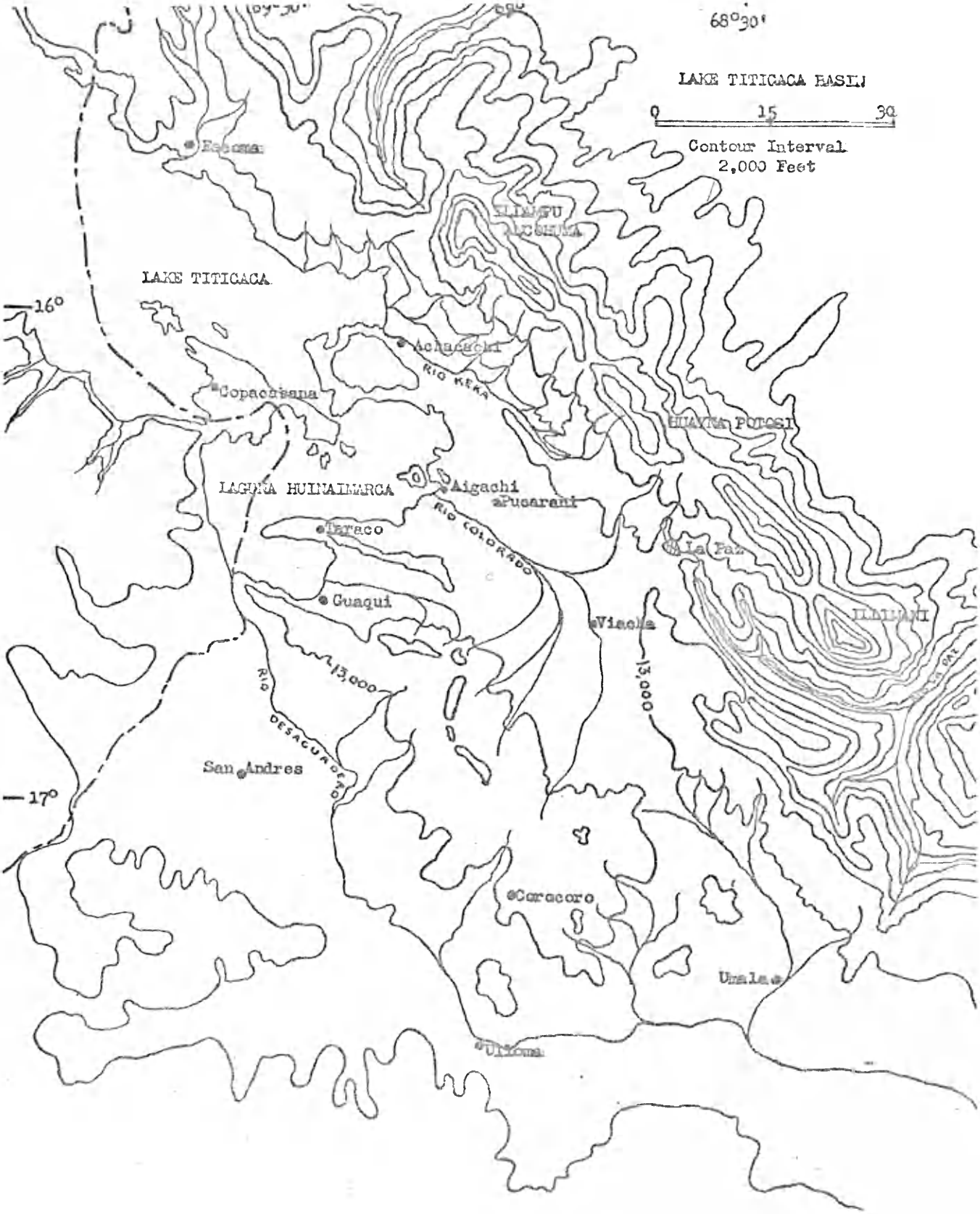
continuous home for man during the past 2,000 years. This physical setting provided a stage for the rise and fall of at least two pre-Incan civilizations; it occupied a strategic position within the framework of the vast Incan Empire and has played host to a foreign invader. Interplay of the various elements in the natural and human environment of the lake basin has been extremely intricate and of long duration, resulting in a complicated land use pattern. In this study, factors in the physical environment--geological structure and landforms, soils, vegetation and climate--furnish a backdrop before which the inhabitants act out their lives. Field studies of land utilization practices on large landed estates and Indian communities provide materials for an analysis of the grave problem created by simultaneous existence of mutually antagonistic systems of land tenure which, although frozen in an uneasy truce, are in reality separated by half a world in origin and development.

A paved highway, near Copacabana, constructed during the period of Inman highway over the southern lake basin, as seen from the modern mud and gravel road.



Top: Archeological evidence of an advanced pre-Inca civilization exists at Tiahuanacu, near the southern shore of Lagunn Huinaimarca. The quarry from which these huge igneous blocks were carved has been discovered approximately 70 miles distant. A cluster of religious temples, living quarters and military fortifications which stretched for several blocks in all directions attest to the immensity of the project.

Bottom: The intricately carved bas-relief over the "Doorway of the Sun" at Tiahuanacu represents the sun god and his worshippers.


68°30'
LAKE TITICACA BASIN
0 15 30
Contour Interval
2,000 Feet
Ilabaya
LAKE TITICACA
16°
Achacachi
RIO KERA
Copacabana
HUAYNA POTOSI
LAGUNA HUINAIMARCA
Aigachi
Pucarani
Tiraco
RIO COLORADO
La Paz
Guaqui
Viacha
13,000
RIO DESAGUADERO
San Andres
17°
Caracoro
Umala
Ulloma

SECTION II

THE LAKE TITICACA BASIN

Physical Setting

For the purpose of this investigation it is unnecessary to place the Lake Titicaca Basin within a definite, continuous physiographic boundary. In general, the waters of Laguna Huiñaimarca, occupying almost the entire width of the interior basin, may be used as the northern boundary, while the eastern limits are sharply defined by the serrate divides of the Cordillera Real. Topographic changes to the south and west are less abrupt, but the deep chasm carved from the altiplano by the La Paz River rather effectively serves as a southeastern demarkation and the Rio Desaguadero, draining Lake Titicaca to the south, as the western border. Furthermore, discussion of the factors in the physical environment--geological structure and landforms, soils, natural vegetation and climate--is limited to those particular elements of each which have materially affected the nature of man's activities in the region.

Geological structure and landforms. An understanding of three events in the geological history of the Central Andes--primary orogeny, vertical uplift and glaciation--are requisite for an accurate interpretation of the important topographic features found in the lake basin. Although the ancestral mountains of the present high Andes were considerably lower in elevation, the geological structure of the two places is strikingly similar. The general strike of the strata up-

folded during early and mid-Tertiary times was northwest-southeast, and this trend has been preserved to the present. The relatively level central plain of mid-Tertiary, flanked by a young eastern mountain range and a high western plateau, has been moulded by diastrophism into the altiplano, the peaked Cordillera Real and the less spectacular Maritime Cordillera of the present. The major features of the drainage pattern were formed during these early geological periods; the Desaguadero River presumably was a strike stream from Titicaca to a point near Ulloma at least, and the La Paz River had already established its major drainage lines. Prior to the second significant phase in the physical history of the region, denudation had taken place in the eastern range, uncovering mineral bearing igneous rocks, and extensive lava outpourings covered portions of the western plateau (15, p. 35).

Vertical uplift, which had been progressing at a rather slow pace through the early and mid-Tertiary, became most pronounced during the late Tertiary Period. The amount of perpendicular displacement is difficult to judge, but in southern Peru, Isaiah Bowman estimated the upheaval at slightly over a mile (5, p. 149). Considerable faulting along the margins and slow sagging and down-faulting in the central plain accompanied this relatively rapid elevation; two great normal faults have been mapped along the eastern flank of the granitic residual comprising the Cordillera Real, and the Corocoro-Coniri mining region, southwest of the lake basin, represents a fault zone. The Strait of Tiquina, a deep, narrow channel separating laguna Luinaimarca from the lake proper, in all probability represents a fault-line formed during this period. As indicated by its rectangular form and the steep proclivities of its submerged slopes, Lake Titicaca is a huge down-warped

and down-faulted graben (9, p.22). The central plain was transformed into a basin of interior drainage; lakes were created and sediments began to accumulate, while closely folded sedimentary rocks protruding through these recent deposits were energetically attacked by agencies of erosion.

Several phases of Pleistocene glaciation constitute the third major event in the geological history of the lake basin. Glaciers radiating from snow fields in the Cordillera Real extended across the piedmont along the range's western incline north of La Paz, while ice tongues from Illimani and Tres Cruces invaded the La Paz gorge (5, p.44). Damming of the La Paz River, which apparently drained Titicaca prior to the glacial epoch, created an immense temporary lake in the interior basin. During the first, higher stage, named Lake Ballivian by Bowman, Titicaca was joined with Poopó to the south by a stretch of water approximately 12 miles in width extending from Aigachi through Viacha and south to Lake Poopó. During the second, lower phase (Lake Minchin) the lake basin was not inundated (3, p.376). The position, level and outline of Titicaca during this later period were not materially different from those of the present. Much of the grandeur of the Cordillera Real was created during the glacial period; sharply pointed aretes, steep-faced serrate divides and ice-chiseled cirques were sculptured by the glaciers, while recessional moraines and pater noster lakes marked their retreat.

One of the major differences between the Bolivian Altiplano and most other interior drainage basins in the world is that the former contains a large body of fresh water, Lake Titicaca, and has an important permanent drainage system, the Rio Desaguadero. These unique physiographic features have made possible a population density in the

vicinity of the lake of approximately 125 inhabitants per square mile and have fostered the development of an advanced indigenous civilization. Nestled in an elongated basin 12,500 feet above the Pacific Ocean, Titicaca is the largest lake in South America; it measures approximately 110 by 30 miles and is exceptionally deep--the deepest sounding reaching almost 900 feet below the surface. Truncated sandstone folds with interbedded rhyolites, creating a local relief of approximately 1,000 feet, fashion the sinuous backbone of the jutting peninsulas of Copacabana and Hunta which almost sever the main depression from the southern lagoon. Steeply terraced slopes alternating with carefully tilled patches of sloping agricultural land support many small Indian communities which have managed to survive in this less accessible part of the basin. Many of the crumbling higher terraces (andenes), created for the purpose of soil retention and to facilitate the cultivation of steep slopes, have remained uncultivated since the bloody internecine wars of the later Incan period and the forced exodus to mining regions after the Spanish Conquest. Also, much of this land is devoted to pasture when it passes from small to large owners. On the peninsulas, transportation routes for motor vehicles follow the contours, curving around promontories or along abrupt valley slopes, while pack trains of sure-footed llamas and burros continue to use the more direct, precipitous routes of earlier civilizations.

In sharp contrast to the steep slopes and deep water encountered in the main depression, the Laguna Huinaimarca (15 miles long, 30 miles wide) is a very shallow body of water with a gently sloping southern shore. Occasional sedimentary folds protruding through the floor of the basin between the lagoon and the rim of the La Paz *gorge* emphasize

the monotony of the landscape. In the economy of the lake basin, the lagoon is cast in an important role. It supplies Indians residing around its borders with an auxiliary food supply in the form of many varieties of edible fish; it provides avenues of transportation for tiny sailing vessels made from the totora reed found along the marshy shores; and its waters are used to irrigate the productive soils slowly being exposed by recession of the lake. Recognizing the agricultural importance of this section of the lake basin, the Spanish conquerors promptly superimposed their form of land tenure--the great landed estate--on the indigenous population, and their creole descendants have continued to wage incessant economic warfare against the surviving Indian communities.

A progressive though slight reduction in the size of Lake Titicaca has been noted during historical time. The contribution of water to the lake from surrounding hills and mountains is greater than the outflow through the Desaguadero River, but intensive evaporation over the immense surface is causing a gradual lowering of the level. The most striking result of this lake recession is evident along the shallow margins of the Laguna Huinaimarca where slow retreat of the shoreline has added large areas of irrigable agricultural land to the estates and Indian communities located around the semi-circular southern shore. Off the steeply dipping slopes on the peninsulas of Copacabana and Huata little benefit is derived from the lake recession, but Indian communities nestled in shallow valleys have profited from the addition of small pockets of relatively level agricultural land.

Determination of the rate at which the level of Lake Titicaca is being lowered requires further intensive study, since the problem is

complicated by wide seasonal as well as annual variability in precipitation, the question of glacial retreat in the mountains surrounding the lake basin, and changes in volume of discharge through the Rio Desaguadero. At Finca Belen, a large estate on the southern shore of Laguna Huiñaimarca, several hundred yards of land, representing a vertical displacement of approximately 14 feet, have been uncovered since the beginning of the colonial period. There is also evidence that the rate of recession has become progressively more rapid in the recent past. The owner of an estate near Toraco in the Laguna Huiñaimarca region, now an elderly man, recalls that during his childhood visits to the family properties the shoreline of the lagoon reached almost to the hacienda house. By 1945, several hundred yards of bottom land had been exposed between the house and the retreating waters.

The altitude of the interior basin increases along a slight northwest-southeast incline from 12,500 feet at the lake to slightly over 12,700 feet at Viacha, situated near the La Paz gorge, a distance of approximately 30 miles. Between the piedmont of the Cordillera Real on the northeast and the hills of the Cerro de Comanche on the southwest, underlain by diorite intrusives containing the largest native copper deposits in the world, the width of the basin proper increases from approximately 20 miles near La Paz to almost 50 miles at the lake. Since the ameliorating climatic influences of Titicaca are confined to the immediate vicinity of the lake, a more rigorous climatic regime exists on the level expanse of the altiplano. Approaching Estacion El Alto from the direction of the lake, private estates become larger, more extensive agriculture is practiced and the population density shrinks to

10 to 25 per square mile. Surviving Indian communities in this area are concentrated in the rugged Cerro de Commanche or on the piedmont stretching along the northeastern margin of the basin.

A simple dendritic pattern, modified in its upper reaches by the structure of the Cerro de Commanche and the Cordillera Real, is produced by drainage lines in the basin. Several small permanent streams, fed by numerous intermittent tributaries, drain the gently sloping platform from southeast to northwest, emptying into the Laguna Huinaimarca or the southern part of the main depression. The two largest streams, whose volume during the wet season from October to May swells to approximately eight times that of the dry period, are the Rio Coloredo, discharging near Aigachi, and the Rio Kaka, which enters Lake Titicaca north of Achacachi. Intermittent affluents feeding the permanent streams emanate from the Cerro de Commanche and the Cordillera Real; racing down the eastern piedmont, tributaries on the northeast perform a sudden, right angle turn upon reaching the basin floor and glide slowly toward the lagoon. Some streamlets, such as the Vilaque and Milluni, become lost in their alluvial fans before reaching the base of the piedmont. The flow of the permanent streams draining the basin, however, is everywhere too inadequate and undependable for extensive irrigation purposes. The Rio Desaguadero, the only large permanent river system on the altiplano, reverses the drainage pattern of the basin by draining Lake Titicaca to the southeast, only to become extinct in Lake Poopó, a huge evaporating pan at the southern end of the altiplano.

The piedmont area of discontinuous hills surrounded by coalescing alluvial fans is lodged between the lower limit of permanent agriculture and the faulted red shales and quartzites abutting against the

granitic core of the Cordillera Real. Stretching in a narrow belt from La Paz to Achacachi, this area (puna or dry highlands) is covered by coarse, sparse grasses upon which flocks of llamas, alpacas and sheep graze. Buffeted by penetrating winds and chilled by sub-freezing night temperatures, the life of the highland shepherd who follows these migratory flocks is a rigorous one indeed.

Some of the highest mountain peaks in the world are concentrated along the sharp crest of the Cordillera Real. At the northern terminus, the summit of Illampu reaches to 21,000 feet and that of Ancohuma rises 300 feet higher. Isolated snow fields, mere vestiges of former giant glaciers, extend down to the 16,000 foot snow line. Other pinnacles pierce the eastern sky between Illampu and Nuyna Potosi, 40 miles to the southeast, which ascends to more than 20,000 feet. Across the gorge cut by the swiftly running La Paz River, individual peaks, their dark-faced precipices a sharp contrast to snow-clad summits, eventually culminate in 21,000 foot Mount Illimani. The influence this majestic backdrop has exerted upon the mores of the Indians residing in the lake basin, particularly their worship of land and the forces of nature, must certainly have been profound. To the erstwhile resident it imparts a latent urge to return; the inhospitable climate and rigorous conditions of life soon fade into the obscurity of the subconscious, while recollection of the chroma cast against the face of Mount Illimani by the evening sun remains forever etched on one's mind.

Soils. Young soils, not sufficiently comminuted from their mineral constituents to be available for plants in a high degree, exist over much of the area. The solvent action of water which favors chemical change is reduced by the relative aridity of the area.

Therefore, the cycle of development is taking place slowly. Average soil temperatures are low and the natural recovery of the soil after cropping is slow, so that fields lie fallow as long as 12 years before recultivation. Since very little fertilizer is now used, the soil must recover largely under its own power.

The most productive lake basin soils are located along the immediate margin of Laguna Huinaimarca. Gradual recession of Lake Titicaca has exposed relatively large expanses of lake bottom soils along the gently sloping southern shore of the lagoon which, moreover, are capable of being irrigated. Consequently, the greatest concentration of private estates occupy these soils, almost to the complete exclusion of Indian communities.

Less productive lake basin soils are derived from the erosion of sedimentary remnants protruding through the lake basin sediments or from material washed off the eastern piedmont. The largest areal extension of these soils, therefore, exists in the Cerro de Comanche or along the eastern piedmont. A more complicated soil pattern is present immediately to the west of the Cerro de Comanche where periodic inundation of the Desaguadero River floodplain has produced a relatively black soil in places. A majority of the Indian communities have been relegated to the Cerro de Comanche on the west, the eastern piedmont or the Peninsula de Huata, a sedimentary remnant located to the northeast of the lagoon.

The following table presents an analysis by the United States Department of Agriculture laboratory at Beltsville, Maryland of four widely separated surface samples of lake basin soils:

TABLE 1. Soil Analyses.

Lab. No.	Survey No.	Location	pH	Organic Carbon %	Soluble Salts	Physical Classification
481602	S45 Bolivia 1-1	El Alto	4.9	1.9	0.01	Loam
1603	2-1	Carapata	7.8	2.2	0.33	Silt loam
1604	3-1	Tambillo	7.0	0.2	0.01	Loamy fine sand
1605	4-1	Puerto Perez	7.8	0.7	0.02	Fine sandy loam

Survey No. 1 was taken from fallow land supporting the bunch grass paja brava (Stipa ichu) in the immediate vicinity of Estacion El Alto (elevation 13,400'). Due to its extreme acidity (4.9), the sample in this respect is presumably not too representative of the area from which it was secured. With a pH of 7.8, and 2.2% organic carbon, Survey No. 2 is considered to be representative of the soils in the vicinity of Finca Carapata, situated approximately halfway between the southern lake border and Estacion El Alto. The high salt content (.33%) cannot be satisfactorily explained by USDA soil scientists but is believed to have local significance only. Survey No. 3, secured from the vicinity of Tambillo and Survey No. 4, from the lake basin at Puerto Perez, show characteristics which would normally be expected in the localities from which they were procured. Lack of samples at periodic depths and scarcity of numerous samples from each locality have placed very definite limits on the interpretation of these analyses. An accurate interpretation of their value must await further corroborative evidence.

Natural vegetation. Climatic factors usually associated with intermontane plateaus, such as low temperature and insufficient precipitation, and the consequent immature soils, limit the scattered natural vegetation over large areas of the basin to hardy grasses and root

plants. In the vicinity of Lake Titicaca, where hills afford a measure of protection from strong winds and the large body of water minimizes extremes in temperature while increasing precipitation, the vegetation resembles a grass steppe. Here the hardier plants are interspersed with grasses such as trefoil, geranium, gentian and verbana, on which cattle graze, while the eucalyptus, introduced into the Central Andes by man, occurs in scattered stands. The aspect of the vegetation in the dry summer differs only slightly from that of the wet winter; during the latter season the grasses lose their burnt appearance to some extent because of the sprouting of new shoots, many bare spots are covered over by quick growing plants, and the landscape has a greener tint.

Despite an exceptionally limited variety of vegetation types, the Indians have succeeded in incorporating every available species into their aboriginal economy. Paja brava, or ichu grass, (Stipu ichu) grows everywhere in hummocks or bunchy cones reaching at least one and a half feet in height. The more delicate parts in the tuft are nibbled by sheep, while the upper portions of the coarse blades comprise the chief food of llamas and alpacas, those indigenous camaloids of great utility upon which the native economy depends so heavily. The tough blades of this spike-like bunch grass are also made into combs and brooms (chajrāna) by the Indians. Extensive fields of closely spaced hummocks of paja brava are known to the inhabitants as pajonales.

A plant whose leaves are shiny and leathery above and silky underneath, an indication of a low rate of transpiration, is the tola (Lepidophyllum quadrangulare). The cartilaginous stems of this scrubby bush are used for fuel after llamas and alpacas have eaten the coriaceous leaves.

Seen from a distance, the llareta bush (Laretia compacta) appears to be a boulder. Upon closer scrutiny it resembles a hummock of closely packed moss. But only upon being uprooted is its true nature disclosed... a resinous woody stem with innumerable twigs radiating from the center. The plant is like a sponge, retaining moisture after snow or rain despite strong daily evaporation (15, p. 115). After being uprooted and dried, its only practical utility is that of a fuel. For unknown centuries it has supplied the populace of the basin with heat for warmth and cooking. Unfortunately, mining of llareta, like cutting of the gnarled queñua tree (Polylepis racemosa), has long exceeded its natural increment. The queñua tree has disappeared from the lake basin altogether and llareta reserves are exceedingly low. The nearby city of La Paz with a population of 300,000, which in the past had been making the greatest inroads on the fuel supply of surrounding areas, is now satisfying a large part of its fuel requirements by utilizing briquettes of barley chaff impregnated with lubricating oil. Peat deposits located south of Achacachi, and dried animal manure (taquia) also serve to alleviate the natives' dependence on the scant natural vegetation as a source of fuel.

Many square miles within the bays of the Laguna Huinaimarca and in the vicinity of its outlet at the Rio Desaguadero are covered with the peculiar reed beds known to the Indians as totora (Malacochaete totora). In addition to providing cover for innumerable water birds, the reeds are used by residents of the littoral for constructing their unique "balsa" boats and sails, and for making musical instruments and various household utensils. The eucalyptus, a quick growing tree that can withstand light frosts, is not indigenous to the Central Andes but was

introduced into South America from Australia about 90 years ago. Limited at this altitude to plantings around estates and Indian communities in the vicinity of the lake, it presents the only relief from the treeless aspect of the basin and furnishes a windbreak for the grateful inhabitants. Young trees are aided in the struggle for existence by construction of clay fences around their bases to lend protection and conserve water. In order to increase the number of eucalyptus trees, the Bolivian government has provided a bonus of Bs. 500 for the planting of every one thousand trees at least six feet tall on estates near Titicaca and Bs. 1,000 for the same number of trees of equal height away from the lake.

In the vicinity of the snow fields and glaciers of the Cordillera Real there exist thinly clothed patches of vegetation comprising species derived from Antarctic regions whose domain has contracted with the advance of the interglacial period. These elements of the natural vegetation, because of their inaccessibility, are not being utilized by the frugal natives.

Climate. Greater influence is exerted over the climate of the Lake Titicaca Basin by a unique combination of topographic features--great elevation, a towering eastern mountain range and the broad expanse of the lake--than by the latitudinal position of the region in relation to the earth's surface. Whereas sea level temperatures at 16° south latitude are distinctly tropical, the great altitude of the lake basin insures cool temperate conditions. Furthermore, the Cordillera Real effectively disrupts moisture-laden southeast trade winds which sweep across the continent at this latitude, inducing heavy orographic precipitation on the eastern flank of the mountains

and a relatively dry environment on the lofty tableland. The ameliorating effect of Lake Titicaca on an otherwise harsh altiplano climate has long been appreciated by indigenous inhabitants concentrated around its margins, but the extent to which the lake controls local air movements, reduces daily temperature extremes and increases rainfall has only been brought to light by recent meteorological observations. Thus it can be seen how an elevated plateau and the presence of an even higher mountain range have changed the climate from the anticipated moist tropics at this latitude to one which is cool and relatively dry.

Meteorological observations recorded at selected stations within the lake basin are contained in Appendix A. Unfortunately, these observations cover only a short period, the longest, at Guaqui and Copacabana, extending for two years. Consequently the interpretation of these data will necessarily be influenced by the writer's personal observations during two years' residence on the altiplano. The analysis of available climatic records and personal observations contained in subsequent paragraphs will have for its purpose the delimitation of climatic influences upon man's occupance of the region. Since climatic fluctuations cause considerable variation in crop yields, the Indians, who are barely self-sufficient during years of normal agricultural production, suffer severe privation during unfavorable years. The area generally can benefit from only one good climatic year out of four or five.

Temperature. Agricultural production in the lake basin is affected to a large degree by low, equable mean annual temperatures, a great daily range and wide variability from year to year. At El Alto, situated on the rim of the altiplano overlooking the city of La Paz, the daily temperature variation in 1946 exceeded 30° F. during the cooler

dry season from May to October and approximated 20° F. through the warmer growing season from October to May. With the mean annual temperature at this station registering a low 45° F., below freezing night temperatures occurred during June, July, August, September and October. Although the daily temperature range at Copacabana, located at the lake shore on Copacabana peninsula, was only slightly less than at the higher station at El Alto which is not materially influenced by the lake, the mean annual temperature at Copacabana in 1946 was 51.8° F., almost 6° F. higher than the mean annual at El Alto. Thus, Copacabana did not experience any nights with below freezing temperatures and only two months, July and August, during which night temperatures dropped to the freezing point. An average of temperatures recorded in 1940 and 1941 at Viacha, in the lake basin 30 miles southeast of Laguna Huinaimarca, indicates that, during the planting season in October and November, temperatures dropped below 32° F. twice in the former and once in the latter month. December, January and February were entirely frost free, but from March through the harvest season early in May temperatures dropped below freezing on seventeen occasions. Thus the thin air and high percentage of clear days during the dry season, which promotes rapid heating by day and cooling by night, insure below freezing night temperatures over much of the lake basin during planting in the spring and during the latter portion of the growing season and the harvest period in the fall. Only away from the lake, however, is there likelihood of serious crop damage during a normal climatic year due to the occurrence of frost through the growing season. Hardy indigenous crops such as quinoa and cañahua withstand low night temperatures better than an introduced crop, such as barley for example, which matures only at the lake border.

Variation in the year to year temperature regime is marked. In 1945, the mean annual temperature at Guaqui, on the southwestern shore of Laguna Titicaca, registered 51.4° F., but fell to 43.3° F. in 1946, a difference of approximately 8° F. in mean annual temperature from one year to the next. Consequently, Guaqui underwent below freezing night temperatures on one or more occasions each month during nine months of the latter year.

Slightly higher annual temperatures and diminished danger of frost damage in close proximity to the lake permit growth of beans and cebada en grano, a variety of barley that ripens under these climatic conditions, in addition to the hardy staples of quinoa, cañahua and potatoes which are grown throughout the entire lake basin. The great amount of daily insolation and nightly radiation occurring during June make this month particularly favorable for the manufacture of chuño, the dried potato product of the highlands whose unique production requirements include alternate freezing and thawing and a high degree of evaporation. Sun and shade temperatures at these high altitudes vary considerably. While ice may lie all day in a shaded spot, the intensity of the sun in the open is sufficient to burn the skin of a European. A sudden drop in sensible temperature also occurs when the sun becomes obscured behind a cloud. It must be kept in mind, therefore, that these observations refer to shaded temperatures; and everywhere in the lake basin man shuns the shade in carrying out his daily activities.

Precipitation. Seasonal distribution, extreme annual variability and increased rainfall in the vicinity of the lake also exert important influences over agricultural production. Almost all the region's precipitation is received during the slightly warmer season from October

to May, whereas the months from May to October are cooler and practically rainless. On the basis of the meager precipitation records available, three vaguely defined rainfall belts may be tentatively established in order of decreasing intensity away from the lake. Total annual rainfall at Copacabana and Tiquina, the latter station located near the village of San Pablo in the Strait of Tiquina, was 40.7 inches and 37.7 inches respectively in 1946. Guaqui, on Laguna Huiamarca, received 32.5 inches of rainfall that year, while 30 miles southeast of the lake the station at El Alto was the recipient of only 24.9 inches of precipitation, a little over half the amount falling at Copacabana. Thus the influence of Titicaca on the climate of the lake basin again becomes apparent. In addition to exercising a tempering influence over the daily and yearly march of temperatures, the lake causes increased rainfall around its borders.

Although some precipitation occurs every month during the rainy season (number of days with rain averages approximately 100 throughout the lake basin) a significantly large proportion of the annual total generally falls during one month. At Tiquina in 1946, ten of the 38 inches of annual rainfall were received in December; that same month ten of Guaqui's 32 inches fell; Copacabana received 23 of its 40 inches during December, while at El Alto 5.5 inches of the annual 24 fell during this month. Earlier, incomplete records indicate that occasionally November is the month of heaviest precipitation.

After an early morning filled with sunshine, clouds generally begin to form at mid-morning during the normal summer day. These clouds develop into cumulo-nimbus by early afternoon, and convectional rain falls sporadically for several hours. When this regime is

disrupted, which is often, storm conditions prevail, with rain continuing into the night. Over vast tracts the bare soil is porous and the first rains of spring are rapidly absorbed, but after recurrent rains, water fills the gullies and accumulates on the lower flat lands. But evaporation is so much greater than precipitation during the latter part of the growing season that even drought resistant crops such as quinoa and cañagua appear to be dessicated.

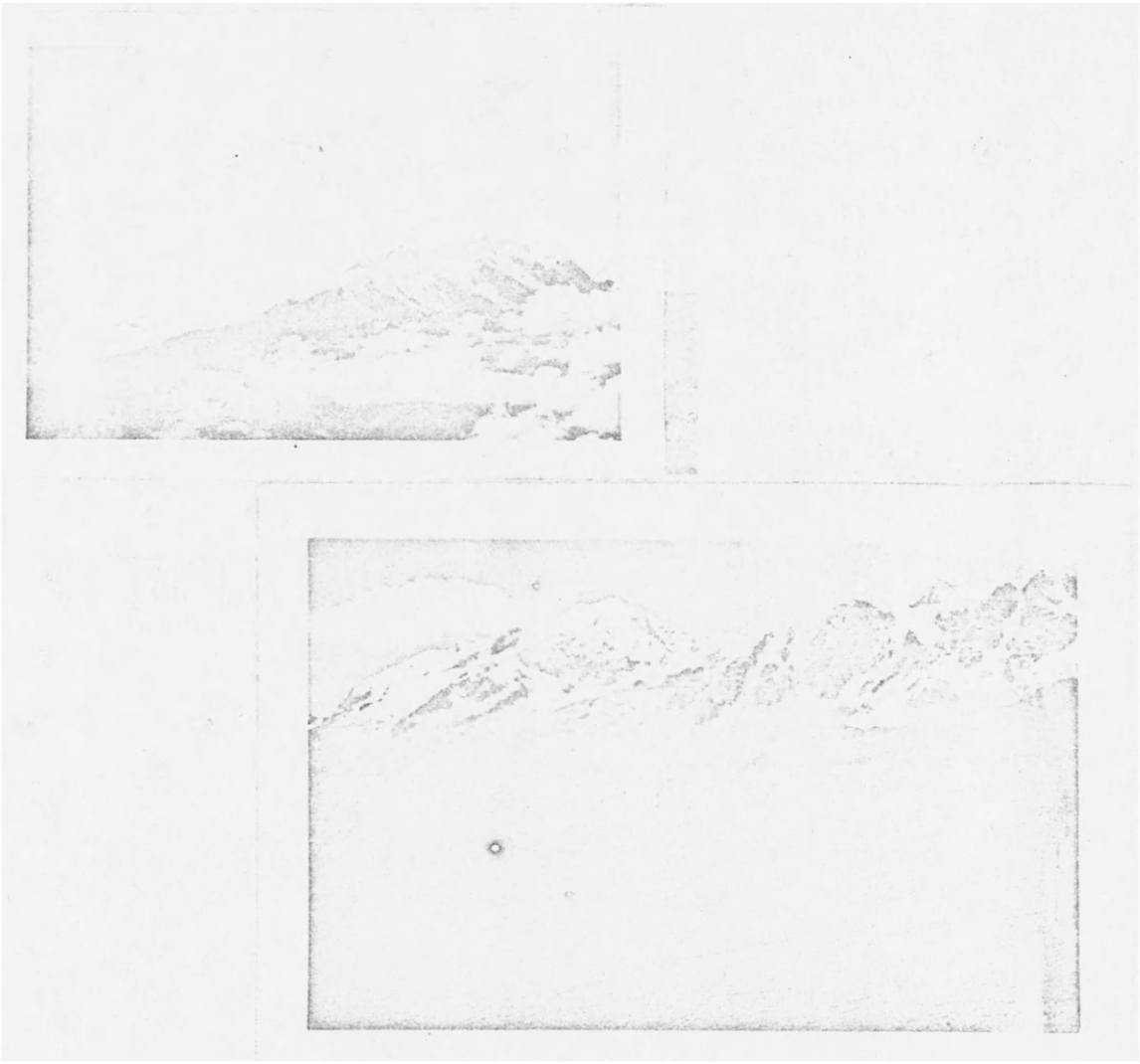
Hail, and the strong gusts of wind usually associated with it, are greatly feared by the altiplano farmer as each year considerable localized damage is done to crops by these heavy ice pellets. Guaqui suffered 21 days with hail in 1946, whereas only four such days were registered in 1945. After escaping without any hail storms in 1945, Copacabana experienced four days with hail in 1946. Watajata, an estate on the eastern shore of Laguna Huinaimarca, received hail during eight days in 1946, while El Alto, on the other hand, had only two days with hail that year. Hail storms may occur at any time during the entire growing season, but generally they are concentrated during the months from January to April when crops are ripening. Spring snows prepare the fields for the plow, therefore are considered beneficial. The two days during which snow occurred at El Alto during August 1946, for example, were beneficial for the plowing which commenced in September of that year.

Winds. Theoretically the altiplano region should fall under the influence of the southeast trade winds; however, the high Andes chain almost completely disrupts these air currents at the lower levels at least, permitting local controls to dominate air circulation in the highlands. The controls exerted by Lake Titicaca over winds in the

lower lake basin have already been mentioned briefly. One informant, owner of an estate near Guaqui on Laguna Kaimaimarca's southern shore, has stated that throughout most of the day air passed from the cool lake to the warm land. By 9:00 P. M. he indentified a return current as the land cooled. At 7:00 A. M. the informant estimated that the air moved from the east or northeast and by 2:00 P. M. this had developed into a breeze. In the evening, the return current varied between southwest and northwest.

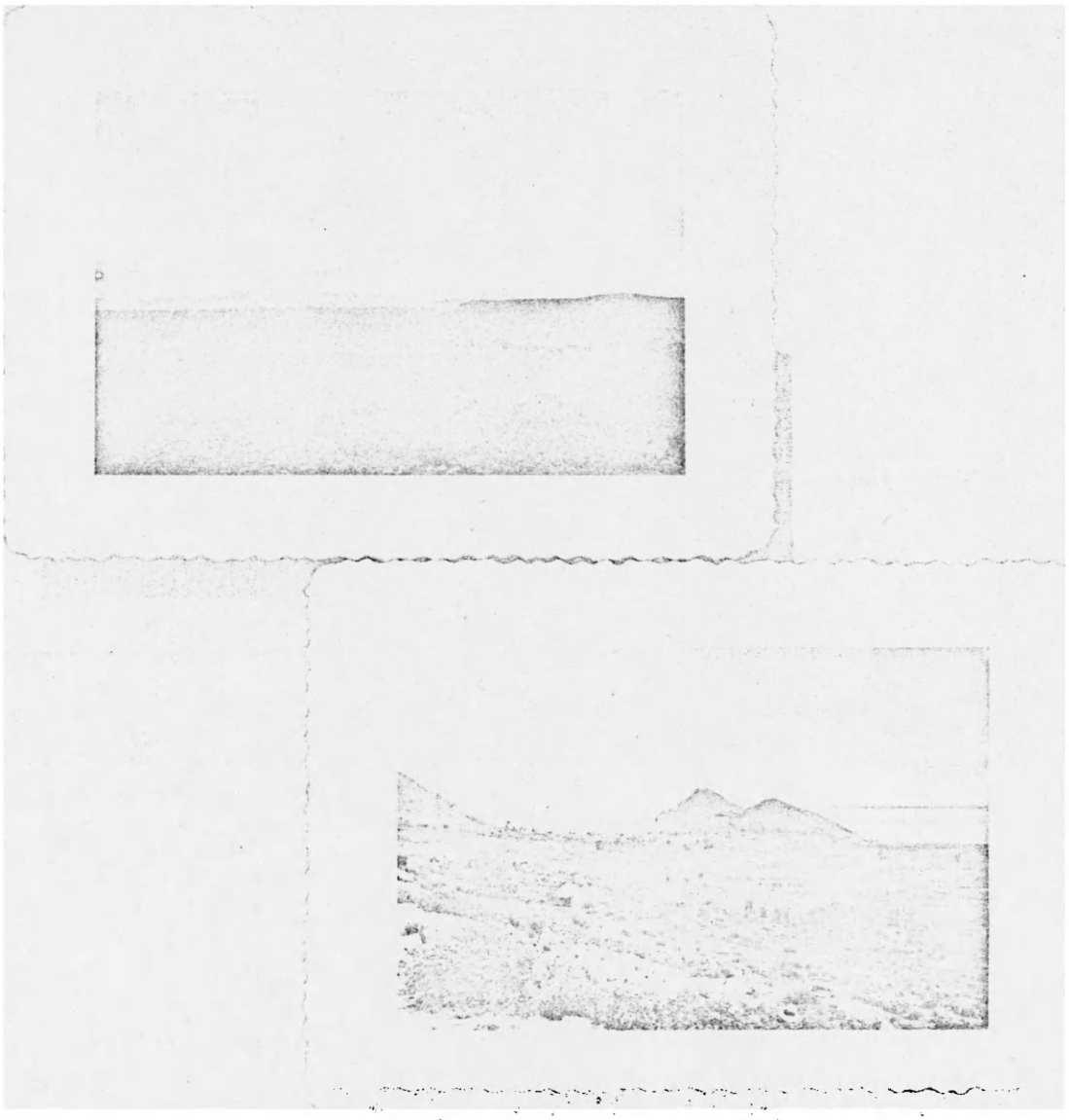
These controls do not pertain at El Alto; the prevailing wind direction there was from the east during the rainy season from August through April 1946, whereas it blew from the west during the dry winter months of May, June and July. This system of air circulation would appear to indicate the presence of trade wind controls, probably resulting from the trades breaking through the lower mountain passes to the southeast of La Paz. The drying effect of the altiplano winds, particularly of the stronger westerlies, has a detrimental effect on agricultural production. At the height of the dry season, these westerlies are referred to as the "cosecha de muerte" (harvest of death) because they carry sand particles in suspension which are thought to be injurious to the health of the inhabitants. In the lake basin these winds take the form of small whirlwinds outlined by their narrow dust-laden funnels as they whisk across the fields. Brisk winds, however, are received by the inhabitants with satisfaction, since they may be utilized for cleaning chuño and winnowing quinoa and cañahua. Toward evening the ever-present winds become raw and biting. The wandering shepherd seeks greater warmth within his heavy woolen poncho and often sleeps close to his animals; the lonely hut dweller secures the door as tightly as possible

and perhaps builds a small fire if he is fortunate enough to have some twigs or dried llama dung. The cold dreary hours of the night are passed in anticipation of the relief which the rays of the sun will minister again on the morrow.



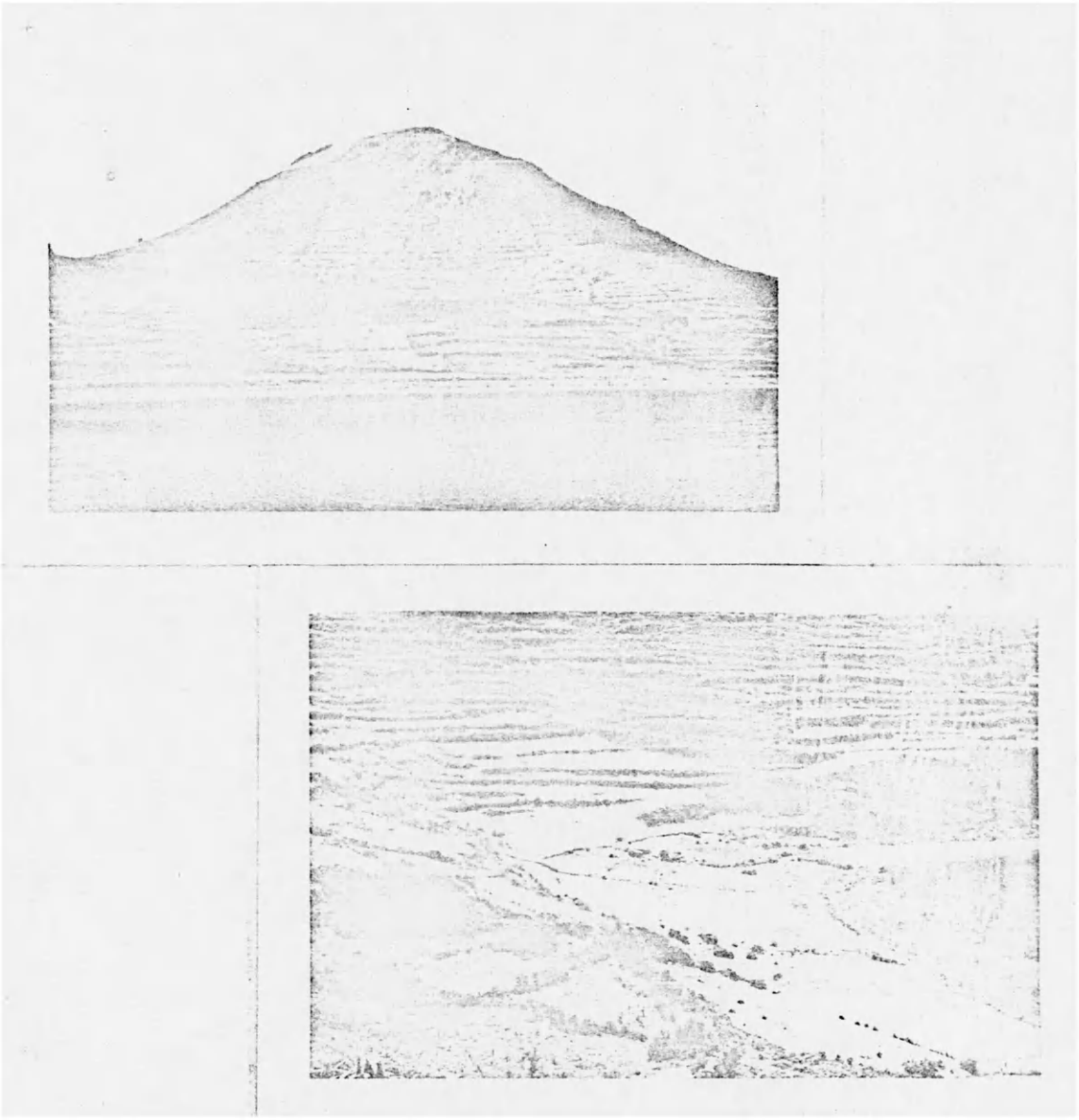
Top: As seen from a plane flying at 29,000 feet, the peak of Mount Illampu comprises numerous sharp aretes. Cumulus clouds on the left cover the valleys of the Yungas leading to the Amazon lowland. This photograph was taken looking southeast at 2:00 P. M.

Bottom: Mount Ancohuma overlooks the high pass (approximately 14,000 feet) leading to the valley in which Sorata is situated. In the foreground is the Laka Kkota; rock glaciers and outwash occupy the middle ground, while bare rock underlies the snow fields.



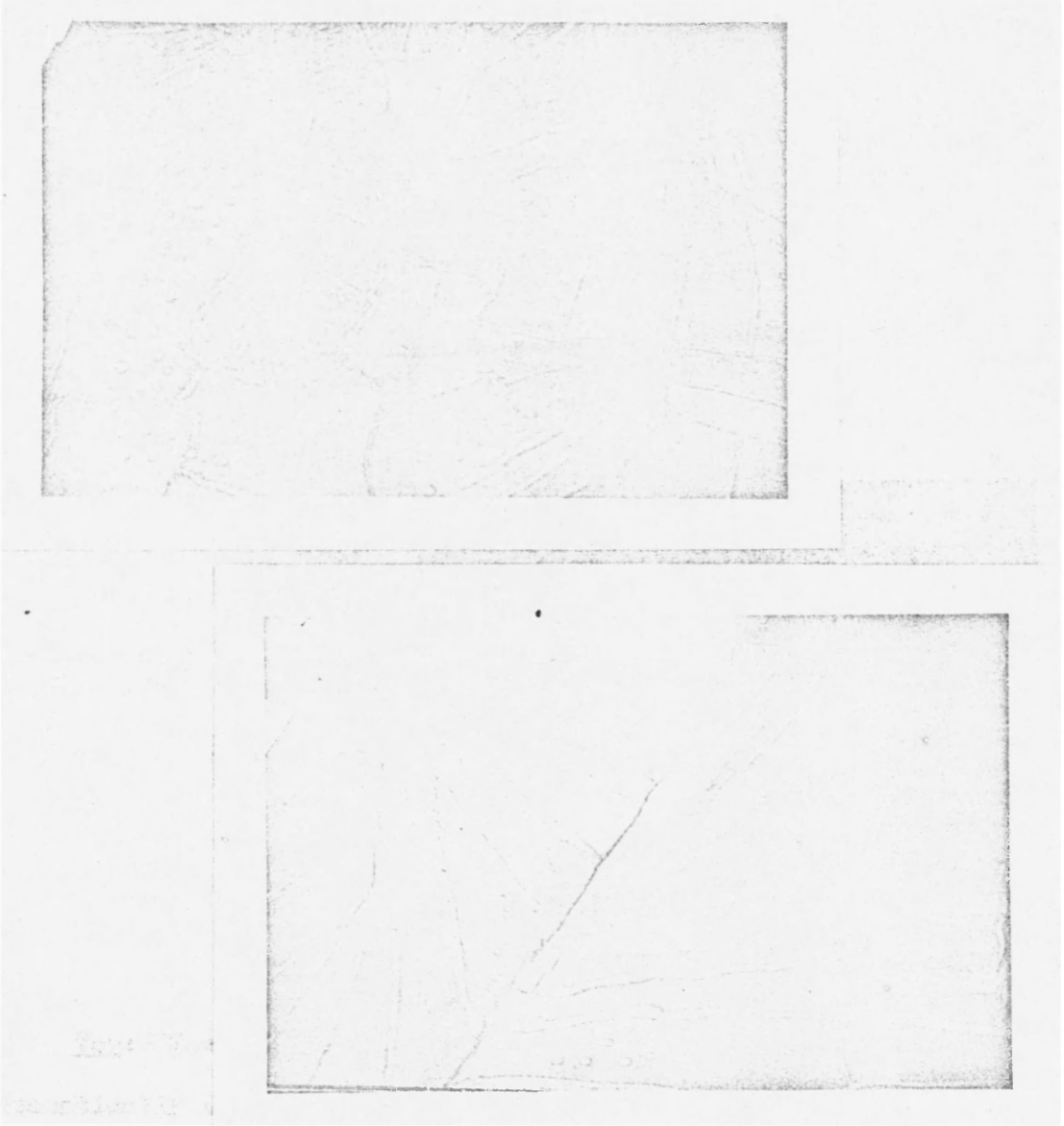
Top: Typical altiplano landscapes away from Lake Titicaca comprise flat, treeless expanses with scattered grass vegetation and sedimentary inliers (at right). On the horizon is the majestic backdrop of the Cordillera Real.

Bottom: Near the lake vegetation becomes more luxuriant and topography more rugged. Intensive use is made of land exposed by lake recession. Nestled in the flat between the hills is Copacabana, religious shrine of the Incas which has maintained its aura of mysticism through the colonial and republican periods.

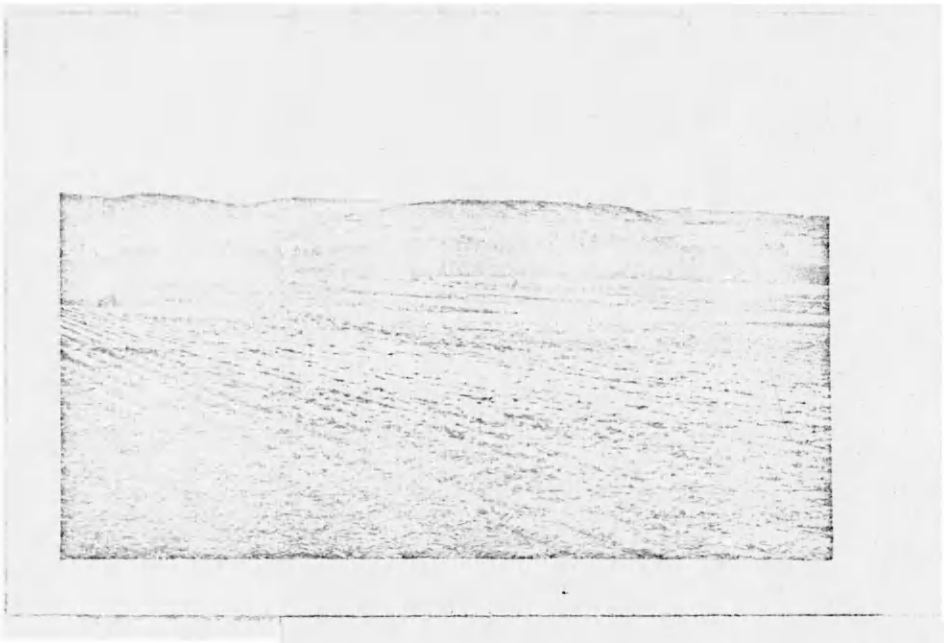


Top: One of several sedimentary remnants encircling Copacabana Bay with slopes laboriously terraced almost to the peak. Terraces (andenes) beyond the line of eucalyptus trees in the middle ground are now abandoned or devoted to grazing. Stone fenced fields in the foreground are intensively cultivated.

Bottom: A close-up of elongated terraces following the contour around the "Isle of the Sun" in Lake Titicaca. Legend establishes this island as the point from which Inca civilization spread.

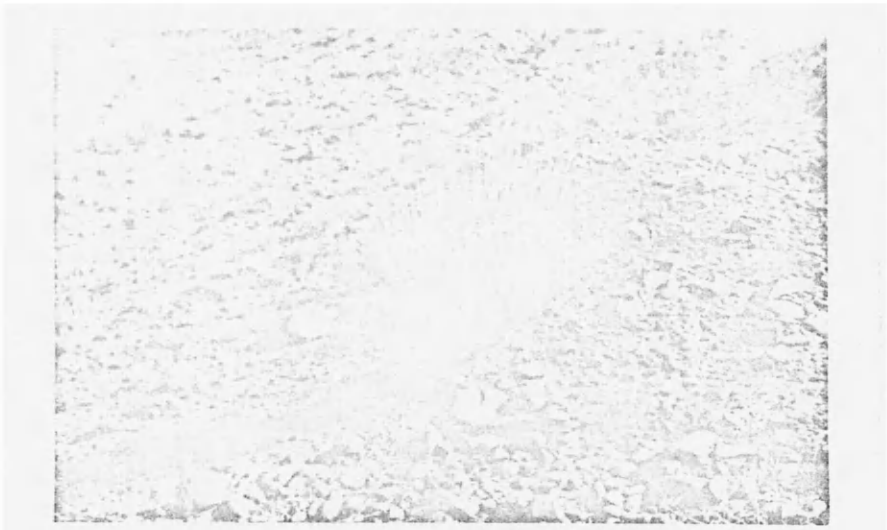


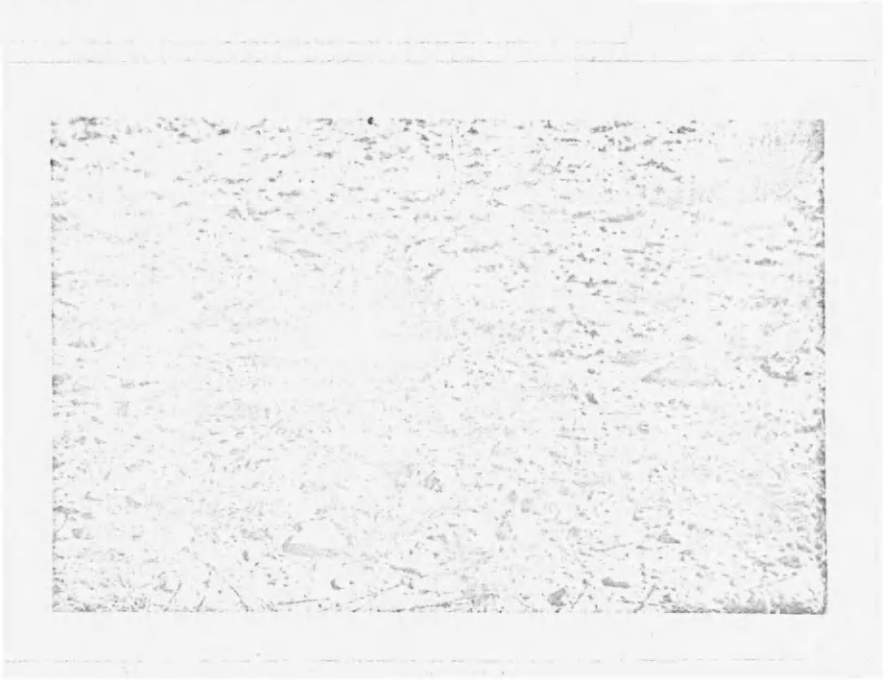
Disposal of rocks uprooted by the plow through centuries of cultivation has become a serious problem. Sinuous lines in the photograph are rock fences separating fields, while the circles represent additional rock piles.



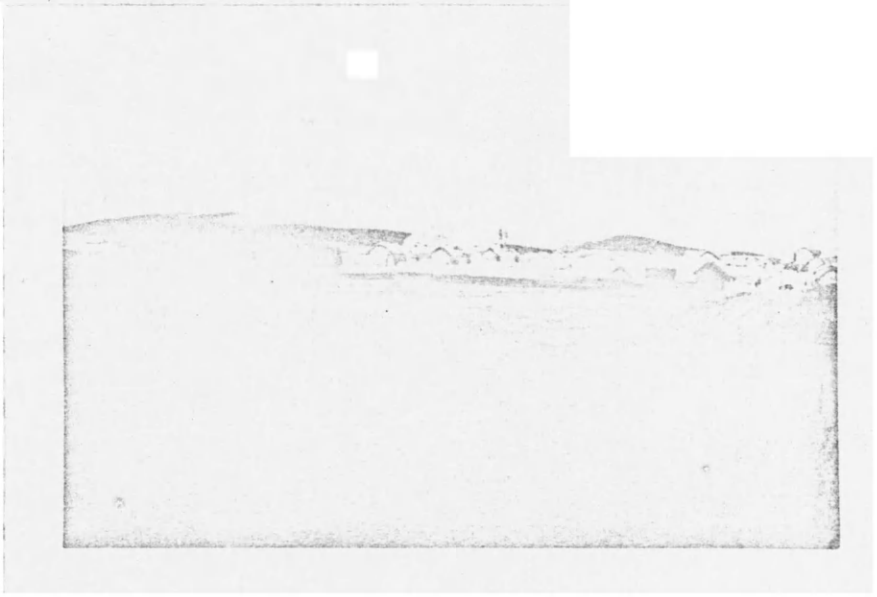
Top: The breadth of land exposed by recession of Lake Titicaca is dramatically illustrated near Finca Batajata on the northeastern shore of Laguna Huiñaimarca. The white areas in the foreground are salt concentrations being leached from the soil. The heavy growth of eucalyptus trees in the middle ground occupy a former shoreline. In the background can be seen the hills of the Peninsula de Huata.

Bottom: Pastoral scene on an estate near Taraco.





The two most common vegetational forms in the lake basin are the spike-like milfoil (top), and the leathery-leaved kelp (below). Note the bushy and dendritic nature of the kelp.



Contrast the modern appearance of La Paz (above), with the drab, adobe and thatch village of Laja. Less than 20 miles separate these two physical sites, yet economically and culturally they are separated by many centuries. Mount Illimani overlooks La Paz, while the Cerro de Comanche rises behind Laja.

Cultural Development

Plant and animal domestication. Although the meager archaeological evidence suggests the presence of land hunters on the altiplano as early as 5,000 years ago, the typical cultural pattern of the lake basin is founded upon the domestication of plants and animals, whether effected by the autochthones or introduced from abroad by the conquering Spaniards. The geographer Carl Sauer has pointed out that the early domestication of plants requires an environment which includes a "forcing bed" or a rich area rewarding intensive use and care of plants; diversified raw materials for a well-balanced economy; soils workable with simple tools; a native vegetation easily disposed of by primitive methods; and a genial climate with seasonal contrasts (10, p. 4).

The natural environment of the lake basin meets these requirements to a large degree; at any rate, a number of plants were cultivated on the lands marginal to Lake Titicaca at an early date. In fact, agricultural practices passed beyond the exploitative stage and reached the point where soils were protected from erosion and systematically built up with fertilizers.

The potato, which ranks with corn among the very great contributions made to human culture, appears to have been the staple food plant of the Titicaca region from the beginning of sedentary agriculture. A map showing the distribution of potato varieties cultivated by South American Indians, constructed by the Russian botanist Bukasov, comprises a striking series of concentric ovals, the central one indicating the greatest number of varieties almost exactly coinciding with

the topographically defined Titicaca basin of Peru and Bolivia (12, p. 82). All potatoes grown on the altiplano are varieties of a single species (Solanum tuberosum) and are known exclusively in the cultivated state (12, p. 83). Varieties of this single species, ranging in color from red through white and black, are extraordinarily numerous. Oca (Oxalis tuberosa) occurs in several varieties--white, yellow, red and purple. All these varieties thrive in dry, rocky and sandy wastes where cereals will not grow; the tubers are a concentrated foodstuff and will keep well in storage. Chuno, the dried potato product, will keep indefinitely, having been found in good condition in ancient graves.

Among the grains, quinoa (Chenopodium quinoa) is the most important. Having a straight, tough stem, this giant pigweed grows up to considerable altitudes. Its spike of millet-like small seeds, inclosed in bitter-tasting shells, gives remarkable yields of 2,000 to one. This grain is highly nutritious, having greater calory content and being richer in the vitamin B_1 complex than wheat. A smaller, less important variety of quinoa is cañahua (Chenopodium pallidicaule).

In addition to the need for a beast of burden, the demand for warm clothing undoubtedly led to the domestication of the llama (Lama glama glama) and alpaca (Lama glama pacos), which probably are closely related to the wild guanaco (Lama guanacoe cacilensis). The wild vicuña (Vicugna vicugna mensalis), whose highly prized wool is as fine as silk, is a second and distinct species. As far back as records are available or traditions reach, the llama and alpaca have been distinct breeds. The llama is the larger animal, standing from 4 to 4½ feet high at the shoulder, while the alpaca is somewhat smaller and less domesticated. About 3½ feet tall at the shoulder, the alpaca has a longer neck, a

smaller head and shorter legs. The wild guanaco rivals the llama in size; but the vicuna is very small, measuring only 25-30 inches off the ground at the shoulder. Coloring of llamas and alpacas may vary considerably--brown, white, gray, mottled or black.

Together with the potato, the llama forms the basis of the Indian economy. Its flesh is used for food or medicine; the wool for clothing, coca pouches or chuno bags; the skin for blankets, rope or sandals, the soles of which are now being replaced by worn automobile tires. Even the dung is utilized as a fuel (taquia) or fertilizer. Moreover, the llama is a beast of burden. Although amazingly sure-footed on the worst trails, caravans comprising 25 to 30 llamas each cover only 12 to 14 miles a day. They will not countenance being overburdened beyond their 50 to 100 pound limit, and when offended for any reason they are capable of spitting an acrid saliva with surprising accuracy upon the object of their wrath.

A domesticated guinea pig (Cavia porcellus) is generally found around the dwellings of the Indians, who consider it a delicacy. However, to the uninitiated, its yellow meat is foul smelling and tastes even worse. The native dog is relatively small, has a small pointed muzzle, a thick skin and short hair.

European domination of the lake basin affected Indian subsistence patterns by the introduction of new plants, domesticated animals and agricultural techniques. The most utilitarian plant introduced into this region by the Spanish is barley (cebada en grano) which matures only in the vicinity of the lake. A short distance from the lake margin it is used as a fodder in its unripened form (cebada en berza). The domesticated animals brought from the old world have been of greater

value to the indigenous economy than the crops. Cattle are more important as producers of cheese than of milk, while oxen are used where possible to pull the Roman type plow, the instrument which has rapidly increased soil erosion in the lake basin. Sheep's wool now augments that of the llama and alpaca; the burro shoulders some of the transportation burden, but over much of the lake basin, the introductions of the Spaniard, with the single exception of the plow, have had little positive effect on the indigenous economy.

A compilation of the major domesticated plants and animals existing in the lake basin prior to the Conquest, and the critical introductions made by the Spanish are contained in Tables 2 and 3.

TABLE 2. Principal Pre-Conquest Domesticated Plants and Animals in the Lake Titicaca Basin

Common Name	Scientific Name
SEED CROPS	
Quinoa	*Chenopodium quinua*
Cañagua	*Chenopodium pallidicaule*
ROOTS	
Potato (Papa)	*Solanum tuberosum*
Oca	*Oxalis tuberosa*
ANIMALS	
Llama	*Lama glama glama*
Alpaca	*Lama glama pacos*
Guinea pig	*Cavia porcellus*
Dog	*Canis familiaris*

TABLE 9. Principal Domesticated Plants and Animals Introduced into the Region by Europeans

SEED CROPS

Common Name	Scientific Name
Barley	Hordeum vulgare
Cebada en grano	
Cebada en bersa	

ANIMALS

Burro	Equus _____
Sheep	Ovis _____
Cattle	Bos taurus

Land tenure systems. In order to evaluate present day land use problems intelligently, an understanding of the evolution of the dominant land tenure systems in the lake basin is helpful. In Bolivia, more than in any other Latin American country, there still exist many of the primitive customs introduced from Spain in addition to persisting remnants of the aboriginal civilization. Since the Indian is the most important economic and social group with which this study deals, the evolution of aboriginal tenure will be briefly sketched. The agrarian system introduced from Spain, having passed through an extremely complicated evolution in the Old World, was further modified to fit the demands of the New World; therefore, it is also considered advisable to outline briefly the land system of 15th Century Spain in addition to pointing out modifications imposed by New World conditions. Thus the present land tenure system in the lake basin resembles the pre-Spanish communal pattern on the one hand, and that of the medieval European manor on the other--with economic ascendancy being maintained by

the proprietors of the manor through political control of the state.

Pre-Conquest tenure: the ayllu. The southern portion of the Lake Titicaca Basin was first occupied by an extremely ancient people who presumably emerged from the Amazonian plains; this type has been preserved as the Urus, who live today in small groups near the outlet of Lake Titicaca, along the Desaguadero River and north of Lake Coipasa (12, p. 23). The Urus still engage primarily in fishing and in hunting aquatic birds. These tribes were later submerged by a pastoral and farming people, the Collas (modern Aymará), who possessed a much higher civilization and developed the very intricate communal organization, based upon the village or ayllu, for which this region has become so well known. Although the ayllu may originally have been a form of social organization based on the clan, it became an agrarian unit as well as a social bond as the establishment of sedentary agriculture progressed (15, p. 199). The primitive community apparently comprised a village of crude earth or stone houses and a fort (pucara) on top of a hill around which lay the fields and pasture (muyca). People related by blood were held together by ties of kinship, informal understanding and mutual protection (23). Thus originated the present day Indian community which still is referred to by the native as his ayllu.

Within the ayllu all land was held collectively and administered by a head man who redistributed it each year. One portion was assigned to individual families according to need rather than ability to produce (within the limits imposed by the availability of land); another section was allocated to the support of religious activities, including the sustenance of the high priests; and a third part, usually the best, was reserved for the head chief (later the Inca). But even when the

harvests of certain land were assigned to rulers and priests, the land itself still belonged to the ayllu—the temporal and spiritual rulers received only the fruits of the land, which was cultivated for their benefit by the people in common as a form of tribute. Individual, assigned parcels of land (sayanas) were exploited privately, the agriculturist being entitled to the usufruct therefrom; however, mutual aid (ajni), common to most agricultural societies, existed to a limited extent even at this level (12, p. 142). But usually the man and woman of a family did the plowing, sowing and harvesting on their sayana, owned by the ayllu, of which they had exclusive use during the period it was assigned to them. Moreover, weapons, utensils, pottery, textiles, houses (the thatch roof, at least) and a number of animals were individually owned as private property.

Communalism under the Incas. Early relations between the Collas and Incas were of a military nature with the former playing the aggressive role, for at this time the Collas controlled the largest and strongest federation of tribes in the Central Andes. With the expansion of the Incas centrifugally from the Cuzco basin under the leadership of a succession of great chieftains, the boundary between the Collan and the nascent Incan Empire was slowly pushed southward along the western shore of Lake Titicaca. Finally the Incas under Mayta Capac (1126-1156) administered a sound beating to their traditional rivals in a battle waged near Cuaqui, in the lake basin on the southern shore of Laguna Aimaimarca, during which 6,000 Collas and 500 Incas were killed (12, p. 24). Although this defeat broke the backbone of Colla resistance, interminable warfare and sporadic rebellions persisted for many years, with the Collas never quite

driving the Incas from their homeland. As a result, an uneasy truce existed between the Collas occupying the southern shore of Lake Titicaca and the Incan Emperor ruling at Cuzco. Although the Collas became the largest tribute paying group of people in the Incan Empire, they were still able to maintain a remarkable degree of independence.

The general policy of the Incas in their imperialistic expansion was to leave the already existing customs and institutions of conquered peoples as far as possible undisturbed, confining their rule to the collection of sufficient revenue to support their efficient military and political organizations (10b, p. 487). Even in this respect they generally operated through local chiefs. If local units persisted in rebelling, as happened in parts of the Collao, they suffered harsh reprisals and, in many instances, were shipped en masse as colonists (mitmaes) to the untamed margins of the extensive Empire. The struggle between local ayllus to acquire more land disappeared with the establishment of the Inca regime. Parcels of land belonging to ayllus were fixed in size to satisfy the needs of the inhabitants; only land belonging to the Inca, religion and the chieftains varied in dimensions, usually due to changing political alignments of the Incan Emperors (10b, p. 489). Each ayllu, or in some instances a group of ayllus, became a government unit under a chief who ruled according to the established custom of consulting with a council of relatives. Regarding the distribution of ayllu lands, the Incan evolved the more democratic process of requiring the chief to confer with all members of the community, thus originating the communal assembly. Cultivation of these assigned lands became not only obligatory, but subject to thorough state control. Idleness and laziness were punishable in accordance with public opinion. The

obligation to perform public work was rigorously imposed-aqueducts were constructed and roads were improved, and troops were raised to fight in further conquests. The patrimony of the ayllus continued to be the marca, an area of agricultural and pastoral land surrounding the village. Rivers, streams and lagoons, pastures and natural forests, herds and wild animals, gold, silver and copper mines, as well as aqueducts, bridges, and roads were integral and unalienable parts of that public patrimony (10b, p. 485). The storage of grain, tubers, fibres and hides was organized. These goods were kept in public regional storehouses (tambos), and were distributed to those who needed them. Thus true property in land in our sense was unknown in the lake basin prior to the coming of Europeans.

Post Conquest tenures; Iberian antecedents. When Roman legions overran the Iberian Peninsula in 200 A. D., they firmly implanted a land system which is distinctly recognizable today despite evolutionary forces imposed by other foreign invaders during the intervening centuries. By granting large tracts of populous agricultural land to deserving soldiers of the Empire as a form of bonus payment, the Roman Emperor successfully established the latifundium (great landed estate with slave or serf labor) on Spanish soil (22, p. 69). During the subsequent six centuries this system of land tenure prospered at the expense of the indigeneous village form of agrarian organization; smaller holdings were consolidated to form the slave-operated latifundia which increased in number as private citizens, church functionaries and even the Imperial Crown itself were attracted to this way of life by the great returns and the prestige which came to be associated with the ownership of large estates. The colonus either worked on land belonging to the patronus

or was permitted to till "individually-owned" parcels of land provided he paid tribute in kind. The type of tenure employed presumably depended on the scarcity of agricultural workers (therefore their ability to demand better conditions) and the degree of control exercised by the vested interests in a specific area.

Although the peninsula experienced three more centuries of mixed Roman and German influence under the Visigoths and was subjugated for an additional five to eight centuries by Berbers and Arabs, the effects of the superimposition of the Roman land tenure pattern proved to be the most lasting and ineradicable. Consequently Roman heritage dominated the cultural landscape which evolved prior to the voyages of discovery (22, p. 61). Indeed, Roman influence was intensified during the period of the reconquest from the Moors, so that the period immediately preceding the discovery of the New World was most important in moulding the Spanish colonial agrarian pattern (22, p. 62).

Due to its wholesale implantation into the New World colonies, the encomienda of 15th Century Spain must be described. It constituted a grant of land and/or serfs by the king to a worthy vassal as a reward for public services. But this grant was for a specific, limited time, generally for two lifetimes (grantee and one heir). The practice fostered a leisure class, a desire for the control of large, remunerative properties, and further entrenched the caste system. When this system was transplanted to the New World, however, the land policy centered around the struggle by the encomendero to obtain title in perpetuity to his individual land holdings which were acquired either as direct grants from the Crown or indirectly through mediation of the Viceroy (22, p. 72).

Agrarian organization during the Colonial Period. "Bring us gold, gold", cried the conqueror, "for we suffer from a disease of the heart that only gold can cure". Although these words were attributed to Hernan Cortes, the conqueror of Mexico, they might just as well have been uttered by Francisco Pizarro when he arrived in Peru in 1531 to begin the reduction of an Incan Empire already rent by internal disorder. The policy of the Spanish Crown, as evidenced by a multiplicity of laws, may have been directed mainly toward indoctrinating the Indians with Christianity, but the soldiers of fortune in actual charge of the Conquest were interested primarily in gold or silver plunder, free labor to work the mines containing these precious metals and, failing to obtain these, land containing productive agriculturists; the Spanish had no intention of dedicating themselves to the cultivation of land for the soldiers of the Conquest had not been farmers in their native Spain. Thus two cultures--diametrically opposed economically, politically, and in religious practice became locked in mortal combat. Stripped of legalistic and religious verbiage, the Spanish system was one of utilitarian individualism with the desire to monopolize and store up wealth and riches to be spent in the acquisition of more power over the rest of the people and the realization of leisure for the pleasures of life (10b, p. 47). In the region of the altiplano approximately 60,000 Indians were employed annually by the mita, a system of forced labor devised for colonial Spanish America. Although a precedent for this work system had been set by the Incan yanaconaji, the conquerors furnished the serfs with food only rather than with all human necessities as did the Incas. Roughly 14% of the natives of each ayllu were continually required to labor in the rich mines located on the high

plateau (12, p. 32). The natives died rapidly due to unaccustomed labor, harsh treatment and disease. Since immediate replacements were demanded by the avaricious mine operators, the actual drain on the population of the ayllus and consequent dislocation of local agricultural production must have been great. Eight million natives, the majority of them Aymará, are estimated to have perished during the conquest of Alto Peru (Highland Peru and Bolivia) (12, p. 33).

Concerning agrarian organization in Colonial Peru and Bolivia, the most effective method of controlling the Indians and their lands proved to be that modeled after the repartimiento (division), a system practiced in medieval Spain which in the New World took the form of outright grants from the King in Spain or de facto usurpations by the conquerors. The repartimiento de tierras (division of lands) was granted in perpetuity, but the repartimiento de Indios (division of Indians), which became the New World version of the previously described encomienda of old Spain, continued to be for two lifetimes (23, p. 158). Since the encomienda gradually evolved into the system of praedial serfdom presently found in the lake basin, a description of the significant stages is indicated. Until 1547 the Indians were required to pay tribute in the form of agricultural products to the encomendero to which they were assigned. Although efforts were made by the Crown to terminate payment of tribute by this method after 1547, the encomenderos circumvented the letter of the law by requiring the Indians to pay tribute in the form of a number of days' personal services each year. In the highlands this type of annual tribute amounted to 40 days for the encomendero, 8 days for hospitalization and medical care, 4 days for upkeep of the towns, 10 days for those caciques (Indian chieftains) who cooperated with the

Spanish authorities and 8 days for the Royal Crown-a total of 70 days' annual personal service from each native (23, p. 160). At this time the Indians did not necessarily reside on the repartimiento de tierras or finca (highland estate), but continued to live in their communities. The inhabitants of an ayllu located in the vicinity of the finca on which its members performed tribute were infinitely more fortunate than those whose ayllus were a considerable distance away. In many instances, the services of an Indian were denied to his ayllu for a complete agricultural cycle while he was many miles away performing tribute. As the encomenderos gained ascendancy in the area and felt they could extract greater concessions from the Royal Crown, the repartimientos de Indios (now the encomienda) were increased from two lifetimes to three and even five in some cases (23, p. 158). This perpetuity in control of both land and natives was becoming an actual fact.

Extensive redistribution of the population accompanied this fixing of control over lands and people. Since the conquerors considered the natives as instruments with which to achieve economic gain, they wanted the Indians to live in accessible places near their farms and mines. Hence their reduction (reducción) was ordered, that is, the natives were required to abandon their communal lands and live in towns selected by the Spanish, two or more ayllus usually being "reduced" to one community in the newly selected location. Encomenderos moved altiplano Indians down to the eastern coastal valleys where introduced crops and animals thrived and the climate was more congenial to the enjoyment of life by the overlord. Those encomenderos who remained on the altiplano nevertheless contributed to the redistribution of the population, although to a considerably less extent than the mine operators. Furthermore,

reductions were made without regard for established land use practices. exclusively herding communities, combination herding and extensive dryland farming communities and irrigated crop communities were frequently relocated on land that could be utilized only for intensive dryland farming. As a result, flocks were abandoned and irrigation works deteriorated or disappeared while great tracts of land, whose fertility had been built up over the centuries, became sterile (10b, p. 439). On the shores of Laguna Rainaimarca and along the piedmont at the eastern border of the altiplano, Indians were congregated in a string of relatively large towns which, although continuing to function as urban agglomerations, have lost their former usefulness.

The encomienda system was officially abolished by Royal Decree in 1721, but the New Repartimiento which was substituted for it permitted the encomienda to continue de facto, if not de jure. As a matter of fact, the importance of this type of patronage increased after this date. Once the pattern was set, it became too remunerative to be abolished or even altered by law; the encomenderos even defied the military might of the royal troops in order to perpetuate their cherished way of life. Thus the step between the perpetual encomienda and praedial serfdom, in which agricultural workers took up residence on the land of the encomendero and became sufficiently attached to this land to be sold with it, was an easy one. In the lake basin this class of Indian is presently known by the ancient Roman term denoting serfdom-colono. And the encomendero has become the patron, from the Roman patronus, or owner. The amount of tribute in the form of personal service gradually increased to 160 days each year, but the colono was granted the right to work small parcels of land on the finca for his own benefit.

Although he was permitted the use of work animals, metal points for his plow and was sometimes paid a small daily wage (late, badly or not at all--as the Spanish refrain runs), he was kept on the property by ignorance of his legal rights, by vagabondage laws strictly enforced and by fear of reprisals on the part of the patron (23, p.161).

When this system of serfdom became known to the King in Spain, the Indians were officially liberated and the system legally abolished. But the execution of these laws was again completely ignored in the region of the lake basin. And why should the King not be defied? Wasn't there always the possibility that a composición de tierras (compromise of lands) would be decreed whereby the Crown, which was in constant financial distress due to disastrous military campaigns on the Continent, would legally acknowledge previous lavish concessions and blatant usurpations in return for a large fee from the colonist?

The division of the marca into individual family plots on the finca led to decay of agricultural practices as well as social disorganization. All that remained of the Indian's spirit was the desire for personal survival and the natural and powerful urge to defend his family "... until he was converted into a nearly irrational being, with a standard of living lower than that of the work animals and only a little higher than that of the llama .... . This together with his hereditary frugality and the rustic simplicity of his herding and farming methods, accustomed him to a vegetative existence, without any element of volition in the monochrome of slothfulness and imbecility." (10b, p. 495).

Finca versus comunidad. The processes contributing to the disintegration of the community and the creation of individual property

ownership did not terminate when Bolivia established its independence from Spain after the battle of Ayacucho in 1824. Since the fight for independence stemmed primarily from a desire for separation rather than revolution, the internal economic system of the colonial period remained the institutional basis on which the new republics were established. There were few men who wished to restore the original rights to the conquered race or to elevate it to the level of the other classes politically, economically or socially. For the Indian, therefore, republican institutions and independence had no significance whatsoever, for their masters under the new regime were not only the same but had acquired even greater authority (10b, p. 496).

Since the community system of land tenure was the chief source of the Aymará's stubborn resistance during the colonial period, the republican government repeatedly though unsuccessfully "abolished" communal ownership by "supreme decree". One such measure, the Law of Envinculation of 1874, forced many Indians to accept individual titles to land belonging to their community. In a legal sense the Indian became a free, ruggedly individual owner in severalty of former ayllu lands (12, p. 32). The express purpose of this law was to create a lever whereby the large landowner would be enabled to wrest desirable agricultural lands and free labor from the established communities. "Surplus" community lands were also confiscated by the government and sold to private owners.

Under the Law of Envinculation, one of the common methods of obtaining land belonging to an Indian community was to force an inhabitant to obtain a small loan from a neighboring landowner which, in terms of the Indian's ability to repay, amounted to hopeless debt. When repayment of the loan at an exhorbitant rate of interest was not forthcoming, the

lender now had legal means of foreclosing on the borrower since the native could be held individually responsible for the debt. The citing of several concrete examples will demonstrate how the law operated in practice. In one village the parish priest selected an Indian who "legally possessed" some desirable agricultural land, which had been assigned to him by his community to lead one of the innumerable church fiestas. Carrying out this duty was mandatory and required an expenditure of several thousand bolivianos (approximately fifty dollars) which the Indian raised by pledging his property to a neighboring landlord. Since the native could not hope to repay the loan, his land was soon added to the encroaching finca by judicial process. The gracious owner, not wanting to deprive the Indian of his ancestral plots, permitted him to live on a small parcel of his former ayllu lands in return for the usual personal services which will be enumerated later in this section. It was inconceivable for the Indian to comprehend that land could be forfeited for non-payment of debt, and since he had a mystic love of his land he docilely accepted the conditions imposed on him (12, p. 38). If the native or his ayllu had protested, which was not likely, the army would have been called in to "clarify" the law of the land. In a footnote to his authoritative The Aymará Indians of the Lake Titicaca Plateau, Weston La Barre, quoting Métraux, tells of the village priest who divided the local cemetery into two sections, one corresponding to heaven and the other to hell. If the sum poured out by the relatives of the dead man did not appear sufficient to him, he threatened to bury the corpse in hell. Terrorized, the Indians would shrink from no sacrifice to assure their loved one a place in heaven. Thus the way was paved for the granting of a loan sufficiently large to deprive

this village of more of its communal lands.

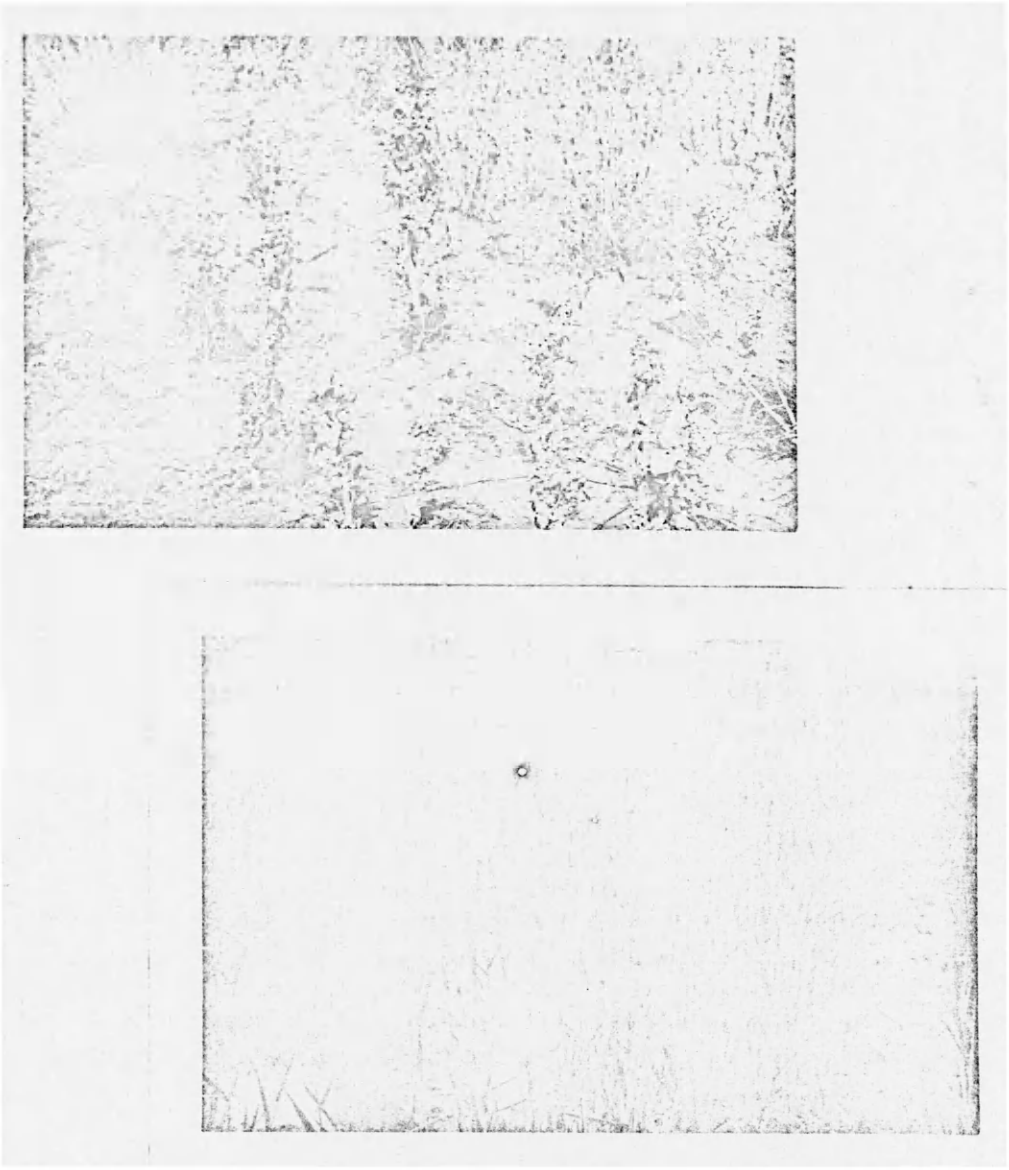
In economic and social fact, however, land in the remaining ayllus is communally owned, despite the legal fiction which has abolished the ayllu. In those cases where ayllu tenure was effectively abolished and individual ownership forced upon the natives, which are numerous in the lake basin, community lands were soon absorbed into the great, privately-owned fincas. The Indians generally remained on their ancestral lands as serfs and were assigned a few acres of land for subsistence by the owner (12, p. 38). In consideration for this, the colono is required to work a customary number of days, usually three or four, each week in the cultivation and harvesting of crops of the patron, provide work animals in working the fields of the owner, take his turn in herding livestock on the grazing lands of the finca, work with his wife as house servants in the home of the patron (pongueaje and mittanaji) whether it is on the finca or in some distant city, deliver the products of the patron, either to his home or to market, perform a number of petty and menial tasks for the mayordomo (resident manager of the estate), and contribute various kinds of products from his fields for the use of the patron (24, p. 327).

The entrenchment of the latifundia system of agrarian organization in the lake basin has created a grotesquely exaggerated and rigidly defended caste system. The chief distinction is drawn between the Indians, who occupy the lowest level, and the cholos (halfbreeds) and whites on the higher rungs, both of whom exploit the Indian in common. Since the boundaries of each group are established by birth, this is a caste system in the strictest sense and not a class system as has been averred by some writers. That the Indian of the finca "displays in his

humble and melancholy bearing the submissiveness of the serf" can be attested by the writer. While visiting altiplano estates in company with their owners, the writer and his wife found it difficult to cover their embarrassment at witnessing the way in which the colonos would come forward individually and bow humbly at the feet of each person before continuing with their prescribed tasks. At no time, however, were the colonos observed to actually kneel before their master and his friends, a custom which is reported in force in various parts of the altiplano and has only recently been abolished in eastern Europe. Submission to this kind of patronage is not tolerated by the free Indian of the comunidad. The natives of the community Jesus de Machaca, located near Guaqui on the southern Lake border, were found to be gentlemanly, proud, courteous and self-reliant, although understandably reserved. Living in greater socio-economic independence than the estate Indian, the community Indian jealously guards his land from the aggression of the large landowner against overwhelming odds and even fights to recover lost lands (10b, p. 497).

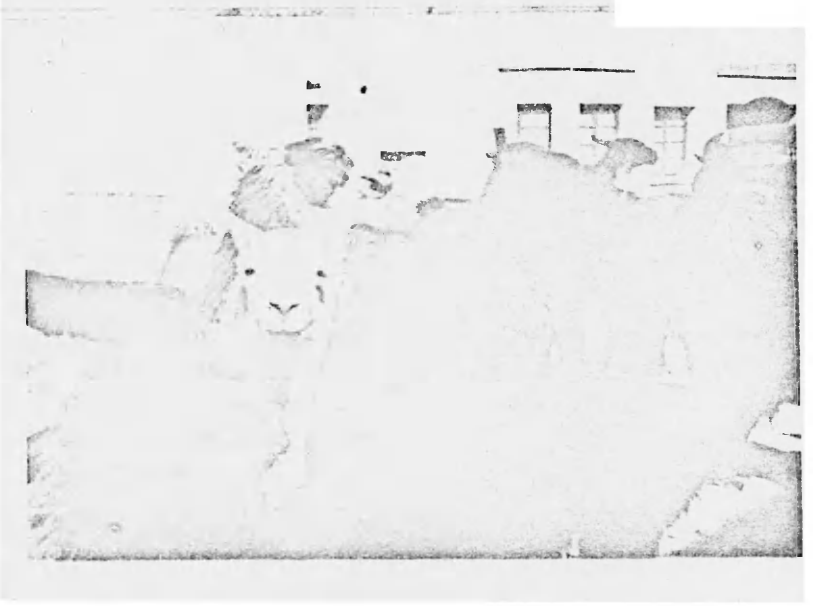
Indians belonging to either communities or estates have often resorted to violence to correct an injustice or to change their status, but the final results have always been disastrous for them. In 1860 a revolt by the Indians near San Pedro on the Strait of Tiquina was quashed by the intervention of government troops. The Indians of comunidad Jesus de Machaca have twice led unsuccessful revolts against the established order. In 1933 government troops were called to Guaqui to put down another rebellion. In 1945 and 1946 estate Indians conducted a series of modern type sit-down strikes, termed brazos caidos (literally, fallen arms), during which the Indians refused to till land

belonging to the owner while asserting ownership rights to the land on the estate which had been assigned to them. This resulted in a significant decrease in agricultural production for those years (11, p. 2). During 1917 an Indian uprising resulted in the death of a patron and a member of his family; Le Paz was threatened with attacks and 140 Indians and their families were exiled to the wilds of the Rio Ichilo in the eastern lowlands (24, p.328). Unfortunately for the Indian, the final outcome of his occasional outbreaks of violence invariably has been a disproportionate letting of Indian blood as government troops restored order.



Top: This poor, open stand of quinoa better illustrates the construction of individual plants. The tough, sturdy stem withstands strong winds and hail, while the seed is encased in a hard, drought-resistant shell.

Bottom: By altiplano standards, this is a thick growth of barley.



Top: A pack train of llamas crosses the rocky wastes of the altiplano after having deposited its cargo at the La Paz market.

Bottom: Llamas rest before leaving La Paz. The one in the foreground has recently been sheared.

LAKE TITICACA
OMASUYOS
Omapusa
ACHACACHI
Gloria
Taramaya-Tipampa
Iquicani
Chigani
SANTIAGO DE HUATA
Pajchani Grande
Coromata Media
Compi
Porajoni
Jango
Matajata
COPACABANA
Amaya
SAN PABLO
SAN PEDRO
HUARINA
Antacolla
Cruzani
Cuyaguani
Rojata
PUERTO PEREZ
Pajcha
PEÑAS
Pariri
Catacora
Kewaya
Las Lomas
Yarwichambi
LAGUNA HUINAIMARCA
Cumana
Calasaya
ANDES
AIGACHI
PUCARANI
Chojnacolla
Taraco
LOS
Pillapi
Yanarico
Masaya
TIAHUANACU
LAJA
LA PAZ
DESAGUADERO
GUAQUI
COLLO-COLLO
Quellani
TAMBILLO
Azafranal
Copajira
Lacoyo
Kentupata
VIACHA
Yarhuicoragua
Corpa
INGAVI
JESUS DE MACHACA
Ponguini
Coniri
SAN ANDRES
NAZACARA
AREAL DISTRIBUTION
OF
GREAT LANDED ESTATES
Provincial Capitals
Great Landed Estates
Roads
Railroads
0
5
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20

SECTION III

CONTEMPORARY LAND UTILIZATION

Great Landed Estates

Having reviewed the factors in the natural and cultural environment of the lake basin which have been most instrumental in shaping present day agrarian policies, this section contains a detailed analysis of land utilization practices and agricultural yields on carefully selected private estates and Indian communities located near Laguna Huinaimarca at the southern end of Lake Titicaca. A total of 38 great landed estates were studied during 1945 and 1946, distributed throughout three provinces of the Department of La Paz as follows: 15 in the Province of Los Andes, 13 in the Province of Omasuyos and 10 in the Province of Ingavi. These three provinces border that portion of Lake Titicaca lying within the Republic of Bolivia. Seven Indian communities, ranging in areal extent from extensive Jesus de Machaca in the Province of Ingavi to restricted Morocollo in Omasuyos, were investigated. Due to its proximity to La Paz and its favored location with respect to productive agricultural land, no Indian communities in the Province of Los Andes were found to be suitable for study.

The assistance of the Bolivian Minister of Agriculture was solicited in the selection of these estates and communities in order to effect a representative cross section from the standpoint of size as well as agricultural production and agrarian organization. To insure greater accuracy in the collection of data, four technicians from the Section

of Rural Economy of the Ministry of Agriculture were assigned to the endeavor and, in order to counteract the usual reticence displayed by estate administrators and the head men of Indian communities, the entire project was given the official support of the Minister of Agriculture. The accompanying map shows the specific location of each estate investigated in this study, and Table 4 indicates the distribution of the great landed estates according to size.

TABLE 4. Distribution of Great Landed Estates According to Size.

Acres	Los Andes	Ocnsuyos	Ingavi	Total
From 0 to 1235	3	3	-	6
" 1236 to 2471	2	2	3	7
" 2472 " 3704	1	3	1	5
" 3705 " 4542	2	-	-	2
" 4543 " 5777	2	1	-	3
" 5778 " 7013	1	2	1	4
" 7014 " 9084	3	-	-	3
" 9085 to 11,555	-	-	1	1
"11,556 " 16,097	-	1	1	2
"16,098 " 18,168	-	-	1	1
"18,169 " 24,710	-	-	1	1
"24,711 " 27,181	-	-	1	1
"27,182 " 31,723	1	1	-	2
Total	15	13	10	38

Los Andes. The Province of Los Andes, with an elevation varying from 12,500 to 12,800 feet, occupies the lower, more level portion of the lake basin southeast of Laguna Huinaimarca. Confined on the north

by the Province of Omasuyos and on the south by Ingavi, its short eastern flank rests against the southern lake border. Puerto Perez is an active port where agricultural products transported across the lake or grown on neighboring estates are assembled for transfer to the large market in La Paz. Merchants from La Paz travel to Puerto Perez each Thursday, the day of the fair in this town, where produce to be sold in La Paz is obtained by means of the primitive barter system in exchange for manufactured goods. The weekly fair at Pucarani takes place on Sunday but is confined almost exclusively to the sale of livestock. During a visit to the fair at Pucarani, the writer observed approximately 300 cattle and upwards of 100 swine being offered for sale or exchange. The majority of the livestock is destined to supply the La Paz market but work oxen may also be obtained.

The principal transportation route for motor cars, which links Puerto Perez with La Paz by way of Pucarani and Laja, is suitable for safe travel during the dry season from May to October only, although more powerful vehicles are able to negotiate the route during the rainy season. Distances separating the principal centers of production in this province from the major market in La Paz are as follows:

from Pucarani	.....	31 miles
Puerto Perez	.....	47 "
Aigachi	.....	40 "
Tambillo	.....	30 "
Laja	.....	22 "
Penas	.....	44 "

Fifteen estates were selected for study in Los Andes totaling 99,528 acres, of which 61,849 acres (62%) comprise relatively level land

and 37,679 acres (38%) represent hill land. The relative distribution of level land and hill land on each estate in Los Andes is contained in Table 5.

TABLE 5. Distribution of Land According to Surface Configuration--Los Andes.

Name of Estate	Total Acres	Acres Level	Per Cent	Acres Hill Land	Per Cent
Chonjacolla	3,088	3,088	100	-	-
Calasaya	3,668	3,668	100	-	-
Copajira	4,940	1,976	40	2,964	60
Quellani	6,422	5,780	90	642	10
Las Lomas (Yanamuyo)	865	87	10	778	90
Kentupata	4,570	1,141	25	3,429	75
Kasaya	9,263	6,948	75	2,315	25
Kewaya	1,482	593	40	889	60
Cumana Grande	1,853	185	10	1,668	90
Yarvichambi	5,928	5,928	100	-	-
Pariri	9,880	7,904	80	1,976	20
Sojata	741	370	50	371	50
Catacora	9,880	9,875	99	5	1
Cruzani	6,175	2,058	33	4,117	67
Ponna (Pajcha)	20,773	12,248	40	18,525	60
Total	98,528	61,849	62	37,679	38

Omasuyos. The Province of Omasuyos, containing the rugged Peninsula de Huata, is located in the more broken portion of the lake basin to the north of Los Andes. Omasuyos has considerably greater lake frontage than Los Andes, a fact which benefits agricultural production on estates situated near the shore. Crop yields on Indian communities located at higher elevations away from the lake border, however, are adversely affected.

Omasuyos' principal port, Santiago de Huata, is less important commercially than Puerto Perez, but two principal highways connect the centers of agricultural production in this province with La Paz. One route skirts the southern shore of the Peninsula de Huata. It is joined by the road from Achacachi at Huarina before continuing to La Paz. The principal centers of production are separated from the La Paz market by the following distances:

from Santiago de Huata	68 miles
Achacachi	69 "
Huarina	53 "

In order to demonstrate the process of amalgamation of latifundia presently occurring in the lake basin, data concerning several contiguous estates which have recently been merged, and are being operated as one unit, have been consolidated. This is the case with Pajchani Grande, which includes Putuma, Khasaya and Tararaya; and Iquicachi, comprising two estates--Iquicachi Grande and Iquicachi Chico. Neglect on the part of many absentee landlords, who receive altiplano properties by inheritance and lose them through foreclosure, is hastening this process of consolidation. Although the average hacendado (proprietor) continues to regard possession of land as an important prop for maintaining character on the Bolivian social scene, he ultimately loses interest in playing a major role if successful operation of his estate requires close attention and effective management. As a result, his property is frequently absorbed by a neighboring estate occupying a more favorable economic position or a more forceful manager. The total area of the 13 properties studied in Omasuyos amounts to 75,662 acres, 38,754 acres (51%) of which comprises level land with

36,908 acres (49%) consisting of hill land. Table 6 illustrates this relationship on individual properties.

TABLE 6. Distribution of Land According to Surface Configuration--Omasuyos.

Name of Estate	Total Acres	Acres Level	Per Cent	Acres Hill Land	Per Cent
Taramaya and Tipampa	494	482	98	12	2
Pajchani Grande	7,074	3,537	50	3,537	50
Omapusa	2,470	617	25	1,853	75
Gloria (formerly Cruz-Huyo)	469	235	50	234	50
Chigani	25	25	100	-	-
Compi	30,875	9,262	30	21,613	70
Porejoni	3,088	927	30	2,161	70
Janco-Amaya	3,705	2,470	67	1,235	33
Iquicachi Grande and Chico	1,534	1,235	80	299	20
Coromata Media	6,175	6,175	100	-	-
Antacolla	3,705	1,853	50	1,852	50
Watajata	600	360	60	240	40
Cuyaguani	15,448	11,576	75	3,872	25
Total	75,662	38,754	51	36,908	49

Ingavi. Although possessing fewer miles of lake frontage than Omasuyos and a smaller area of lake basin soils than Los Andes, Ingavi is one of the most economically important provinces in the Department of La Paz. Estates occupying the lake border have a relatively high agricultural production, and the town of Guaqui serves as the lake port through which large quantities of strategic minerals are exported and food products and manufactures are imported via the seaport of Mollendo, Peru. Guaqui and neighboring Desaguadero have occupied strategic posi-

tions commercially since the time of the Collas and Incas when a reed toll bridge across the Desaguadero River was operating in this vicinity.

The town of Viacha, located approximately 15 miles southwest of La Paz, contains the only cement manufacturing plant in Bolivia and is the nucleus of the nation's railway network; the Arica, Chile-LaPaz, Antofagasta, Chile-LaPaz, and Mollendo, Peru-La Paz routes pass through Viacha before continuing to the capital city. In addition to its importance as a rail center, Viacha is the focal point on which the altiplano's major highways converge. The famous Pan-American Highway crosses the Peru-Bolivian border at Desaguadero and passes through Viacha before spiralling down the river gorge in which La Paz is located. Moreover, the highway connecting La Paz with the historic copper mines at Corocoro touches Viacha and reaches Jesus de Machaca, one of the most extensive concentrations of Indian communities in Bolivia. Several communities under the juriadiction of Jesus de Machaca in the inhospitable Cerro de Comanche region were investigated in connection with this study.

Distances separating La Paz from the dominant centers of agricultural production in Ingavi are as follows:

from Viacha	15	miles
Guaqui	59	"
Tiaco	60	"
Tiahuanacu	47	"
Jesus de Machaca	67	"
Desaguadero	71	"

In the Province of Ingavi only 10 individual estates are indicated as having been studied. Again due to the process of amalgamation under

one owner, the composite data concerning these 10 properties actually pertain to 23 formerly independent estates. Thus, the process of incorporating smaller estates under a single management may be considered an established trend in the lake basin. Pillapi, for example, has absorbed seven estates in its immediate vicinity (Chiva, Piquire, Calacota, Accapata, Humamarca, Chambri and Pituta), and Taraco now includes six formerly separate properties (San Jose, Santa Rosa, Chacollo, Sapana, Nochoca and Ilacoca). The total area of the 10 estates in Ingavi reaches 111,418 acres, of which 54,530 acres (49%) comprises level land and 56,888 acres (51%) consists of hill land. The distribution by estates is contained in Table 7.

TABLE 7. Distribution of Land According to Surface Configuration--Ingavi.

Name of Estate	Total Acres	Acres Level	Per Cent	Acres Hill Land	Per Cent
Pongaini	3,088	771	25	2,317	75
Conini	23,156	5,789	25	17,367	75
Azafranal	1,418	667	47	751	53
Lacoyo	18,525	9,263	50	9,262	50
Copajira	2,470	1,235	50	1,235	50
Yarhuiscragua	2,223	1,667	75	556	25
Taraco	9,902	4,951	50	4,951	50
Pillapi	26,429	19,812	75	6,617	25
Ocoya	17,290	6,916	40	10,374	60
Yanamico	6,917	3,459	50	3,458	50
Total	111,418	54,530	49	56,888	51

Population. Population estimates made by the Bolivian government have been subject to considerable error in the past. Therefore, using

only the number of inhabitants on the estates visited and the total area of these estates, it was determined that the rural density per square mile was lowest in Los Andes (29.8) and highest in Ingavi (40.3). The average rural population density of all three provinces is 35.1. On certain estates the population density is so great that little land remains for the proprietor's crops, and the personal services of the colonos are completed with a minimum time and effort. Conversely, on other estates too few inhabitants apparently occupy an area too large for them to farm successfully with present agricultural techniques. In densely populated sectors, a large portion of the estate is worked by colonos for their own benefit, thus prohibiting an enterprising owner from acquiring agricultural machinery to be employed on the small section cultivated for his benefit. This results in a small agricultural surplus being marketed in La Paz, but the inhabitants of the estate sometimes profit from a reduction in the time required for performance of personal services. In the second case, in which the rural population density is low, the scarcity of workers impedes large-scale production because the large areas capable of being cultivated with modern machinery cannot be harvested adequately due to the scarcity of hands to process the crop. Information regarding rural population and density, and the number of inhabitants on each estate, is contained in Table 8.

Agricultural production. The area under cultivation on all 38 estates represents only 13.6% of their total acreage. The smallest proportion of cultivated land to total area occurs in the Province of Omasuyos (6.7%) and the largest ratio is represented in Ingavi (19.3%). This distribution is illustrated in Table 9.

TABLE 8. Rural Population and Density.

Province	Number of Estates	Area Square Miles	Rural Population	Density per Square Mile	Total Population (Estimate)
Los Andes	15	144	4,294	29.8	38,340
Omasuyos	13	118	4,080	34.5	67,300
Ingavi	10	163	6,575	40.3	69,040
Total	38	425	14,949	35.1	174,680

Los Andes		Omasuyos		Ingavi	
Estate	Population	Estate	Population	Estate	Population
Chojñacollo	230	Turamaya-Tipampa	210	Tonguini	123
Calasaya	300	Pajchani Grande	537	Coniri	114
Copajira	390	Cumpusa	780	Azafranal	256
Quellani	161	Gloria	92	Lacoyo	710
Las Lomas	56	Chigani	5	Copajira	90
Kentupata	180	Coapi	620	Yarhuicoragua	275
Masaya	344	Porejoni	115	Taraco	2,867
Kawaya	110	Jenco-Kaaya	820	Pillapi	1,453
Cumana Grande	533	Iquicachi	64	Corpa	497
Yarhuichambi	480	Coromata Media	220	Yanarico	190
Pariri	230	Antacollo	300		6,575
Sojata	142	Watajata	16		
Catacora	255	Cuyaguani	301		
Cruzani	75		4,080		
Peñas (Pajeha)	800				
	4,294				

TABLE 9. Ratio of Cultivated to Uncultivated Land by Provinces.

Province	Total Area of the Estates	Area Cultivated by the Owner and Colonos	Per Cent	Area not Cultivated	Per Cent
Los Andes	99,528	12,410	12.5	87,118	87.5
Omasuyos	75,662	5,103	6.7	70,559	93.3
Ingavi	111,418	21,549	19.2	89,869	80.7
Total	286,710	39,164	13.6	247,546	86.4

Of the total acreage under cultivation on the 38 estates, 33.7% is land cultivated by the colonos for the benefit of the owners, whereas 66.3% represents land the owners permit the colonos to work for their own benefit. These averages, however, do not reflect the wide variation existing among individual estates. In Los Andes, the amount of land cultivated by colonos for the owner's benefit varies between 1.9% (Peñas) and 46.2% (Las Lomas). In Omasuyos the percentages vary between 5.2 (Ocapusa) and 100 (Chigani and Watajata). These last two estates are special cases in which labor is paid a daily wage and the agriculturists are to own the property they cultivate and on which they reside. That an average of 50% of the cultivated area in Ingavi is worked for the owner's benefit is due to the presence of modern agricultural machinery on several estates which permits more advantageous exploitation of the available labor supply. The estate in actual possession of colonos, on which the greatest amount of land is cultivated for the benefit of the owner, is Villapi in the Province of Ingavi with 92.1% of its 8,000 cultivated acres utilized in this manner. Tables 10, 11 and 12 furnish this information for each estate.

TABLE 10. Distribution of Cultivated Land between Proprietors and Colonos--Los Andes

Estate	Total Area Cultivated	Area Cultivated for Owner	Per Cent	Area Cultivated by Colonos	Per Cent
Chojñacollo	543	49	9.1	494	90.9
Calasaya	510	68	13.3	442	86.7
Coyajira	971	190	19.6	781	80.4
Quellani	705	296	42.0	409	58.0
Las Loras	193	89	46.2	104	53.8
Kantupata	914	49	5.4	865	94.6
Macaya	2,240	215	9.6	2,025	90.4
Kasaya	105	12	11.8	93	88.2
Cumana Grande	451	26	5.8	425	94.2
Yarhuiohambi	633	114	18.0	519	82.0
Pariri	1,556	72	4.6	1,484	95.4
Sojata	509	40	7.8	469	92.2
Catacora	766	25	3.2	741	96.8
Cruzani	185	30	16.0	155	84.0
Pomas (Lajcha)	2,129	40	1.9	2,089	98.1
Total	12,410	1,315	10.6	11,095	89.4

TABLE 11. Distribution of Cultivated land between Proprietors and Colonos--Omasuyos

Estate	Total Area Cultivated	Area Cultivated for Owner	Per Cent	Area Cultivated by Colonos	Per Cent
Taramaya and Tipampa	121	17	14.3	104	85.7
Pajchani Grande	1,033	321	31.1	712	68.9
Ompusa	1,277	67	5.2	1,210	94.8
Gloria	237	25	10.4	212	10.4
Chigani	18	18	100.0	--	--
Compi	1,240	203	16.3	1,037	83.7
Perojoni	133	52	38.9	81	61.1
Janco-Amaya	274	94	34.2	180	65.8
Iquicachi	69	49	71.4	20	28.6
Coromata Media	210	17	8.2	193	91.8
Antacolla	240	22	9.3	218	90.7
Watajata	98	98	100.0	--	--
Cuyaguani	153	96	62.9	57	37.1
Total	5,103	1,079	21.2	4,024	78.8

TABLE 12. Distribution of Cultivated land between Proprietors and Colonos--Ingavi and Summary

Estate	Total Area Cultivated	Area Cultivated for Owner	Per Cent	Area Cultivated by Colonos	Per Cent
Penguini	185	74	40.0	111	60.0
Conciri	2,181	47	2.2	2,134	97.8
Asafranal	493	26	5.3	467	94.7
Lacoyo	1,921	69	3.6	1,852	96.4
Copajira	1,233	232	18.8	1,001	81.2
Yarwicoragua	257	166	64.4	91	35.6
Taraco	6,268	2,859	45.6	3,409	54.4
Pillapi	7,662	7,054	92.1	608	7.9
Corpa	929	40	4.3	889	95.7
Yamarico	420	198	47.1	222	52.9
Total	21,549	10,765	50.0	10,784	50.0

Summary

Province	Total Area Cultivated	Area Cultivated for Owner	Per Cent	Area Cultivated by Colonos	Per Cent
Los Andes	12,410	1,315	10.6	11,095	89.4
Omasuyos	5,103	1,079	21.2	4,024	78.8
Ingavi	21,549	10,765	50.0	10,784	50.0
Total	39,062	13,159	33.7	25,903	66.3

The principal crops grown in the lake basin were enumerated in the section on plant and animal domestication. In addition to major crops such as potatoes (Solanum tuberosum), quinoa (Chenopodium quinua) and barley (Hordeum vulgare), beans (Vicia faba), oats (Avena sativa), for forage only, oca (Oxalis tuberosum), wheat (Triticum vulgare), commonly known as Chilean wheat, and cañagua (Chenopodium pallidicaule) are cultivated on a minor scale. On the basis of type of crop cultivated, the divi

estates takes the form indicated in Table 13.

TABLE 13. Distribution of Cultivated Land between Proprietors and Colonos by Crop.

Crop	Total Area Cultivated	Cultivated for Owner by Colonos	Per Cent	Cultivated by Colonos	Per Cent
Potatoes	11,471	3,073	26.8	8,398	73.2
Quinoa	4,228	503	11.9	3,725	
Cebada en hoja (barley)	6,470	845	13.1	5,625	86
Cebada en grano (barley)	12,656	6,986	55.2	5,670	44.8
Beans	1,707	290	17.0	1,417	83.0
Cañahua	892	68	7.6	824	92.4
Oca	93	46	49.3	47	50.7
Oats	63	63	100.	--	--
Wheat	1,448	1,250	86.3	198	13.7
Pearled barley	27	27	100.	--	--
Rye	7	7	100.	--	--

The harsh natural environment of the lake basin is primarily

responsible for limiting the crop varieties to those few which are able to withstand low temperatures and scant, variable rainfall. The average acre yields, however, are held to the minimum on most estates due to lack of interest on the part of the proprietors in introducing better agricultural techniques, including greater incentives for the agriculturists. It is readily understood how the colonos, who are entrusted with accomplishing all phases of the agricultural cycle on the owner's land, are interested primarily in finishing these unremunerative tasks in

only for themselves but for their work oxen.

The only fertilizer in general use is manure. Under these circumstances, the number of livestock belonging to the owner invariably determines the amount of fertilizer received by fields cultivated for his benefit. The fields assigned to the colonos not only receive less fertilizer than those of the proprietor, but generally are located on less productive land. Therefore, a greater quantity and quality of minerals are being removed from the soil than are being replaced because fertilization is deficient in both amount and kind. In some severe cases (even during normal climatic years) the yield of a field barely returns the amount of seed used. The majority opinion of the mayordomos (resident managers) on the estates visited is that the excessive cost of chemical fertilizers, when they are available, does not justify their use. Some administrators claimed that the use of chemical fertilizers had not increased the quantity or quality of the harvest, but these results are probably due to the indiscriminate use of chemical fertilizers without regard for specific soil deficiencies.

The seed used is not subjected to careful selection; the seed for

the following year's crop simply being separated from part of the current harvest without regard for quality. No system of disinfection is employed nor are better varieties of seeds imported or developed locally. The interplay of increasingly degenerate seed and poorer harvests has resulted in a downward trend in agricultural yields on a great majority of the estates. Administrators were agreed as to the causes of this decline.

The crop rotation system is a curious mixture of pre-colonial practice
Spain by the conquerors. The first year potatoes are planted in a given field; the second, quinoa or beans; the third and fourth years, barley in some instances alternating with cañagua. Once this agricultural cycl is completed, the field is permitted to lie fallow (descanso) for from one to ten years before the rotation plan is renewed. The period during which the field is permitted to lie fallow is regulated by the size of the estate rather than by the time required for the soil to recu Consequently, the larger the estate, the longer is the fallow peric When queried as to why such a crop rotation plan is maintained, the usua answer given by an administrator was "porque así los hacian mis antepasados" (because this is the method employed by my ancestors), or simply "por ser costumbre" (it is the custom). The average acre yields obtained on all the estates under study are indicated in Table 14.

Although it is seldom advisable to draw comparisons of agricultural yields among areas which are subjected to widely divergent controls in their natural and human environment, Table 15 has been included in order to demonstrate the great discrepancy in yields between the Lake Titicaca Basin on the one hand, and Chuquisaca, a department in southeastern Bolivia with elevations under 9,000 feet, and the Republic of Argentina

and Chile on the other. The statistics for the Department of Chuquisaca were obtained from an experimental agricultural census conducted in 1942, the average yields in the Republic of Argentina were taken from a manual published by the Agricultural Engineer, Emilio A. Coni, and the Chilean statistics appeared in a publication of the "Agenda Del Salitre de Chile".

TABLE 14. Average Acre Yields--Los Andes, Omasuyos and Ingavi.

Crop	Los Andes	Omasuyos	Ingavi	Average Lbs.	Prod. Bu.
Potatoes	4,124	4,123	3,821	4,023	67
Quinoa	1,045	905	773	908	
Cebada en hebras (Barley)	2,603	2,348	1,442	2,131	
Cebada en grano (Barley)	543	399	357	433	9
Beans	786	973	708	822	
Canacua	689	1,057	561	769	
Oca	2,274	2,273	--	2,273	
Oats	409	491	869	590	18
Wheat	--	471	306	388	6.5
Pearled Barley	1,536	498	--	1,017	
Rye	--	712	--	712	12

TABLE 15. Average Acre Yields--Lake Basin, Chuquisaca, Argentina, Chile.

Crop	Average Yield per Acre in Pounds			
	Zones Studied	Census of Chuquisaca	Argentina	Chile
Potatoes	4,023	4,645	13,360	26,720
Cebada en grano	433	1,302	1,781	2,494
Oats	590	956	2,226	2,672
Wheat				
Rye				
Beans	822	504	2,004	--
Quinoa	908	538	--	--
Cebada en hersa	2,131	3,237	--	--
Oca	2,273	2,538	--	--

The major market for the estates' agricultural production is the city of La Paz, although much of the produce from fincas located in the Province of Ingavi is shipped by rail and truck to the mining communities in the vicinity of Oruro. The limited surpluses produced for the proprietor satisfy only a small portion of the demand created by the population concentrated in La Paz. The seasonal and yearly price fluctuation is considerable, and since the proprietors of great landed estates have a strictly mercantilistic attitude toward the consuming public, the vicious, inhuman laws of scarcity economics are permitted to run their normal course unimpeded by any form of regulation. In many quarters, greater agricultural production is feared because the creation of larger surpluses would result in lower per unit prices. Since the potato is the basic food in the lake basin, its production in sufficient quantities to supply the demand at a reasonably low price is not re-

garded as good business practice. Crops produced by the colonos for their own benefit are barely sufficient to maintain these unfortunates above the starvation level. Any small surplus produced by the colonos is generally utilized for barter purposes in the local weekly markets rather than being sent to La Paz. During years of agricultural scarcity, the barely self-sufficient colonos are converted into consumers, thus creating an even greater demand on the surpluses produced on the private estates.

Pasturing activities. Two significant factors contributing to the poor quality of pasture land in the lake basin are: (1) lack of moisture away from the lake border and (2) scarcity of extensive permanent pasture between 12,500 feet, the level of Lake Titicaca, and 13,000 feet, the upper limit of successful intensive agriculture. Along the margin of Laguna Huinaimarca, livestock can be grazed on grass-covered fallow land, or irrigated pasture. Since the better agricultural land is limited vertically by the 13,000 foot contour, above which crops do very poorly, extensive pasturing activities are relegated to those lands above 13,000 feet known locally as the puna brava. This is the region covered by the unnutritious pajonales and tola from which livestock must gain sustenance during the rainy season. Most estates have developed ahijaderos, natural pasture lands located in the more humid, lower areas of the estate around which adobe fences have been constructed to exclude livestock during the normal grazing season. During the dry season, livestock are turned into the ahijaderos and cattle are fed supplementary rations of cebada en hierba, a non-maturing barley which is cut green. Under these adverse conditions, sheep are the most important grazing animals, although some few estates are attempting to introduce

good quality milk cattle. The number and types of livestock maintained on the estates under study, including those of the owner and colonos, are indicated in Table 16, whereas detail by estates and type of owner with regard to cattle and sheep is contained in Table 17.

TABLE 16. Total Livestock--Los Andes, Omasuyos, Ingavi.

Province	Sheep	Cattle	Swine	Horses	Mules	Burros
Los Andes	77,833	2,254	6,664	57	291	1,886
Omasuyos	36,703	1,877	2,637	59	84	864
Ingavi	79,888	5,279	7,133	24	543	3,252
Total	194,424	9,410	16,434	140	918	6,002

TABLE 17. Distribution of Cattle and Sheep between Proprietors and Colonos--Los Andes, Omasuyos, Ingavi and Summary.

Los Andes

Estate	Belonging to Proprietor			Belonging to Colonos		
	Cattle			Cattle		
	Bulls	Others	Sheep	Bulls	Others	Sheep
Chojnacolla	4	17	1,100	40	0	2,200
Calasaya	1	49	2,645	102	0	3,770
Copajira	1	41	1,580	103	0	2,405
Quellani	2	7	2,226	80	29	945
Las Lomas	6	4	1,500	12	24	1,220
Kentupata	0	0	300	70	0	1,375
Masaya	0	27	2,440	30	13	3,243
Kewaya	0	6	500	60	41	900
Cumana Grande	2	11	868	276	94	5,720
Yarhuichambi	10	50	5,300	120	53	3,500
Perini	2	42	3,074	120	59	9,700

Los Andes (Cont.)

Estate	Belonging to Proprietor: Cattle: Bulls	Others	Sheep	Belonging to Colonos: Cattle: Bulls	Others	Sheep
Sojata	1	29	2,580	66	0	1,980
Catacora	6	8	850	100	55	4,000
Cruzani	1	6	1,000	36	54	722
Penas (Pajcha)	2	67	4,715	131	85	7,450
Total	38	364	30,678	1,346	506	47,155
Orasuyos						
Turamaya and Tipampa	0	0	900	150	0	830
Pajchani Grande	42	12	5,000	300	0	3,610
Ornapusa	0	0	1,260	106	0	1,805
Gloria	0	0	120	18	0	260
Chigani	0	2	40	0	0	0
Compi	1	30	241	140	92	2,205
Parejoni	1	6	410	50	26	700
Janco-Amaya	1	30	3,000	220	93	2,540
Iquicachi Grande	15	10	204	12	4	160
Coromata Media	12	25	2,680	90	40	1,080
Antacolla	4	29	1,726	84	56	1,680
Watajata	0	0	60	0	0	0
Cuyaguani	27	28	3,430	70	46	2,842
Total	103	172	19,071	1,240	362	17,712
Ancoví						
Ponguini	2	4	485	38	15	640
Conini	0	0	1,665	206	130	9,950
Azafranal	14	22	1,800	126	178	2,725

Ingavi (Cont.)

Estate	Belonging to Proprietor			Belonging to Colonos		
	Cattle			Cattle		
	Bulls	Others	Sheep	Bulls	Others	Sheep
Lacayo	0	9	1,700	290	190	7,100
Copajira	0	18	1,030	50	39	800
Yarvicoragua	0	15	450	70	117	1,240
Taraco	1	94	2,769	1,040	436	20,000
Pillapi	13	508	16,000	550	710	3,600
Corpa	-	4	1,159	110	105	2,700
Yanarico	2	23	2,700	90	60	1,015
Total	32	697	29,738	2,570	1,980	50,070
			Summary			
Los Andes	38	364	30,678	1,346	506	47,155
Omasuyos	103	172	19,071	1,240	362	17,712
Ingavi	32	697	29,738	2,570	1,980	50,070
Total	173	1,233	79,487	5,156	2,848	114,937

The demand created by the infant textile industry in La Paz has become an incentive for the intensification of sheep raising in the lake basin. This opportunity for economic gain has already led to preliminary attempts to improve degenerate native stock by the importation of thoroughbred animals. Apparently the sheep best suited to the lake basin and most favored among livestock ranchers is the merino, although Finca Taraco in the Province of Ingavi is attempting to acclimatise thoroughbred sheep for the development of a carecul industry. This estate also possesses relatively large herds of Australian merino and Corredale sheep. The total number of thoroughbred sheep maintained on the properties visited amounts to 3,595 head, distributed among the estates in conformity with

Table 18.

TABLE 18. Distribution of Thoroughbred Sheep on Estates--Los Andes, Omasuyos, Ingavi and Summary.

Los Andes

Estate	Rams	Ewes	Lambs	Total
Calasaya	5	10	10	25
Copajira	50	30	-	80
Quellani	6	15	5	26
Masaya	7	15	-	22
Sojata	20	-	-	20
Total	88	70	15	173

Omasuyos

Pajchani Grande	50	-	-	50
Campi	21	-	-	21
Iquicachi Grande and Chico	4	200	-	204
Watajata	3	10	5	18
Cuyaguani	25	136	78	239
Total	103	346	83	532

Ingavi

Conini	22	-	-	22
Copajira	30	-	-	30
Tarace	522	1,944	303	2,769
Corpa	3	64	2	69
Total	577	2,008	305	2,890

Summary

Los Andes	88	70	15	173
Omasuyos	103	346	83	532
Ingavi	577	2,008	305	2,890
Total	768	2,424	403	3,595

Throughout the lake basin, however, native sheep are small in stature, the quality of the wool is poor (short fiber and unclean) and yields are low. On land that should support no more than one animal per acre, five to seven sheep are grazed. The mortality rate among lambs is very high because ewes are milked for the manufacture of cheese. Sheep having contagious diseases are not isolated from the others; only four of the properties visited had dipping pens for disinfecting their animals. During 1945, the number of lambs raised amounted to only 56% of those born. Discounting the normal mortality rate of 10%, this represented a loss of approximately 35,000 sheep on the 38 properties studied, enough to feed La Paz for eight and one-half months. Under these discouraging circumstances, it is not likely that the quality of the animal or the yield of wool will increase appreciably in the near future.

The shearing of sheep is accomplished annually, particularly during the months of April and May, which coincide with the harvest, or October, which is the height of the planting season. The labor connected with shearing sheep and transporting wool to market is another of the obligations with which the colonos must comply. They must supply their own shearing tools which usually consist of dull knives, pieces of tin can or broken glass. The shearing capacity of each colono is about 15 sheep per day.

With the exception of Finca Pillapi in the Province of Ingavi, which possesses more than 300 thoroughbred milch cows, cattle in the three provinces consist of native mixed breeds. Although supplementary forage in the form of cebada en berza is provided, the milk production of the average altiplano cow is very limited not exceeding, in the lake basin,

two quarts of milk per animal per day. Even the milk production of thoroughbred animals on Finca Pillapi is lower than that normally expected in a more favorable environment. Of relatively greater importance to the economy of the region are the work animals belonging to the colonos.

Almost every Indian family possesses several swine which are left to their own devices to obtain food, except during the potato harvest when they are fed badly damaged or diseased tubers. Swine are maintained on estates for consumption by the administrator or owner, but the Indians generally sell their swine on the hoof in the local markets. There were few mules and horses on the estates studied; instead burros are used by the colonos for transportation purposes. Llamas and alpacas, which generally are very numerous on Indian communities possessing large grazing lands, are very scarce on the estates. On the 38 properties visited there were only 244 llamas or alpacas distributed as follows:

Province	Estate	Alpacas	Llamas
Los Andes	Penas	233	0
Ingavi	Azafranal	0	3
	Copajira	5	3
	Total	238	6

Pastures are excessively overgrazed; even the ahijaderos are not sufficiently large to carry livestock through the dry season. Tables 19, 20 and 21 indicate the number of cattle and sheep on each estate in relation to available pasture. However, the compilation of these statistics has not been consistently accurate. In some instances it is apparent that only ahijaderos are included as pasture to the exclusion of natural, open pasture. In other cases, ahijadero pasture is included

with open pasture. In general, however, it is believed that these tables, especially the summary, Table 22, present a fairly representative portrayal of the pressure of livestock on grazing lands.

TABLE 19. Total Area, Acres of Pasture and Number of Cattle and Sheep--Los Andes.

Estate	Total Area	Acres of Pasture	Cattle	Sheep
Chojnacollo	3,088	5	61	3,300
Calesaya	3,668	926	152	6,415
Copajira	4,940	74	145	3,985
Quellani	6,422	1,482	118	3,171
Las Lomas	865	124	46	2,720
Kentupata	4,570	62	70	1,675
Masaya	9,263	25	70	5,683
Kowaya	1,482	12	107	1,400
Cumana Grande	1,853	20	383	6,588
Yarhuichambi	5,928	618	233	8,800
Pariri	9,880	741	223	12,774
Sojata	741	198	96	4,560
Catacora	9,880	618	169	4,850
Cruzani	6,175	510	97	1,722
Ponos (Pajcho)	30,773	494	284	12,165
Total	99,528	5,909	2,254	77,833

TABLE 20. Total Area, Acres of Pasture and Number of Cattle and Sheep--Omasuyos

Estate	Total Acres	Acres of Pasture	Cattle	Sheep
Taramaya and Tipampa	494	25	150	1,730
Pajchani Grande	7,074	3,959	354	8,610
Ompusa	2,470	247	106	3,065
Gloria	469	25	18	380
Chigani	25	5	2	40
Compi	30,875	2,470	263	2,446
Porojani	3,088	59	83	1,110
Janco-Amaya	3,705	57	344	5,540
Iquiachi Grande	1,534	69	41	364
Coromata Media	6,175	619	167	3,760
Antacollo	3,705	185	179	3,406
Watajata	600	3	-	60
Cuyaguani	15,448	371	171	6,172
Total	75,662	8,008	1,877	36,783

TABLE 21. Total Area, Acres of Pasture and Number of Cattle and Sheep--Ingavi.

Estate	Total Area	Acres of Pasture	Cattle	Sheep
Ponguini	3,068	17	59	1,125
Coniri	23,156	69	336	11,615
Azafranal	1,419	74	340	4,525
Lacoyo	18,525	3,088	489	9,100
Copajira	2,470	74	107	1,830
Yarvicoragua	2,223	10	202	1,670
Taraco	9,902	494	1,571	22,769
Pillapi	26,429	7,410	1,881	19,600
Corpa	17,290	1,112	219	3,859
Yanarico	6,917	2,223	175	3,715
Total	111,418	14,541	5,279	79,808

TABLE 22. Number of Livestock per Acre--Los Andes, Omasuyos, Ingavi.

Province	Acres in Pasture	Number of Cattle	Number of Sheep	Number of Livestock per Acre: Cattle	Sheep
Los Andes	5,909	2,254	77,833	.38	13.1
Omasuyos	8,088	1,877	36,783	.20	4.5
Ingavi	14,541	5,279	79,808	.36	5.5
Total	28,538	9,410	194,424	.31	7.7

By-products. Among the by-products obtained from livestock, the manufacture of cheese occupies a preferred place, the labor for which is again furnished by the colonos. Approximately two and one-half quarts of cow's milk are sufficient to make two lbs. of cheese, but it requires a

gallon of sheep's milk to make the same amount. With the single exception of Finca Pillapi, butter is manufactured on a scale sufficient to satisfy the requirements of the proprietor only.

The three most important by-products are typically Bolivian, namely, chuno, tunta and cava. The month of June possesses the best physical requirements for the manufacture of chuno, since the days are sunny and hot; the nights cold and dry. The complicated process of manufacturing chuno commences with the spreading of the "amarga" potato on a small patch of level grassland. The potatoes remain on the ground for three or four days to be alternately frozen at night and thawed during the day. Peelings are removed and much of the moisture is extracted in the second step, in which the colonos (generally the women and children only) tread barefooted with a sharp twisting motion of the foot on small piles of potatoes. Again the product is spread thinly over the grass to become exposed to the evaporative action of the hot sun. After 30 to 60 days the potatoes are converted into small, dry, hard pellets of starch which may be preserved indefinitely.

Tunta, also called chuno blanco is made by a much more elaborate process than is required for the manufacture of chuno. The process consumes almost two months and is divided into two phases. The first phase is similar to that followed in making chuno, except that the potatoes are peeled by being tramped on by feet covered with sandals or other footwear. During the second phase the product is stored in shallow water where it remains for a period of 20 or 30 days, at the end of which it is again subjected to the strong evaporating action of the sun. Cava, obtained by using quaa, is made by a process similar to that used for tunta.

The manufacture of these by-products is one of the most important of the obligatory personal services performed by the colonos. Under the leadership of a camanis, the colonos are responsible for the entire manufacturing process from the moment they are given the raw material to the final product--which must satisfy the proprietor both as to quality and quantity. In order to obtain 100 lbs. of chuno, tunta or caya, approximately 300 lbs. of potatoes or ocas are required. Table 23 indicates the amount of raw material used and amount of finished product obtained, by provinces.

TABLE 23. Manufacture of By-Products--Los Andes, Omasuyos, Ingavi.

Province	Chuno		Tunta		Caya	
	Raw Material Lbs.	Production Lbs.	Raw Material Lbs.	Production Lbs.	Raw Material Lbs.	Production Lbs.
Los Andes	241,248	64,324	503,956	171,521	3,801	1,267
Omasuyos	173,048	55,911	207,008	89,879	56,065	17,433
Ingavi	294,982	95,946	373,604	122,135	--	--
Total	709,278	216,181	1,084,568	383,535	59,866	18,700

Work regime. With the exception of the small estates named Chigani and Watajata in the Province of Omasuyos, where laborers are paid a daily wage, the agricultural and pastoral activities on the remainder of the estates are performed by the colonos. In compensation for the personal services rendered the estate by the colono, he is assigned various kinds of land. A sayaña is a small piece of land located in the neighborhood of the casa de hacienda (great house) which generally contains a drab, one-room adobe residence hut (choza), corrals (lacayes) for livestock and storage houses for agricultural products. In addition, each family is assigned from three to five parcels of agricultural land, generally

one in each ainoka (large field planted in one crop)--the ainokas being redistributed annually by the administrator. Each year, therefore, an Indian family may receive a piece of land (callpa) in the ainoka planted in potatoes, a piece in the ainoka growing quinoa or small parcels in other ainokas depending upon the crop rotation plan established for the particular estate on which he resides. Not only is the total land assigned each family very small, averaging about three acres, but individual agricultural parcels of the colonos are generally relegated to the less productive land within each ainoka.

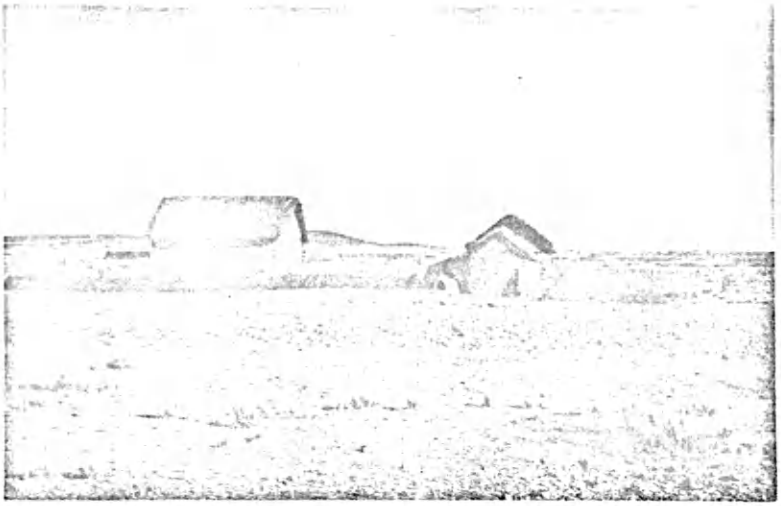
The use of these parcels of land is paid for by personal services. An average of three days' obligatory labor per week is required. This service is usually performed in planting and harvesting the crops of the proprietor or making repairs on the estate under the watchful eye of the mayordomo. Threshing, storing produce, pasturing activities and the manufacture of such by-products as chuno and cheese, as well as the performance of other duties for the personal benefit of the administrator, are 'extra' services generally not included in the three days' obligatory labor each week. The more greedy or heartless the mayordomo, the more of these 'extras' are demanded of the colonos. During the harvest, operations for the owner's benefit require the maximum number of hands to perform the labor in the least possible time. Therefore, continuous work is required of the colonos during this period, in some cases amounting to 14 successive days, with the overtime being discounted during subsequent weeks. After the harvest has been gathered and threshed, the colonos are permitted to harvest the crops growing in the parcels worked for their own benefit, but by this time their crop has usually been damaged to some extent by the advance of the season. A similar danger is present during

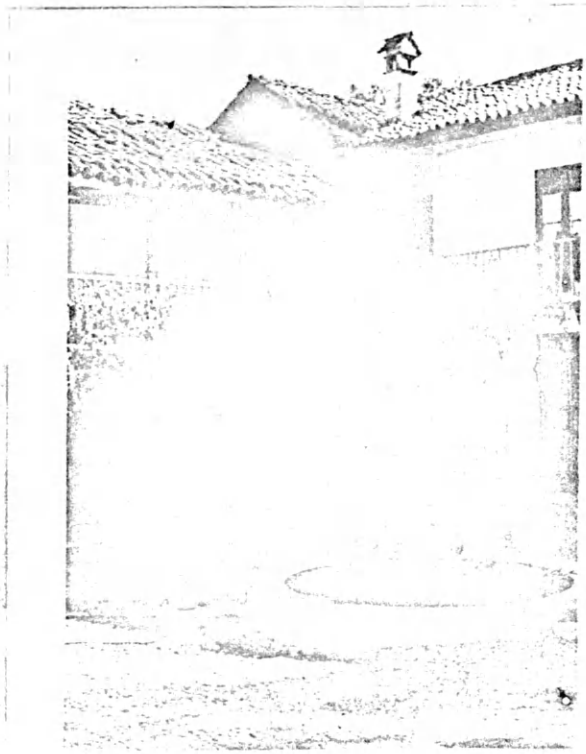
the planting season when the colonos' fields, invariably the last to be plowed, receive the seed. Work in the proprietor's fields is communal; all the families take part, with each family operating as a unit. While the colono manipulates the plow and urges the slow-moving yoke of oxen (yunta) to open a furrow, one of his children follows and places a small quantity of manure in it. The wife brings up the rear by dropping the seed and closing the furrow. Some families do not possess sufficient oxen or laborers to accomplish their prescribed tasks. This unfortunate circumstance forces them to hire both work oxen and extra laborers. The debt incurred is usually paid in the form of additional personal services to the colono from whom the oxen or laborers were borrowed, a form of patronage which has obtained the name pinzon.

Absenteeism. More than 90% of the proprietors of the altiplano estates under study are absentee owners. This situation is reflected in the state of abandonment and ruin in which most properties were found. Since the land usually has been acquired by the simple process of inheritance or foreclosure, the proprietor does not feel attached to the land, although he may have his ego elevated by the fact that he is a landowner. The amount of agricultural produce grown on the estate is not important; for purposes of social prestige legal possession of land is sufficient. The absentee owner is a man of the city, the desire to be an urban dweller being inherent in his Spanish background. Living in the relative comfort and safety offered by the city, he does not wish to become resigned to the sacrifice of life in the country, especially under the rigorous conditions imposed by the climate of the lake basin. It must also be kept in mind that he would be a member of a small white minority among Indians who, although physically conquered, are capable

of perpetrating acts of violence at any time. The proprietor has found it more politic and rewarding to have his centuries-old claims on his Indians enforced by a bilingual mixed-blooded administrator. As long as the urban dwelling landowner receives his customary rentals in money, in kind and in services, he is inclined to overlook those activities of his administrator which redound to his benefit at the expense of the Indians. It is not the usual procedure for an hacendado to question the prosperity of his mayordomo as long as these excesses are absorbed by the colonos.

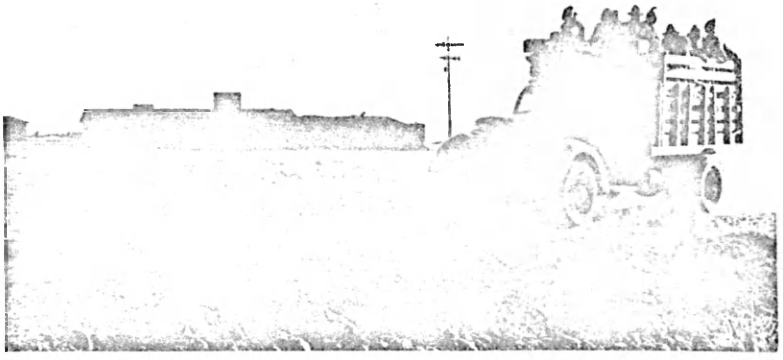
Barely scratching the soil, the wooden plow is symbolic of the backward state of agricultural practices in the Lake Region.





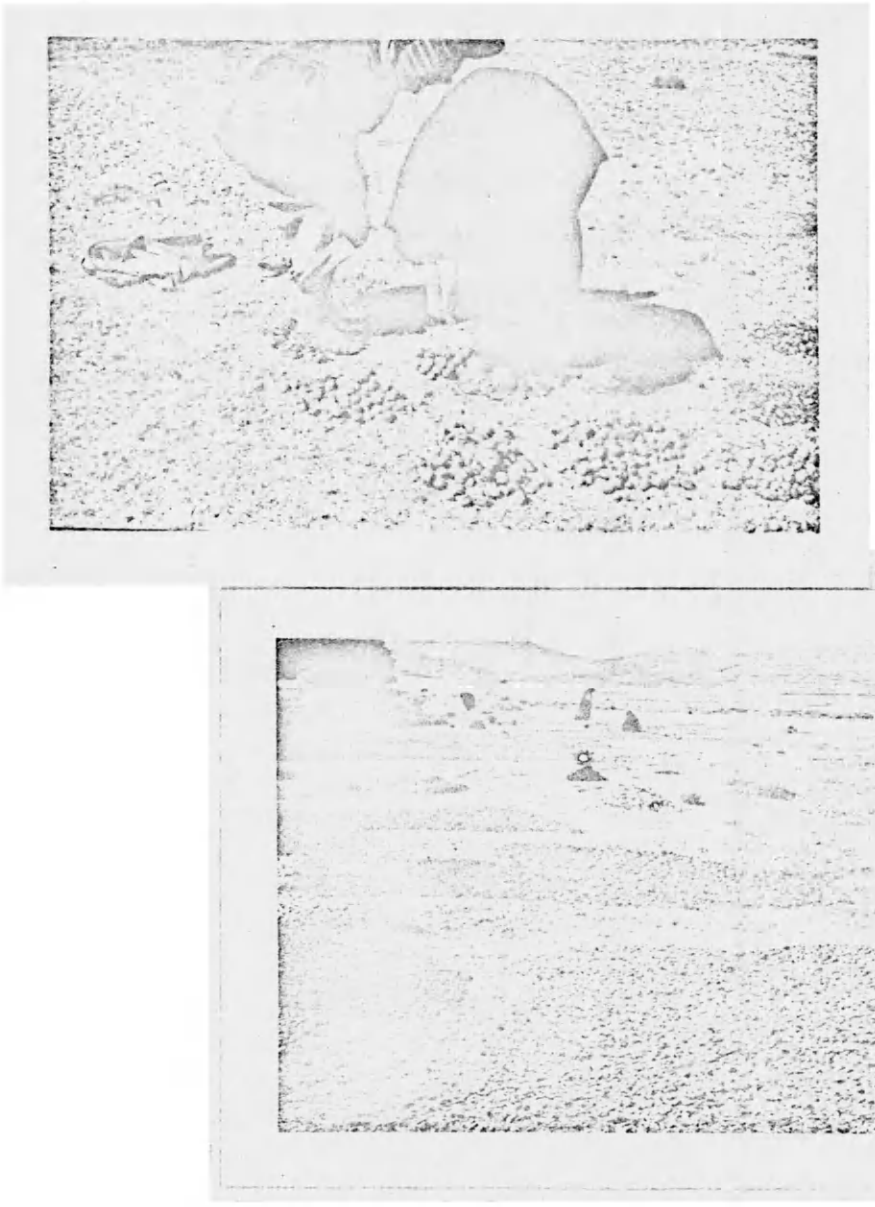
Top: This Indian homestead (sayana), located on a great landed estate, is enclosed by a low adobe wall. Outdoor oven, storage huts and corrals (lagayes) are situated near the one-room adobe house at left.

Bottom: Patio of one of the better hacienda houses located on lake border.

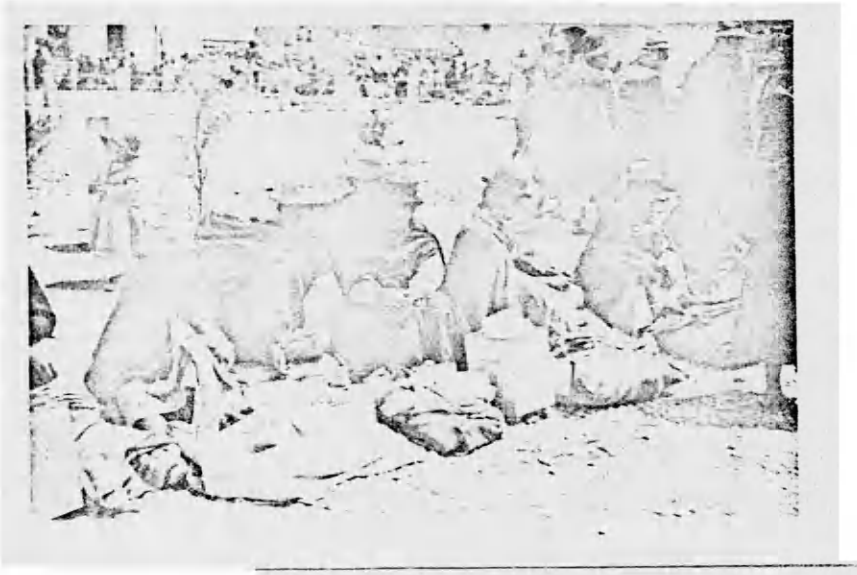


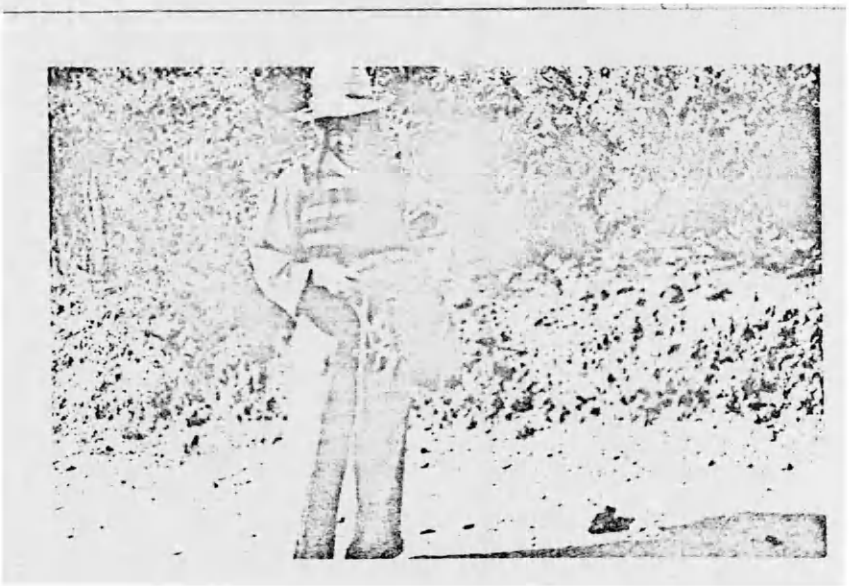
Illustrated are two phases in the history of altiplano transportation. The burro, introduced by the Spanish, has largely supplanted the llama for transporting produce of the estates, while the American motor truck is fast becoming the most common general cargo and passenger carrier.

Non-ripening cebada en heras is stacked in these water-repellent loaf-like mounds until fed to livestock. Sticks protruding through the leaves serve to anchor the top sheaves.



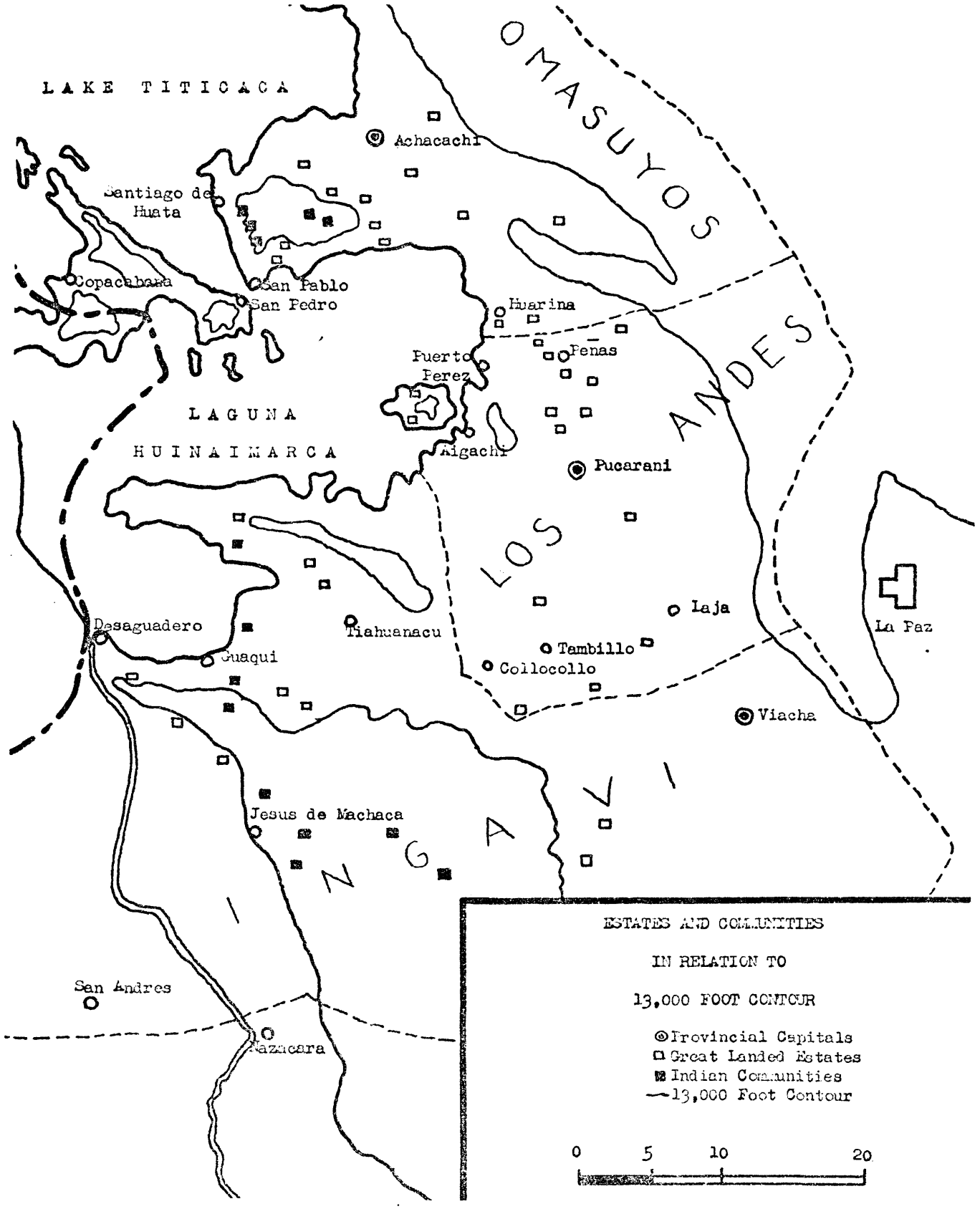
Two important steps in the manufacture of chuno are illustrated: removing moisture and peelings from potatoes by trampling (top), and exposing the tubers to intense solar rays (bottom).





Top: This market scene in the central plaza of Pucarani, in the Province of Los Andes, is typical of those to be seen throughout the altiplano. Indeed, allowing for regional variations in costume, it is characteristically Andean.

Bottom: The shallow character of European cultural superimposition on the indigenous civilization is symbolized by simultaneous use of the native woolen cap for warmth and the modern brimmed hat for prestige.


LAKE TITICACA
OMASUYOS
Achacachi
Santiago de Huata
Copacabana
San Pablo
San Pedro
Huarina
Penas
Puerto Perez
LAGUNA
HUINAIMARCA
Aigachi
Pucarani
LOS ANDES
Laja
La Paz
Desaguadero
Tiahuanacu
Tambillo
Guaqui
Collocollo
Viacha
Jesus de Machaca
YUNGAS
San Andres
Mazacara
ESTATES AND COMMUNITIES
IN RELATION TO
13,000 FOOT CONTOUR
Provincial Capitals
Great Landed Estates
Indian Communities
13,000 Foot Contour
0
5
10
20

LAKE TITICACA
OMASUYOS
ACHACACHI
SANTIAGO DE HUATA
Watari
Wichiwichi
Chuquinapi
Tajocachi
Morocollo
COPACABANA
SAN PABLO
SAN PEDRO
HUARINA
PEÑAS
PUERTO PEREZ
ANDES
LAGUNA
HUINAIMARCA
AIGACHI
PUCARANI
LOS
Jachajahuira Pampa
TIAHUANACU
DESAGUADERO
Arcata
TAMBILLO
COLLOCOLLO
Sullcata
Charapata
VIACHA
INGAVI
Jacuri Milluni
JESUS DE MACHACA
Achuma Alta
Calla Arriba
Calla Abajo
Chama Arriba
SAN ANDRES
NAZACARA
AREAL DISTRIBUTION
OF
INDIAN COMMUNITIES
Provincial Capitals
Indian Communities
Roads
Railroads
0
5
10
20

Indian Communities

Seven Indian communities in the Provinces of Omasuyos and Ingavi were visited and intensively studied. One of the two communities investigated in Omasuyos comprises four widely separated sections, and one of the five communities located in Ingavi, Jesus de Machaca, is subdivided into thirteen sections, five of which will be considered in this study. Consequently, fourteen separate community studies were made in Omasuyos and Ingavi. Owing to the rugged terrain and the general inaccessibility of Indian communities, the non-contiguous nature of their holdings and the reticence of community Indians to discuss their problems in the presence of government officials, personal verification of the information obtained was made considerably more difficult. The most profuse source of information regarding Indian communities, although not always the most accurately interpreted, proved to be police officials stationed in the immediate locality of the community under study. These officers exercise political control over Indian communities by operating through the jilacatas (head men) in the time-honored colonial fashion.

Omasuyos. The communities studied in this province are Morocollo and Calaque, the latter being divided into four sections named Tajocachi, Wichiwichi, Chuquinapi and Wateri. The last three sections occupy a privileged position in relation to Tajocachi and other Indian communities on the Peninsula de Huata in that much of their agricultural land is situated in protected valleys opening toward the Strait of Tiquina. Here the elevation is somewhat lower, rainfall is greater, seasonal

temperatures less variable and relatively level land more abundant than at Tajocachi and Morocollo. Community Morocollo is located at an elevation exceeding 13,300 feet--perilously above the recognized limit of successful intensive cultivation at this initially high altitude--which is considered by the agriculturists in the lake basin to coincide roughly with the 13,000 foot contour. It is not intended to give the impression that the boundary of this zone coincides exactly with the imaginary 13,000 foot contour line. The number of hours of exposure to the sun's rays, the angle of slope, or the physical properties of the soil may extend the zone of intensive cultivation above its normal limit; unfavorable conditions may correspondingly depress this limit. It should be emphasized that, because of various factors, dissimilar zones may interpenetrate each other in such a way as to produce a more complex agricultural landscape. Economic factors, such as the proximity of the highway leading to the La Paz market, may also influence the placement of the zonal boundary.

Ingavi. Five communities, comprising nine individual units, were visited in the Province of Ingavi--Juchajahuira Pampa, Sullcata, Arcata, Charapata and Jesus de Machaca (sections Chama Arriba, Calla Abajo, Calla Arriba, Achuma Alta and Jacuri Milluni). Jesus de Machaca is the administrative center of an extremely large group of Indian communities, totaling some 15,000 inhabitants, which has been relegated to the hilly Cerro de Jaranche, averaging 13,500 feet in altitude. Arcata and Sullcata, located near Chaqui, occupy better agricultural land than Jesus de Machaca, a fact which is reflected in the greater proportion of land under cultivation on these two lake border communities. Therefore, Jesus de Machaca emphasizes pasturing activities rather than

intensive agriculture. This community is divided into 13 sections (estancias), several of which are further subdivided into individual units depending upon the altitudinal relationship of their composite parts. For example, section Calla is composed of Calla Arriba (Upper Calla) and Calla Abajo (Lower Calla), the former being situated as the name implies at a higher elevation than the latter. The 13 sections comprising Jesus de Machaca are as follows:

Ilatiti	Sullcatita
Achuma	Chama
Cuipa	Parina
Konko	Calla
Yauriri	Titicana
Ankoaka	Titiri
	Jacuri Milluni

Community government. For the purpose of imposing taxes, the Bolivian government has separated community Indians into two categories: originarios and agregados. The first class of Indian possesses property rights to an unspecified amount of community land which date from the colonial period and were revalidated by the Ley de Revisitas, decreed on 31 July 1871. The title is hereditary and is passed from generation to generation within one family, indicating that the ancestors of the present originarios have been members of a particular community from colonial times, at least. The agregados are considered as having been incorporated into the community after the legal establishment of private property in land. In general, the originario has a more favorable economic status than the agregado because he is permitted the usufruct of a larger amount of cultivable land, consequently, a higher tax (territorial contribution) is imposed on him.

There is considerable confusion regarding the origin of the terms originario and agregado. In his exhaustive study entitled The Aymará

Indians of the Lake Titicaca Plateau, Bolivia. Weston La Barre quotes Latcham relative to this problem as follows (12, p. 145):

> The Aymarás, besides the term Ma-saya and Aran-saya, corruptions or adaptations of Quechua forms, had their own native denominations of the same divisions, which enable us to obtain an inkling of their real meaning and functions. These archaic names were Huari and Llacahuaz. The Huaris, called also Llactayoc, correspond to the Hurinsayas, and referred to the original settlers in a locality, while the Llacahuaz or Llacuaz, were late comers, who were looked upon as strangers and intruders. They were the Hananasayas.

La Barre then states, "The Hurin-sayas were thus the originarios, the Hanansayas the agregados; the terms had a geographical meaning also, since the original settlers took the lower mouths of the valleys, the more level, irrigable, cultivable land, whereas late comers took the upper valleys." Apparently this kind of division within a community had existed for many centuries before republican lawmakers made the distinction official and took cognizance of the economic differential to impose a sliding tax scale. Moreover, wholesale population transfers during colonial times probably intensified the cleavage between original settlers and late comers in any particular community.

Theoretically all land of an Indian community belongs to the residents in common; legally each community Indian is the private owner of an undesignated parcel of community land. In actuality, however, the results of unrestrained individual enterprise are becoming evident. This is due principally to the destruction of the strong central government of the Incas during the Conquest and to the decrees promulgated after the overthrow of colonial rule, which were primarily intended to destroy the stubborn strength of the community Indians. Indian communities frequently make legal complaints against each other because of alleged boundary violations. The land of one family within a community is occasionally,

upon the death of the head of the household, usurped by an individual Indian not of the same family, especially when the bereaved is a widow with minor children. In this manner, some individuals among community Indians gain possession of large parcels of cultivable land despite efforts of the head men to stop this practice. Since successful violation of unwritten community laws hastens the destruction of community solidarity, government authorities do not support the pleas of local chiefs to correct such abuses.

In the model community of Arcata in the Province of Ingavi, occupied entirely by agregados, 500 family heads are responsible for cultivating 7,425 acres of land, an average of 14.8 acres per family. At Sullcata, also located in Ingavi and occupied entirely by originarios, 320 family heads have control of 5,585 acres of cultivable land for an average of 17.4 acres per family. On the private estates located in the neighborhood of these two communities, the average colono family is assigned from three to five acres of cultivable land. Although the average amount of land assigned Indians in lake basin communities varies considerably, due to such factors as population density and whether emphasis is placed on grazing or intensive cultivation, community Indians occupy a higher status than estate Indians in terms of land, income and freedom from personal services. Moreover, community Indians may seek employment in mines, as carriers, or engage in subsistence manufacturing during the slack season, and thus add considerable sums to their annual real income. Table 24 indicates the size of each community, the total population, number of originarios and agregados and the land controlled by each group.

TABLE 24. Distribution of Land in Indian Communities--Canasuyos and Ingavi.

Canasuyos

Community	Total Area	Total Population	Joint Land Holders: Originarios	Joint Land Holders: Arrendados	Area Controlled by: Originarios	Area Controlled by: Arrendados
Marocollo	773	45	11	34	296	477
Calacoa:						
Tajocachi	12,350	1,050	8	1,042	247	12,183
Wichiwichi	6,175	300	10	290	371	5,805
Chuquinapi	3,458	350	30	320	1,383	2,075
Watari	5,434	700	26	674	543	4,891
Total	28,190	2,445	85	2,360	2,840	25,431

Ingavi

Charapata	9,263	700	121	579	3,088	6,175
Arcata	9,880	2,030	-	2,030	-	9,880
Sullcata	6,175	905	905	-	6,175	-
Jachajahuira Pampa	6,175	200	18	182	618	5,558
Jesus de Machaca:						
Chama Arriba	6,175	164	79	85	3,705	2,470
Calla Abajo	7,719	540	75	465	2,319	5,402
" Arriba	6,946	360	50	310	2,085	4,861
Achuma Alta	12,350	420	210	210	6,175	6,175
Jacuri Kalluni	4,940	164	27	137	1,235	3,705
Total	69,629	5,483	1,485	3,998	25,400	44,226

Summary

Canasuyos	28,190	2,445	85	2,360	2,840	25,431
Ingavi	69,629	5,483	1,485	3,998	25,400	44,226
Total	97,819	7,928	1,570	6,358	28,240	69,657

The supreme authority within a community is the jilacata (cacique or chief). He is aided by various assistants, namely, alcaldes de campo, amautas de escuela, regidores and mandones, each one performing a specific function. The jilacata is responsible for administering justice within the jurisdiction of his community but may use moral suasion only. He does not possess police power to enforce his decisions. In order to take forceful action he must seek the aid of neighboring police officials who have ultimate control over the conduct of a community. The alcaldes de campo are charged with maintaining vigilance over community lands and distributing cultivable parcels. When a community possesses water for irrigation purposes, it is the duty of this individual to insure that equal distribution is made among all those whose lands require water.

The amautas de escuela exercise control over the school system, select teachers and act as truant officers to insure that classes are properly attended. It is also the duty of the amautas de escuela to chastize families who encourage truancy among their children. Although proprietors of estates have largely disregarded a decree promulgated in May 1945 requiring each estate to establish a primary school for the education of colono children, the Indian communities visited are operating a relatively successful school system, considering the adverse conditions under which the community elders are required to rule. Table 25 contains a breakdown of the school system in the communities investigated.

Regidores and mandones are responsible for enforcing decisions of the jilacata, alcaldes de campo and amautas de escuela in the most isolated sections of an extensive community. Due to their widely scattered holdings and large size, many communities cannot be controlled

efficiently by the primary authority. Regidores and mandones have the added responsibility of collecting the annual territorial contribution for governmental authorities.

TABLE 25. Analysis of Community School System.

Community	Number of Courses	Number of Instructors	Total No. Students	Boys	Girls	Total School Age Population
Oraguyos						
Marcocllo	1	1	6	5	1	15
Tajocachi	3	1	50	50	-	452
Wichiwichi	3	1	65	65	-	83
Watari	4	2	95	90	5	140
Chaquinapi	1	1	44	40	4	295
Total	12	6	260	250	10	985
Inavi						
Charapata	3	3	200	170	30	400
Arcata	4	4	90	60	30	679
Sullcata	2	2	80	60	20	120
Jachajahuira Pampa	3	2	40	40	-	80
Jesus de Machaca:						
Chuma Arriba	1	1	16	16	-	30
Calla Abajo	3	1	35	30	5	270
Calla Arriba	3	1	39	34	5	144
Achuma Alta	2	1	40	20	20	251
Jacuri Villuni	1	1	12	10	2	44
Total	22	18	552	440	112	2,012

Agricultural production. Six and one-tenth per cent of the community lands in the Province of Omasuyos and 22% in Ingavi are under cultivation. Table 26 contains the total area of each community and the amount of cultivated and uncultivated land.

TABLE 26. Ratio of Cultivated to Uncultivated Land on Communities.

Omasuyos

Community	Total Area	Area Cultivated	Per Cent	Area not Cultivated	Per Cent
Morocollo	773	69	8.9	704	91.1
Calaque:					
Tajocachi	12,350	1,202	9.7	11,148	90.3
Wichiwichi	6,175	212	3.4	5,963	96.6
Chuquinapi	9,458	88	2.5	3,370	97.5
Watari	5,434	161	3.0	5,273	97.0
Total	28,190	1,732	6.1	26,458	93.9

Ingavi

Charapata	9,263	346	3.7	8,917	96.3
Arcata	9,880	7,425	75.2	2,455	24.8
Sulloata	6,175	5,585	90.4	590	9.6
Jachajahuira Pampa	6,175	105	1.7	6,070	98.3
Jesus de Machaca:					
Chama Arriba	6,175	1,294	21.0	4,881	79.0
Calla Abajo	7,719	89	1.2	7,630	98.8
Calla Arriba	6,946	1,528	22.0	5,418	78.0
Achuma Alta	12,350	30	0.2	12,320	99.8
Jascri Pallani	4,940	333	6.8	4,607	93.2
Total	69,623	16,735	22.0	52,888	78.0

The principal crops cultivated on the Indian communities are similar to those produced on the estates--potatoes, barley (cebada en grano and berza), quinoa and cañahua. As producers for the La Paz market, Indian communities are a negligible factor, since their total production is funneled into the satisfaction of their immediate needs. Average acre yields and related details are included in Table 27.

TABLE 27. Average Acre Yields--Omasuyos and Ingavi.

Omasuyos

Crop	Area Cultivated	Amount of Seed Used (lbs.)	Amount Harvested (lbs.)	Seed Used Per Acre (lbs.)	Yields Per Acre (lbs.)
Potatoes	533	262,143	730,224	706	2,195
Quinoa	147	4,792	79,697	32	542
Cebada en berza	124	10,300	298,232	83	2,414
Cebada en grano	810	33,862	417,481	41	515
Oca	167	64,073	203,254	383	1,219
Beans	121	6,552	58,267	54	481
Wheat	5	231	1,797	47	364
Papalisa	15	4,543	9,735	306	657
Corn	2	253	2,024	103	819

Ingavi

Potatoes	5,481	2,942,689	6,923,347	537	1,263
Quinoa	3,739	129,488	1,865,666	34	499
Cebada en berza	1,312	95,924	2,257,772	73	1,722
Cebada en grano	3,982	342,663	2,467,049	86	620
Cañahua	787	31,671	456,190	40	579

Agricultural techniques employed on Indian community lands are very similar to those in force on private estates. Since much of the land cultivated by community Indians is too steep to be plowed with the customary yoke of oxen, the ancient digging stick (huiso-cato) remains in use. Soil erosion is decreased by the huiso-cato, but the planting process is slow and the necessity of cultivating unproductive soils offsets this advantage. The digging stick also permits deeper planting of the seed, which is especially important in semi-arid lands where moisture is not readily available at the surface. In the lake basin, the huiso-cato consists of a stick of hard wood approximately 6 feet long and pointed at one end. A step on which the agriculturist places his foot is attached to the stick at knee height. This permits greater force when plunging the pointed end into the earth. After the stick has been driven several inches into the soil, it is moved in a circular motion to loosen the earth, removed and seed and fertilizer are dropped into the hole.

The extent to which Indian communities occupying good agricultural land have been absorbed by the expanding latifundia is strikingly illustrated by the accompanying map on which the locations of the various estates and communities investigated in this study have been plotted in relation to the 13,000 foot contour line, which is a critical elevation in this region. This is the altitude above which successful intensive cultivation of crops for the market is considered generally impractical by residents of the basin, particularly by the experienced estate administrators. Attention is drawn to the fact that the majority of the estates are located between 12,500 feet, the lowest elevation in the basin, and 13,000 feet, which generally coincides with the base of the

rugged sedimentary remnants protruding through lake basin sediments. Conversely, it will be noted that almost all the Indian communities are relegated to hill lands exceeding 13,000 feet. These conclusions are based on the intensive studies of a small minority of the total number of estates and communities located in the region, but so selected it is felt as to be representative. Indeed, during the period of field investigations it was observed that estates clung to the lower lying, more fertile land, and the communities were, with few exceptions, found in the higher, steeper, more infertile sectors. Thus an altitudinal zoning has evolved as the institutional organizations, represented by the great landed estates and the Indian communities, have struggled for control of the most favored physical sites.

Pasturing activities. Although a few Indian communities possess large herds of llamas and alpacas, sheep herding is their most important pasturing activity. Only small amounts of the wool obtained from these herds are marketed in La Paz; the usual practice is for the available surpluses, after immediate family needs are satisfied, to be exchanged at the local fairs. Community Indians have retained much of the unsurpassed weaving skill of their ancestors, whereas estate Indians with very little free time in which to engage in handicrafts, have almost completely lost such skills. Cattle are maintained on Indian communities to provide motive power for plowing, but burros are rapidly replacing the llama and alpaca as a means of transportation. In certain communities, pasture lands are open to all the inhabitants regardless of status. In other communities each family is assigned a specific area in which it is required to graze its animals. In this type of distribution cultivables again have preference over surrendos in the quality and

quantity of assigned land. In some few cases, there remains insufficient pasture for the *arregado*, so he is obliged to rent additional pasture from an *originario*. Table 28 indicates the number and type of livestock maintained on each community.

TABLE 28. Number and Type of Livestock on Communities--Omasuyos, Ingavi and Summary.

Community	Cattle	Sheep	Swine	Horses	Mules	Burros	Llamas	Alpacas
Omasuyos								
Morocollo	7	70	7	-	-	5	-	-
Calaque:								
Tajocachi	80	1,600	525	-	-	150	-	-
Wichiwichi	140	930	60	-	-	15	-	-
Chuquinapi	398	1,500	400	4	18	302	-	-
Watari	180	6,500	330	-	10	20	-	-
Ingavi								
Charapata	990	4,380	160	-	-	160	-	-
Arcata	620	3,810	130	-	8	281	-	-
Sullcata	270	1,000	50	-	5	50	-	-
Jachajahuira	160	225	-	-	2	60	-	-
Jesus de Machaca:								
Chama Arriba	88	4,000	35	-	-	50	250	-
Calla Abajo	50	1,800	-	-	-	30	30	-
Calla Arriba	60	3,300	-	-	1	30	900	-
Achuma Alto	16	1,200	10	-	-	-	100	20
Jacuri Killuni	85	4,100	38	-	-	30	1,000	-
Summary								
Omasuyos	805	10,600	1,322	4	28	492	-	-
Ingavi	1,729	23,815	423	-	16	691	2,280	20
Total	2,534	34,415	1,745	4	44	1,183	2,280	20

Chuño and its related forms of dried potatoes are the most important by-products manufactured on Indian communities, but cheese, llama wool and sheep's wool are also processed in significant amounts. Detailed production by communities is contained in Table 29.

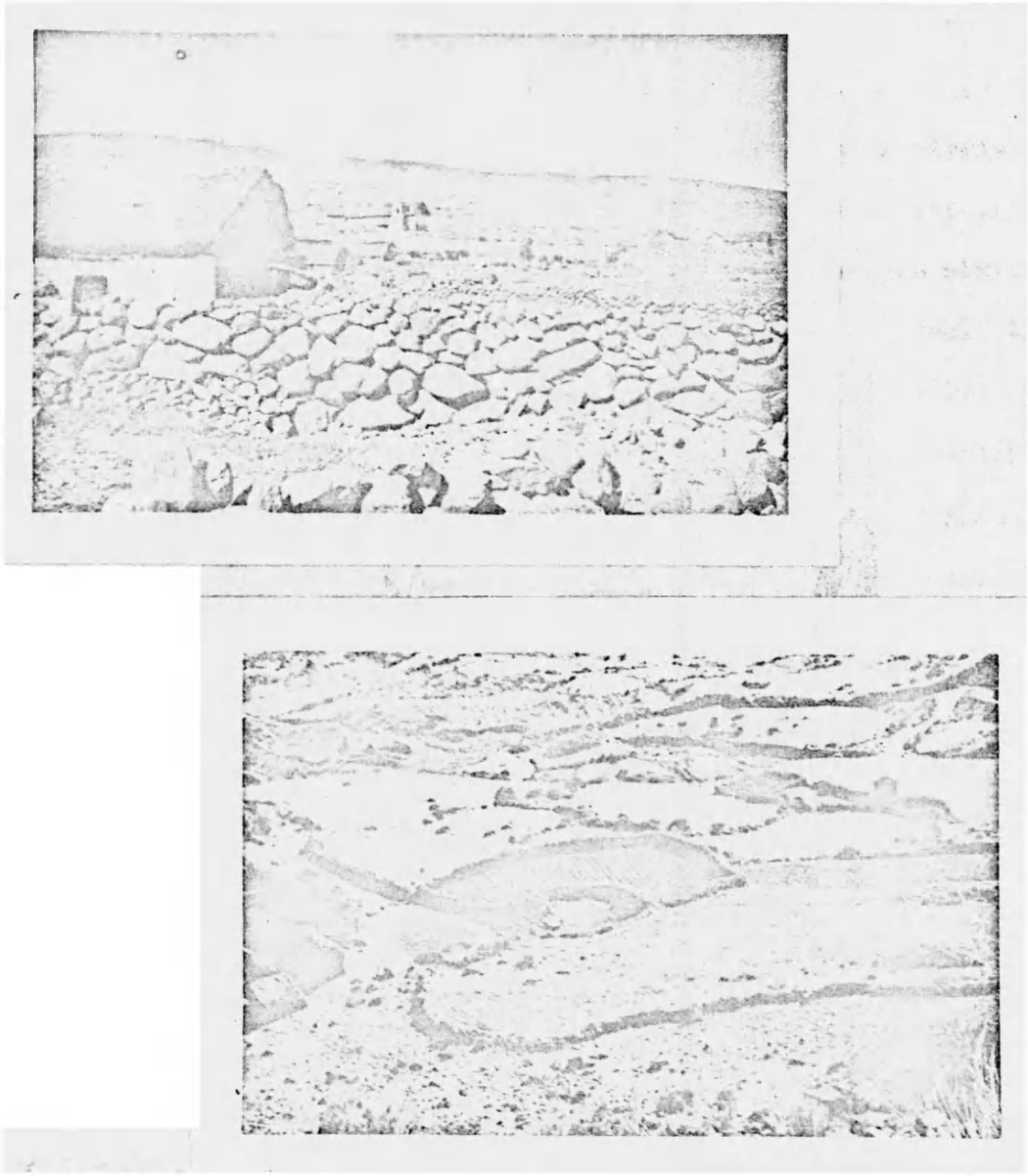
TABLE 29. Manufacture of By-Products on Communities.

Omasuyos

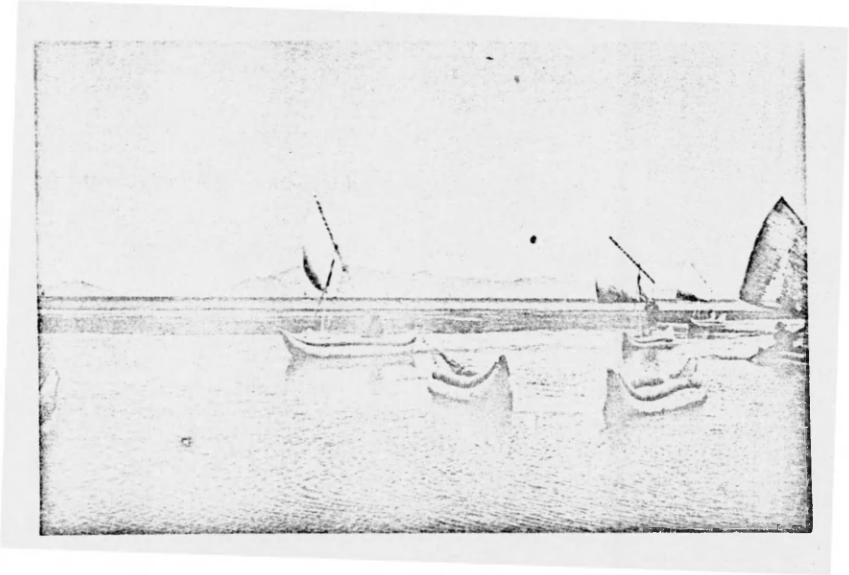
Community	Cheese: Raw Material (Qts.)	Cheese: Production (Lbs.)	Llama Wool: Raw Material (Lbs.)	Sheep Wool: Raw Material (Lbs.)
Morocollo	144	51	-	810
Calaque:				
Tajocachi	806	405	-	504
Wichiwichi	540	455	-	506
Chuquinari	16	81	601	2,024
Watari	55	304	-	505

Ingavi

Charapata	900	825	-	7,040
Arcata	322	396	-	4,180
Sullcata	216	152	-	880
Jachajahuira Pampa	386	708	-	231
Jesus de Machaca:				
Chama Arriba	69	101	810	1,771
Calla Abajo	69	84	-	44
Calla Arriba	40	101	1,012	3,300
Achuma Alta	35	66	286	26
Jacuri Milluni	40	88	440	220



Contrasting land use patterns on an Indian community located near Lake Titicaca (top), and in the community Jesus de Machaca (bottom), are acutely responsive to local topographic features.



Fishermen put into the eastern shore of Laguna Huinaimarca at the end of the day. Their picturesque canoes are made from the totora reed, a bank of which is growing in the marsh behind the boats. Across the lagoon rise the steep hills of Copacabana peninsula.

SECTION IV

THE PROJECT

In the preceding chapters it has been seen that a small firmly knit group of people in the Lake Basin has obtained control over large blocs of the best land, the economic base which makes possible elevated social position and dominant political status for the landed few. Although in many parts of the modern commercial world the possession of liquid wealth is more important than ownership of land, this concept has not made much headway on the Bolivian Altiplano, where are found land tenure systems reminiscent of medieval Spain and of pre-Conquest Inca land. The physical isolation of the inhabitants of the mountain-rimmed fastnesses has been in large part overcome by the railway, the motor car and the airplane; but the economic, social and political status quo is stoutly defended by the estate owners, whose authority over their labor force is hardly less absolute than their control of the land.

As for the village community Indians, they too are hedged around by physical and cultural barriers to material progress, but almost all their surplus production has been prorated among the group, with the result that their standard of living is higher than that of the estate Indians. The existence within the same region of these two systems of land tenure has resulted in dissimilar land utilization practices which are reflected in the differences in the material culture of the two segments of the agricultural population. Problems have arisen which cry loudly for solution. The Bolivian Development Corporation,

an agency of the Bolivian government, partially supported by United States technical aid and financial assistance, has purchased an estate in the Province of Omasuyos near the southern shore of Lake Titicaca. A sheep experimental station has been established there for the purpose of diagnosing and controlling diseases peculiar to these animals, and improving the quality and quantity of their wool. The BDC is also importing thoroughbred cattle from Peru which will improve the degenerate native stock. Technicians from the Ministry of Agriculture are being trained in the use of modern machinery, better agricultural techniques and irrigation methods and will be responsible for disseminating the knowledge gained to altiplano agriculturists through a network of rural school centers.

Although the development of more successful agricultural practices and their adoption by the rural inhabitants--both community and estate--may increase agricultural production somewhat, the variety of crops which can be grown at this altitude is definitely limited by the adverse natural environment. The foodstuffs in greatest demand by the nation's consumers, such as wheat, rice, corn and beef, can be obtained in Bolivia only from the lower valleys and plains along the eastern margin of the Andes Mountains. If importation of these products from neighboring countries is to be supplanted by sources within Bolivia, which is an announced government objective, it would appear that greater effort should be directed toward developing the eastern foothills and lowlands, and connecting these regions with the food-dependent highlands by adequate transportation routes. In short, the Bolivian Altiplano, including the Lake Titicaca Basin, is not capable of producing the food surpluses required by the inhabitants of the cities

and mining camps located in the highlands. Yet the lake basin, a region whose niggardly physical environment would seem to point to the intelligent development of subsistence agriculture and grazing, is presently dominated by a static system of plantation-type land tenure whose low economic gains in this limited sphere hardly compensate for its social disadvantages. Only in regions capable of producing great surpluses for the world market has the plantation system met with remarkable success. Thus the efforts of the government to increase agricultural production on the altiplano under the existing agrarian regime, although commendable, will probably meet with only limited success in solving the region's basic agricultural problems. It would seem that in the lake basin greater success might accrue from an attempt to adjust social and economic inequalities along with the endeavor to increase total production.

The economic and social issues facing Indian communities in the lake basin are not only less serious than those confronting the large estates but are also less controversial. A recent suggestion by the Ministry of Agriculture that Indian communities be forged into cooperative enterprises under the guidance of the federal government is both theoretically and practically sound. Despite 400 years of steadily worsening conditions, the community still constitutes an economic institution capable of being transformed into a powerful cooperative system of production and consumption in agriculture, herding and subsistence manufacturing.

That a land tenure problem exists on the altiplano is recognized by farsighted Bolivians as well as foreign agricultural experts who have visited the region. Eduardo Romecin, a Bolivian agrarian

specialist, pointed to the crux of the agrarian problem when he recommended that "... the working out of a national land tenure system for the Indians would seem to be one of the most necessary items in the solution of the whole agrarian problem" (18, p. 249). Equally emphatic is the American land tenure authority, David Weeks, who, after engaging in intensive research on the genesis of Hispanic American agrarian policy which culminated in a searching analysis of Bolivian tenures, reported that "the most urgent tenure problem is the status of the Indian agricultural workers in relation to their patrones" (24, p. 326).

Opinions differ, however, as to how this potentially explosive situation can best be resolved. In too many instances, unfortunately, the remedy prescribed depends on the private interests of the individual or group making the diagnosis. The Ministry of Agriculture, not wishing to incur the organized wrath of the landed aristocracy, but nevertheless desiring to produce the statistical victory of increased agricultural production, has advanced a proposal which would substitute a money transaction for both personal services and rentals. Under the Ministry's plan, the colonos living on estates would be paid a daily wage for working in the owner's fields. On the other hand, the colonos would be required to pay rent to the proprietor for use of the land which, under the present system, is assigned them in return for personal services. Although advocates argue that the substitution of a money economy for payment in kind or personal services would increase production on the proprietor's portion of the estate, it is evident that the great gulf between the colonos and the patron, economically and socially, would not be materially narrowed. And no agrarian policy

that does not courageously consider this basal aspect of the overall problem can possibly succeed in the long run.

Carlos Gonzalo Saavedra, intellectual socialist and nephew of a former President of Bolivia, has evolved a plan whereby the present land ownership status would not be altered, because Saavedra feels that it is too firmly entrenched to be changed. Instead, he suggests that the total production of each estate be more equally shared between the agricultural workers and the owner. Government officials would represent the colonos in their dealings with the proprietor, acting in the colonos' best interests to assure them a fair share of the production. This unique proposal would not only give the colono greater economic equality than he now possesses, but would funnel the estate's production into subsistence channels rather than concentrating on the market.

From Saavedra's point of view it is unfortunate that the central government is controlled by the very elements of Bolivian society whose economic position would be most adversely affected by the inauguration of his plan. In its present state of intellectual and moral bankruptcy, the landed aristocracy could be expected to fight most vehemently the adoption of any such plan, and the opposition of this group would insure defeat of Saavedra's proposal even prior to its inception. Nor could one hope that the narrow-visioned local officials entrusted with enforcement of the colonos' newly-granted rights would do otherwise than to feather their nests at the expense of the Indian agriculturists. Only a sweeping revolution--economic, social and political--the victors to be kept in power by the military whether ushered in by bullets or ballots, could, in the writer's opinion, insure the successful institution of so radical a plan in the fore-

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seeable future.

Any solution that proposes to educate and make the colonos' lot more attractive, while simultaneously demonstrating that it will benefit the owner, possesses the fundamental requirements for becoming a working success. The alternative to the simple substitution of a money economy, as the Ministry of Agriculture advances, or a form of socialism as advocated by Saavedra, might be a system whereby the large landed estates gradually revert to the colonos as small, privately-owned, family type farms. The educated, progressively minded land owners (of which there is a tiny nucleus) who pioneer this movement could invest the capital obtained from the sale of their altiplano estates to individuals, or to the government acting as a bank for individual purchasers, in Bolivia's future--the eastern valleys and lowlands. Already the Bolivian Development Corporation is transporting freshly killed beef by airlift from Reyes, in the lowlands, across the highest peaks of the Cordillera Real to undersell that imported from Argentina at the La Paz market. Not only would the nation benefit from the development of a region capable of producing the agricultural products necessary for greater economic independence, but the larger margin of profit inherent in frontier development and the discovery of new resources would accrue to the investor.

In recent years small independent farmers have been created from the Mexican peones and the serfs of eastern Europe. In other parts of the world a similar evolution occurred at a much earlier date. A visit to the new peasant farms of France in 1789 caused Arthur Young to remark "the magic of property turns sand into gold". Throughout the world it is apparent that the most accomplished farmers are often

found among the peasant proprietors. Where a plantation-type land use pattern fails to produce adequate economic and social returns for the community as a whole, as is occurring in the lake basin, subsistence farming may succeed.

Living proof of Arthur Young's words is the moral rejuvenation occurring among the once sullen Indians on Finca Watajata, a Canadian missionary society estate in the Province of Omasuyos. This remarkable transformation has been brought about by the opportunity to obtain permanent possession of land, functional education and general enlightenment. Intensive field investigations were made at Watajata for the express purpose of contrasting the agrarian policy established there with that prevailing on estates in the lake basin. The community being moulded at Watajata incorporates some of the best features of the Incan agrarian regime with more recently evolved concepts of land utilization. Each Indian family has been provided with three to four acres of fertile land on the shore of Laguna Huinaimarca and from five to ten acres of hill land for grazing purposes. If the family can demonstrate that it deserves land by good conduct during a trial period, it is presented with a clear title to the property. Few families have violated this trust despite temptations to indulge in wild, drunken orgies during the numerous fiestas. If the Indian desires to earn additional money during his spare time, he is invited to work on the few acres still owned by the missionary society, where he is paid an hourly wage. On the society's property he is taught to use agricultural machinery and is exposed to better agricultural practices. With the accumulated savings from their land and additional work, two Indian families have purchased a truck to transport their small surplus to market!

Painstaking argument and interminable patience were used to persuade the inhabitants to tear down the filthy, evil-smelling mud huts that belonged to their less fortunate progenitors. Under the guidance of the manager, the Indians have replaced these hovels with roomier, white-washed adobe huts. Tile roofs, wooden floors, glass windows--even wallpaper in a few instances--have replaced thatch, mud and darkness. Many of these "homes" have acquired wooden beds and some contain additional pieces of furniture. Education and medical care on Watajata have kept pace with the physical improvements.

Yet this long continuing experiment at Watajata, begun in 1900, was considered a miserable failure by the missionary society until the present manager recognized that permanent possession of land, and thereby economic stability and personal dignity, must necessarily precede medical care, education and even Bible study itself. In other words the society has applied the better social concepts of the community Indians and has at the same time introduced modern agricultural and marketing techniques. To a geographer with a deep professional interest in the struggle of humanity to extract the utmost from its physical and cultural environment, a visit to Watajata is indeed a joy to behold, for this experiment in practical Christianity, it is felt, also contains the formula for solving the region's basic agrarian problem--the outmoded land tenure system.

Will the large landholders, who already have sufficient wealth and social prestige to satisfy all their ambitions, remain content with farming methods reminiscent of the Middle Ages? The stark alternative to evolutionary change of the present economy is a violent upheaval which would dispossess the patrones and place the land in the hands of

those who work it. But those who now work the estates are not aware of the best in current technology, and would be helpless to make use of it without education and capital. However, enlightened self-interest might reasonably prompt landed proprietors to modify the system under which they have operated in the past, in the direction of applying the optimum combination of labor, capital and management to the land resources of the Bolivian Altiplano. Thus the gap--largely institutional rather than physical--between agricultural production and agricultural potential, would gradually close, the general standard of living would rise as more people shared in the increasing productivity, and a stable political regime could come into being.

APPENDIX A

CLIMATOLOGICAL DATA

Compilation of existing records
at selected stations within the
Lake Titicaca Basin

VIACHA

Date: Jan.-Dec. 1940 and 1941.

Location: In lake basin 15 miles SW of La Paz.

Elevation: 12,705.

Number of Nights during which Temperature Dropped below Freezing - Two Year Average.

Month	Number	Month	Number
January	0	July	30
February	0	August	28
March	7	September	11
April	16	October	2
May	20	November	1
June	22	December	0

Source: Ministerio de Agricultura, Ganadería y Colonización, Dirección General de Riegos "Informe General de Los Trabajos Desarrollados" - Unpublished Report - 1944.

WIND DIRECTION AND VELOCITY AT EL ALTO - 1946

Location: On rim of La Paz gorge, elevation 13,464.
Direction in percent and velocity in feet per second.

Wind Direction and Velocity	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
North	3	6	4	9	5	5	13	11	6	5	9	4	6
Velocity	14	8½	15	9	3	15½	10	9	4	10	15½	6½	10
North northeast	5	4	4	3	2	1	4	3	7	10	2	1	3
Velocity	8	12	5	10	3	6½	3½	20	8	7	11	10	8
Northeast	60	15	67	9	4	3	-	10	27	2½	18	16	15
Velocity	10	6½	7	7	8½	5	-	6	4	9	7	5½	7
East northeast	1	1	2	1	1	1	-	-	2	1	-	-	1
Velocity	3	3	14½	3	3	3	-	-	16	13	-	-	8
East	23	23	35	31	8	22	4	3½	27	28	47	45	26
Velocity	7½	6½	6½	5	5	5	3	6	8	7	8	7	6
East southeast	1	1	2	4	3	1	-	-	-	1	2	2	1
Velocity	6½	6½	7	9½	5	6½	-	-	-	13	10	5	7
Southeast	3	5	3	2	2	3	3	1	3	5	3	3	3
Velocity	8	9½	3	4	3	3	6½	6½	7	7	11	10	6
South southeast	-	-	-	-	-	-	1	-	-	-	2	2	1
Velocity	-	-	-	-	-	-	10	-	-	-	8	8	6½
South	3	-	-	3	3	1	2	2	-	-	1	2	2
Velocity	6	-	-	5½	6½	9	3	11	-	-	10	8	7
South southwest	-	-	-	1	1	-	-	-	1	-	1	-	1
Velocity	-	-	-	6½	3	-	-	-	29½	-	13	-	13
Southwest	15	4	1	3	4	9	2	-	2	-	1	1	3
Velocity	10	7	10	7	5	10½	6½	-	8	-	6½	13	8
West southwest	-	-	1	-	2	-	-	-	-	-	-	-	1
Velocity	-	-	3	-	10	-	-	-	-	-	-	-	6½
West	20	11	8	15	37	37	25	12	2	2	1	11	14
Velocity	10	5	5	8	15	12	9½	13	10	8	12½	8½	11
West northwest	1	-	-	-	9	9	12	6	1	1	-	-	4
Velocity	6½	-	-	-	10	13	17	11	6½	10	-	-	15½
Northwest	1	8	3	4	5	3	3	8	12	8	5	3	5
Velocity	8	6	3	15½	13	19½	5	4	6½	15½	11	10	10
North northwest	2	-	2	-	3	1	7	-	-	2	-	2	2
Velocity	5	-	5	-	11	3	6	-	-	13	-	5	7
Calm	2	22	3	6	11	15	24	13	10	13	7	8	12
Prevailing direction	NW	E	E	E	W	E	W	E	E	E	E	E	
Velocity	10	6½	6½	5	15	12	9½	6	7½	7	8	7	

Source: Ministerio de Agricultura, Ganadería y Colonización-Servicio Meteorologia de Bolivia, Boletin Anual Meteorologia - 1946, La Paz, Bolivia.

EL ALTO

Date of Record: Jan.-Dec. 1946

Location: On rim of La Paz gorge. Latitude: S 16°31'

Elevation: 13,464. Longitude: W 68°08'

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Feb.	Nov.	Dec.	Year
Relative Humidity	60%	69%	67%	57%	45%	46%	45%	47%	52%	48%	52%	75%	55%
Mean Temperature	47.6	47.8	50	48.2	43.1	41.7	38.3	41.7	43.8	45.1	46	45	45
Mean Maximum Temperature	59.7	59.3	57.9	60	52.1	55.4	53	56.1	55.9	56.1	55.7	51.6	56.1
Mean Minimum Temperature	35.8	36	42	36.3	34.1	27.7	23.5	27.3	31.6	34	36.5	38.3	33.6
Maximum Temperature	65.5	66	66	71	60	59	56	62.6	60.8	60.8	62.6	60.8	-
Minimum Temperature	32	32	36	33	32	19.4	18.5	22.2	23	28.4	32	35.6	-
Rainfall in Inches	2.10	7.6	.6	.51	1.	.39	1.2	1.62	1.65	.7	1.1	5.5	24.3
Maximum Rainfall in 24 hours	.4	1.	.2	.35	.48	.35	.6	.63	.87	.24	.2	1.14	-
Days with Hail	-	-	-	-	-	-	-	-	-	-	-	2	2
Days with Rain	13	18	6	4	2	2	3	9	5	5	12	21	100
Days with Snow	-	-	-	-	-	2	-	2	-	-	-	-	4
Days with Fog	-	1	-	-	1	2	-	-	-	-	1	2	7

Source: Ministerio de Agricultura, Ganaderia y Colonizacion, Servicio Meteorologia de Bolivia, Boletin Anual Meteorologia, 1946, La Paz, Bolivia.

Date of Record: Jan.-Sept. 1946

Location: Estate on eastern shore of Laguna Huinaimarca near Husrina. Latitude: S 16°14'

Elevation: 12,625. Longitude: W 68°10'

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean Temperature	51	59	51.6	52.5	47.1	47.3	41.4	45.7	50	No Information	No Information	No Information	49.5
Mean Maximum Temperature	60.8	66.2	59.4	61	56.5	56.1	54	57.2	59.5				59
Mean Minimum Temperature	41.5	51.6	43.8	44	37.8	38.5	28.8	34	40.6				40
Minimum Temperature	41	41	41	28.4	30.2	32	24	26.6	35.6				-
Maximum Temperature	68	67	66.2	66.2	62.6	59	62.6	64.4	66.2				-
Rainfall in Inches	2.7	2.74	.3	.1	.23	0	No In .1	.03	.09				5.94
Maximum Rainfall in 24 hours	1.2	.43	.04	.039	.16	0	.08	.023	.035				-
Days with Hail	2	1	1	2	1	-	-	-	1				8
Days with Rain	7	18	11	5	7	3	4	3	6				64
Days with Snow	-	-	-	1	-	-	2	3	-				6

Source: Ministerio de Agricultura, Ganaderia y Colonizacion, Servicio Meteorologia de Bolivia, Boletin Anual Meteorologia, 1946, La Paz, Bolivia.

COPACABANA

Date: February to December 1945 and
January to December, 1946.

Location: On Copacabana Peninsula facing Lake Titicaca.

Latitude: S 16°09'

Elevation: 12,675.

Longitude: W 69°05'

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Year	
	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946
Mean Temperature	No Information	56.7	57.6	56.7	56.5	55.8	58.5	No Information	58.6	51.	59.	48.6	58.2	45.	61.1	46.4	54.9	No Information	52.5	No Information	56.1	52.7	56.7	53.8	57.0	51.8
Mean Maximum Temperature		69.8	69.6	70.1	67.	70.5	73.8		77.7	63.3	79.9	56.9	79.5	54.7	77.7	58.1	68.7		64.4		69.3	77.5	71.2	64.1	72.7	64.1
Mean Minimum Temperature		43.7	45.5	43.1	45.9	41.1	43		39.7	38.7	38.1	40.2	37.2	35.2	40	34.7	41		40.8		43.1	36	42	42.4	41.5	38.5
Maximum Temperature		73.4	73.4	73.4	69.8	73.4	82.4		80.6	72.6	82.4	59	82.4	57.2	80.6	62.6	80.6		69.8		78.8	79	77	78	-	-
Minimum Temperature		42.8	42.8	41.	42.8	39.2	57.2		37.4	35.6	35.6	37.4	32.8	32.	35.6	32.	33.8		33.8		35.6	38	35.6	30	-	-
Mean Cloud Cover (1-10)			7.1		7.9		2.8		0.6		0.6		2.4		3.5		4.4		5.5		5.3		8.2		4.4	No Info.
Rainfall (Inches)	5.91	5.3	5.4	10.3	6.6	4.1	2.3		0	12.7	0	.15	.35	.9	.6	2.2	1.9		4.		3.3	2.	7.8	23.1	38.1	40.7
Maximum Rainfall 24 Hours		.8	.7	1.	.7	.8	.8		0	.8	0	.1	.2	.2	.27	.5	.6		1.		.8	1.4	1.	1.	-	-
Days with Hail		1	0	2	0	0	0		0	1	0	0	.0	0	0	0	0		0		0	0	0	0	0	4
Days with Rain	17	12	14	17	21	8	4		0	7	0	2	2	5	3	7	10		10		6	2	16	22	104	82
Days with Fog	0	2	0	0	0	1	0		0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	3
Days with Snow		0		0		0				0		0		4		0						0		0	No Info.	4

Source: Ministerio de Agricultura, Ganaderia y Colonizacion, Servicio Meteorologia de Bolivia, Boletin Anual Meteorologia, 1945 and 1946, La Paz, Bolivia.

GUAQUI

Date: February to December, 1945 and
January to December, 1946.

Location: Railhead on southern shore
Laguna Rainaimarca.

Latitude: S 16°36'

Elevation: 12,502.

Longitude: W 68°52'

		Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Year	
		1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946	1945	1946
Relative Humidity	No Information	74%	75%	83%	64%	74%	50%	70%	46%	58%	32%	58%	34%	61%	32%	63%	No Information	62%	65%	59%	63%	68%	74%	76%	53%	67%
Mean Temperature		48.6	48.7	47.	48.2	47.3	47.1	44.6	52.3	40.7	51.2	38.3	38.2	33.3	68.1	38.8		42.8	46.2	45.5	46.8	47.3	48.2	46.8	51.4	43.3
Mean Maximum Temperature		59.	56.1	55.4	55.9	58.1	56.8	57.7	61.3	54.5	60.2	52.5	69.8	48.7	83.1	59.4		55.	59.7	57.2	60.9	59.4	58.1	56.1	62.2	55.6
Mean Minimum Temperature		38.1	41.1	38.7	40.4	36.7	37.4	31.6	43.3	27	42.4	24.	46.8	17.8	53.2	24.3		30.4	32.9	33.8	32.5	35.2	38.5	37.4	40.8	31.9
Maximum Temperature		66.2	62.6	62.6	59.	60.8	60.8	62.6	66.2	57.2	64.4	57.2	84.2	53.6	87.8	59		60.8	66.2	64.4	68.	66.2	64.4	62.6	-	-
Minimum Temperature		28.4	35.6	32	33.8	30.2	32.	24.8	41.	17.6	39.2	17.6	44.6	8.6	48.2	15.8		29	32	26.6	32	32	30.2	32	-	-
Mean Cloud Cover (1-10)		6.3		8.2		4.3		4.3		3.			7.4		8.4			6.		7.1		8.1		6.	No info. available
Rainfall in Inches		5.4	4.77	7.4	3.64	1.8	.73	.83	0	.35	0	.02	0	.71	0	1.4		1.3	1.1	.24	2.65	3.4	3.5	9.7	16.3	32.5
Maximum Rainfall 24 hours		.94	.72	1.18	.72	.67	.37	.31	0	.31	0	.02	0	.4	0	.67		.83	.89	.24	.51	.55	.48	1.1	-	-
Days with Hail		2	0	0	0	4	1	2	0	1	0	2	0	0	0	1		2	1	0	1	5	1	2	4	21
Days with Rain		20	15	22	16	14	4	5	0	2	0	1	0	3	0	7		5	5	1	13	11	20	25	73	116
Days with Fog		0	0	0	0	0	0	0	0	0	0	2	0	0	0	0		0	0	0	0	0	0	0	0	2
Days with Snow		0		0		0		0		0		0		1		2		0		0		0		0	No Info.	3

Source: Ministerio de Agricultura, Ganadería y Colonización, Servicio Meteorologia de Bolivia, Boletín Anual Meteorologia, 1945 and 1946, La Paz, Bolivia.

Station	Location
Tiquina	At village of San Pedro on Copacabana Peninsula. Elevation: 12,615'.
Penas	In piedmont of Cordillera Real, approximately midway between La Paz and Achacachi. Elevation: 14,421'.
Viacha	In lake basin 15 miles SE of La Paz. Elevation: 12,705'.

Month	Tiquina 1945 Prec. (in.)	Tiquina 1945 No. Days Prec.	Tiquina 1945 Max. Prec. 24 hrs.	Tiquina 1946 Prec. (in.)	Tiquina 1946 No. Days Prec.	Tiquina 1946 Max. Prec. 24 hrs.	Viacha 1946 Prec. (in.)	Viacha 1946 No. Days Prec.	Viacha 1946 Max. Prec. 24 hrs.	Penas 1946 Prec. (in.)	Penas 1946 No. Days Prec.	Penas 1946 Max. Prec. 24 hrs.
January	4.9	12	.7	5.0	11	1.0	No	No	No	3.	12	.6
February	-	-	-	6.0	18	1.5				4.3	15	.8
March	-	-	-	4.7	9	.9	In	In	In	1.6	6	.7
April	-	-	-	1.2	3	.7	for	for	for	0	0	0
May	-	-	-	2.7	4	.8	mo.	mo.	mo.	0	0	0
June	-	-	-	0	0	0				.4	2	.2
July	.7	3	.4	0	0	0	.17	3	.10	0	0	0
August	-	-	-	.5	4	.2	.10	3	.06	.1	3	.06
September	.6	13	.5	3.6	6	1.8	1.06	4	.57	.4	2	.4
October	4.4	8	1.4	.9	3	.4	.30	3	.10	0	0	0
November	-	-	-	3.1	11	.7	1.40	9	.25	.9	5	.5
December	-	-	-	10.	26	1.4	8.20	24	.74	4.7	23	.8
Total	-	-	-	37.7	95	-	11.23	46	-	15.4	68	-

Source: Ministerio de Agricultura, Ganaderia y Colonizacion, Servicio Meteorologia de Bolivia, Boletin Anual Meteorologia, 1945 and 1946, La Paz, Bolivia.

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