AGRICULTURAL PRODUCTION ON HACIENDA VICOS

Description and Analysis of a Hacienda Agricultural Society
in the Andes of Peru

by

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1955

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AGRICULTURAL PRODUCTION ON HACIENDA VICOS*

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I. INTRODUCTION

Hacienda Vicos, a 35,000 acre plantation-community, is situated in an Inter-Andean valley of north-central Peru.

Its social organization has, with good reason, been likened to that of a medieval European manor. Approximately 1,900 Indian tenants (over 350 families) live on subsistence plots scattered over the large area. The patrón, or landlord, of the hacienda, has a written contract with the Indians. This contract obligates each peasant family to provide three days of labor a week to the patrón, in exchange for the right to occupy small tracts of land, on which the family may grow food crops and raise animals. All land is owned or rented by the patrón; none is owned by the Indian farmers. Traditionally, any Indian who wants land, and agrees to work his labor tax of three days per week, will receive a minimum of three fields, one for each of the major crops: corn, wheat, and potatoes. An Indian who enters into this relationship with the patrón is called a peón. The heads of all families which have the use of lands by virtue of such agreement are, accordingly, peones. There are, at present (1954), about 250 of such individuals on Hacienda Vicos. If a peón does not provide the required labor, the patrón has the right dispossess him. If he wishes, he may give a favorite Indian additional land. Thus the patrón may keep an extremely powerful grip on his Indian tenants.

His role has historically been conceived of as paternalistic; in many ways, the peones regard him as their master. In their petty disputes and disagreements he is invariably called upon to act as judge.

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* This paper is based on a study done at Vicos during July and August of 1954. It was made possible by a grant from the Cornell-Peru Project of the Department of Sociology and Anthropology, Cornell University. The author is grateful for the experience that he has gained from this opportunity and wishes, particularly, to thank Professor Allan R. Holmberg, Director of the Cornell-Peru Project, for his continuing aid and encouragement and for editing the manuscript. For editorial assistance the author is also indebted to Mr. Nahum Waxman.

While the power of the patrón over the lives of his peones is nominally limited by the Peruvian Government, the only national laws extending to the hacienda are those dealing with criminal behavior. To some extent, the traditions of the hacienda limit the patrón's power to organize and operate it as he wishes, but his control is, nevertheless, like that of a feudal lord, nearly absolute.

The hacienda organization has been in existence for so long that it is taken quite for granted by the Indians. It has its origins in the earliest history of settlement in Peru. Immediately following conquest, the Spanish set into operation a most efficient system in order to exact tribute from the Indians. This system, known as the encomienda, involved "a fiduciary commission of the labor of the Indians to a white colonist who is their trustee."1/ During the sixteenth century most of the rich areas in Peru became included in the network of the encomiendas. This system did not give the colonists the right to take any lands operated by the Indians, but in the years that followed, particularly during the revolutionary period, title to much of the land in Peru was acquired by Spaniards who felt that at a distance of thousands of miles, they could safely defy the Crown, without fear of punishment. In this way the hacienda system developed, with the Indians continuing to give a labor tax, no longer as tribute, but as rent for the land that they are using. Today in Vicos, as in many other haciendas, this labor tax is the basis of agricultural operations.

1/ Kubler, George. The Quechua in the Colonial World. Handbook of South American Indians, Vol. 2. Smithsonian Institute, U.S. Government Printing Office, 1946, pp. 331-410.

II. THE RESOURCE BASE

A. Location and Topography

Peru is characterized by three major physiographic and corresponding climatic regions. A flat desert zone runs along the Pacific coast for most of the length of the country. It varies in width from a few hundred feet, where the mountains rise almost out of the sea, to about fifty miles in some areas where it extends up the river valleys. The coastal strip is, on the average, ten to fifteen miles in width. To the east of the desert lowlands, and parallel to the coast line, lie the Andes. The broken mountain chain rises abruptly from the desert, and, where the coast is narrow, appears to emerge nearly directly out of the ocean. The Peruvian Andes average about 14,000 feet in altitude although their width seldom exceeds 200 miles. The eastern slopes of the mountains descend gradually to elevations of about 500 feet. This lower area, the montaña, adjacent to the upper Amazon Valley, is the third major geographic region of Peru. It is almost entirely jungle.

Vicos, which is located in north-central Peru, lies in the upper Santa River Valley, an inter-montane valley of the Andean region. The slopes on either side of the valley are steep and rugged. In the area of Vicos, the range on the western side of the valley, the Cordillera Negra, rises to about 14,000 feet. Less than twenty-five miles from the summit of this range lies the valley floor, which is approximately 9,000 feet above sea level. On the east, at an elevation of more than 18,000 feet are the tops of the Cordillera Blanca.

The Santa River, from which the valley derives its name, is one of the more important rivers in Peru. It rises at Lake Conococha, 14,000 feet above sea level, and flows northward for about one hundred miles down the narrow Santa River Valley, dropping finally to an altitude of 4,000 feet before it turns to pass through a narrow canyon in the western range. From here it flows to the sea, a distance of fifty miles.

There are, in addition to the main valley of the Santa River, many deep side valleys. Vicos is situated in one of these valleys, to the east of the Santa. The hacienda is approximately six kilometers from the town of Marcara, which is in the center of the main Santa River Valley, and twenty-six kilometers north of Huaras, capital of the Department of Ancash. The valley in which Vicos is located is formed by the Marcara River, which rises to the east in the Cordillera Blanca and empties into the Santa at Marcara.

A rough dirt road follows along the streambed of the Marcara River and, about half-way to the hacienda, passes the Baños de Chancos, where there are hot springs and a resort hotel. The casa hacienda, or main building (from which the hacienda is directed), is 6.6 kilometers up the side valley from Marcara, at the head of a relatively flat alluvial terrace backed up by steep hills. The casa is located on one side of a plaza (or "small square"), which is the center of Indian social life. A chapel and school, as well as other community buildings, are nearby.

The casa hacienda is situated in the northeast corner of the land area which comprises the hacienda. However, this location also corresponds to the center of the lowest, warmest, and most productive tract; it is also in the part of the hacienda nearest to Marcara.

B. Geology

Two major geological types characterize the hacienda, a mountainous area, consisting largely of acid igneous rock (including granite), and a lower foothill region, which appears to overlie sedimentary rock. Evidence for the geological character of the latter area includes a small coal seam just below the puna level, and the appearance, in several places, of limestone outcroppings; there were also protrusions of other bedded rocks in this region.

Glaciation has occurred within recent geological history. At the present time glaciers may be found at high elevations in the mountain valleys, extending as far down as 13,000 feet in a few places. This is not the greatest glacial advance, however, as proven by numerous terminal and lateral moraines found at lower levels. (see map) Further indications of glacial action may be noted in the geological structure of the U-shaped Quebrada Honda in the upper part of the hacienda.

C. Soil

As might be expected in a locale of such rough and broken terrain, the soil pattern is very complex. This is particularly so in the eroded hill or cabeceras sector. Generally, in the foothill region the soils are developed from residual materials, except for two areas where there are glacial deposits. There are, in addition, small strips of alluvial soil along the rivers and streams. In the mountainous region most of the soils are developed from glacial materials, as glaciers once covered most of this area. The Quebrada Honda contains a number of very flat canyon valleys, suggesting the existence of old lake basins.

The topography of the estimated total of 35,000 acres of hacienda lands is of two types, a mountainous region containing about four-fifths of the land, and a lower "foothill region." In the foothills area there can be distinguished three sectors. Along the river, and near the casa hacienda (elevation: approx. 9,000 feet), are areas of relatively flat (7 per-cent slope) alluvial land, which total about 45 acres. A second sector, containing more than half of the foothills area (about 4,000 acres), consists of steep, greatly dissected and eroded hills called cabeceras. This is the area which is most intensively cultivated. The hills rise abruptly from the narrow alluvial plan along the river. In this area 10 to 20 per-cent slopes are common, and there is much land with slope of greater than 20 per-cent; directly behind the casa one may climb nearly 1,000 feet in less than a mile. The broken eroded hill area rises about 1,000 feet from the Marcara River toward the mountains, and the land then levels off to what constitutes the third topographic area, a relatively flat plateau called the puna. The puna is composed of

smooth, gently rounded hills, at an altitude of about 10,000 feet. It occupies somewhat less than half of the foothill region, or about 2,000 acres.

A mountainous area with deep narrow valleys rises sharply from the puna. The mountains attain three or four thousand feet in a few miles, and a few peaks are as high as 18,000 feet. A deep valley, or canyon, which cuts through this region, is known as the Quebrada Honda; its floor is approximately 12,000 feet about sea level. The Marcará River flows through this canyon from its source to the lower foothill region. There are also small side canyons, waterfalls, and other features of rugged terrain.

In discussing the soils of the hacienda the following factors relevant to crop growth must be considered: acidity, slope, erosion, stoniness, texture, level of organic matter, and nutrient content.

Surface soils in the foothill region are, for the most part, acid, about pH 5.3. In contrast, some of the soils of the lacustrine area in the Quebrada are nearly neutral (pH 6.7).

The steep quality of the terrain has already been mentioned. In one fairly typical area of about 200 acres, three-fifths of the land has slopes of over 20 per-cent; one-fifth has a slope of 10 to 20 per-cent, and the remaining fifth has a slope of less than 10 per-cent. Tractors are of little use on such land. There are, in fact, some cultivated hills so steep that even the use of oxen and wooden plow is not attempted. However, I have seen a man using these on a slope of 20 per-cent. The most acutely graded fields are worked by hand, with a short-handled hoe as the tillage implement.

These steep slopes are the major cause of erosion damage, the most serious soil problem on the hacienda. The Indians understand little of erosion and have made only a few attempts to control it. Some terracing has been done by the Cornell-Peru Project, and it has succeeded in reducing erosion in a number of fields. The majority of fields, however, are marked by severe gullies. In some areas the "A" horizon has been completely washed away leaving a hard clay "B" horizon, which cannot be cultivated. A common Indian practice of rapid irrigation on steep slopes contributes greatly to the washing away of natural organic matter contained in the surface soil.

Stoniness is a severe limiting factor in the use of some areas. For this reason, the moraine and outwash areas are practically useless for crop cultivation. In one of these areas the soil has, apparently, proven productive enough otherwise so that it has been worthwhile to clear the ground, as much as possible, of stones, planting between the boulders which remain.

The dominant texture of the surface soils is silty and silty clay, often underlain at one or two feet by a heavy clay layer.

Despite the fact that lack of sufficient organic matter is a major problem at Vicos, the normal rotation does not include a sod crop. After

a few years of cropping, the fields that are not needed are left fallow (with a complete removal of crop residues) for one or more years. A few sparse weeds are the only cover that comes in naturally. The only additions ever made are manure, and occasionally guano. Under these conditions, the amount of organic matter in the soil is likely to be low. Thus, the soil structure is poorer than it might be, and the release of plant nutrients is severely reduced; only one-third of necessary nitrogen, phosphorous and potassium are liberated naturally from the organic matter in the soil.

It is not easy to estimate the importance of plant nutrient deficiencies in limiting crop yields for each of the soil groups at Vicos. Using the parent materials of the soils as the basis for speculation, the soils of the hacienda may be placed into four classifications. The largest class is derived from residual materials, which cover most of the foothill area. In certain other areas organic soils predominate. The remaining two varieties are alluvial soils and highlime, developed from lacustrine materials on the floor of the Quebrada Honda; we know very little about them. Because of their great distance from the casa hacienda they are seldom cultivated. It appears, however, that they are very productive by hacienda standards. This speculation is supported by the luxuriant growth of a wild lupine called tauri, which has grown as high as five feet on one of the flat Quebrada fields.

Some of the areas of organic soils drain naturally, while others must be drained artifically. Where they can be cropped they are thought to be productive, but the summer of 1954 produced only a fair crop of barley on the Ismuś field. This may have been due to the low levels of phosphorous and potassium which are generally expected in such organic soils.

Of the two most important groups of soils on the hacienda, the alluvial are thought to be more productive than the residual. Crops on both of these soils give a good response to guano fertilizer (Nitrogen total: 0.5 to 15 per-cent; P_2O_5 total: 10 to 25 per-cent). This is the only commercial fertilizer now used on the hacienda. It is provided through the Cornell-Peru Project, as guano is generally in short supply and is not readily available to farmers in the mountain valleys. The stated analysis of guano delivered to Hacienda Vicos declared 14 per-cent nitrogen. Manure is the only other fertilizer in widespread use. It is usually applied to the land by staking or herding animals on the field which is to be fertilized. One plot of ripe wheat most clearly illustrated the results of such a haphazard method of application. The wheat was, in most places, very short and thin; where the manure had been dropped, however, it was much denser and considerably taller. The crop appeared to be growing in clumps. This response to manure definitely suggests a deficiency of nitrogen in the soil.

A soil sample taken from Ataś Pampa, one of the better fields in the alluvial area, was tested at the Cornell University Soil Testing Laboratory. It showed organic matter at a level of 2.4 per-cent and a pH value of 5.35. Nutrients were present in the following amounts

(in pounds per acre; 2,000,000 pounds on soil): calcium 1,050 pounds, phosphorous 9 pounds, potassium 190 pounds, magnesium 110 pounds, and manganese 115 pounds. A similar soil analysis of Caldwell Field, Cornell University, revealed the following values: calcium 7,400 pounds, phosphorous 1,160 pounds, potassium 39,000 pounds, magnesium 14,200 pounds (and nitrogen 3,560 pounds). Too much stake shoulld not be put in these figures as factors surrounding the two soils are very different; Cornell soil, for example, is of glacial origin, while that of Vicos is largely residual in nature. Nevertheless, the low organic matter level of 2.4 per-cent in Vicos soil (as compared with about 3.5 per-cent for Cornell) does support the evidence presented earlier that this may be an important limiting factor, both in soil structure and in nitrogen supply. The low phosphorous level in Vicos is quite significant, particularly when it is remembered that only half of the phosphorous in the earth is available for plant growth and that a forty bushel corn crop or a twenty bushel wheat crop uses approximately 4 pounds of this important nutrient. Similarly, only a small proportion of the total potassium is available for plant growth, and, as a corn crop may require from 20 to 40 pounds of potassium, Vicos soil would appear to be quite deficient.

D. Climate

At Vicos the climate is temperate the year round. Cool nights and warm days are the rule. At the casa hacienda there are only a few severe night frosts during the year, and the midday temperature is normally above 70 degrees Fahrenheit. The great altitude of the hacienda (9,000 feet) is responsible for a rapid drop in temperature every night, the result being a day to night fluctuation of about thirty degrees. Mean annual temperature is about 55°F. As for precipitation, June, July and August are almost completely dry while the remaining nine months provide about thirty inches of rain. During the wet months at Vicos the rains are quite irregular, often with unfortunate results for the hacienda production. The corn crop, for example, was nearly a failure in 1953 because the rains were very late in coming. Appendixes I and II present weather information from Vicos and from the town of Huaras fourteen miles away.

Regular readings of soil temperature at Huaras during April, May, June and July of 1954, at a depth of 40 inches, gave anaverage figure of 60°F. As mean daily air temperature does not vary more than ten degrees from 60°F. during the entire year, it is reasonable to assume that soil temperature, likewise, remains at about sixty degrees all year long.

Frost is a serious problem in certain areas. According to popular opinion, the greater the altitude on the hacienda, the greater the danger of frost. However, certain low areas are also known for high frost susceptibility, perhaps due to their limited air drainage. The extent of frost damage to the potatoes and corn crops is difficult to estimate, and the months of greatest danger are not always certain. It appears from available data that June, July, August, and December are the most probable months for frost. There was talk of damage to potatoes during the time that I was at Vicos, July and August of 1954, but I saw none. It is possible that disease is often mistaken for frost damage. Also of possible relevance to the frost problem is a large temperature gradient, apparent between ground level and six feet above ground level. On many mornings during my stay at

Vicos, the grass on the plaza was covered with small but definite ice crystals. However, the reading on a Taylor maximum-minimum thermometer suspended six feet above the surface never dropped below 37°F. It is possible that these conditions may be peculiar to the relatively enclosed plaza.

During some years, the wind may be strong enough to cause serious damage to the corn, wheat and quinoa crops.

E. Ecology and Natural Vegetation

According to the ecological classification made by Holdridge, Vicos may be identified with the Montane Moist Forest region. This region is defined by a mean annual temperature of 6 to 12 degrees Centigrade (42.8° to 53.6° Fahrenheit) and a mean annual precipitation of 500 to 1000 millimeters, with an altitude range of 3,100 to 3,900 meters. The Huaras data are: mean annual temperature, 11° C.; rainfall, 792 millimeters; altitude, 3050 meters. As the name of the region would suggest, ecologists believe that the area was once forested. However, with the present population pressures on the land and the need for wood for heating and cooking, little remains of any historic forest. High in the mountains, in largely inaccessible places, there are a few patches of trees that have attained some size. At present, the most successful tree in the Valley is a species of Eucalyptus, introduced some decades ago, and now growing practically wild alon the irrigation ditches. There trees grow rapidly, but their wood is heavy and hard and not very desirable. Other trees growing in hedgerows, usually in stunted condition, are quaci, aliso, capuli and quinal. (For further information, see Appendix III.)

On the uncultivated puna and several mountain pasture areas where there is abundant moisture wild grasses grown luxuriantly. Such regions may well be classified as Mountain Meadow. On the steeper mountain sides, in the hedgerows, and in other undisturbed places, various types of woody brush have sprung up, usually bearing thorns.

Appendix IV contains a list of wild and cultivated plants collected on Hacienda Vicos during June and July of 1954.

F. Water Supply

Vicos is fortunately endowed with a continuous water supply, coming from glaciers which cover the upper mountain slopes to the east. An extensive system of open irrigation ditches and streams provides most of the inhabited area of the hacienda with water for household use and for crop irrigation. Most of the area below the puna (including a large proportion of the cabaceras and alluvial areas) can be handled with the existing irrigation system. The major canal, on which possible one-half of the hacienda depends, was delivering approximately 600 cubic feet of water per minute during July, 1954. Many of the irrigation canals on Hacienda Vicos were probably built before Spanish times; most, however, have been

added since. The main canals are cleaned every year in May, under the direction of the patrón.

At present, during the dry season, most of the water in the smaller streams and irrigation ditches is utilized. However, only a small proportion of the water in the Chancos River and the Marcara River is used. The fast-flowing Marcara, alone, is capable of supplying water in a volume several times greater than that used by the entire hacienda, for all purposes, at the present time.

III. CROPS AND CULTIVATION PRACTICES

The economy of Hacienda Vicos has its basis in crop production. The patrón sells his crops for cash, and the peones live on what their fields will produce, with some supplement from the sale of animals. The three major crops at Vicos are corn, potatoes, and wheat. Also important are barley, habas (a broad bean), ocas (a tuber) and quinoa (millet).

Table 1, based on a January, 1952 census, gives information on the number of families growing each crop (of 365 families surveyed).

TABLE 1: Number of Families Growing Each Crop

	Number of families growing
A. Field Crops	
Corn	358
Potatoes	321
Wheat (and rye)	356
Barley	353
Habas	338*
Ocas	281
Calabashes	209
Quinoa (millet)	271**
Ollucas	124
Mashua	70
Beans, Kidney	93
Beans, Vari-colored	82
Peas	84
B. Grown in Family Gardens	
Flacon	44
Zapollo (squash)	15
Onions	101
Cabbage	130
Lettuce	7
Oregano	39
Hot peppers (roccoto)	103
Coriander	1[illegible]
Eucalyptus	169
Capuli (choke cherry)	213
Royan (Aliso; alder)	231

* often sown along with corn in the same field.
** quinoa is generally sown with other crops, rarely alone.

A. Preparation of the Fields

Preparation of the soil for planting is much the same for all crops. The land has usually lain fallow for several months, and, during that time, animals have been allowed to graze freely on the stubble, thereby providing manure. It is also a common practice to stake animals, on successive nights, at regular intervals over a field and thus to spread manure. Sheep are kept, for much the same reason, in portable corrals and are moved from field to field. Remains of the previous crop stubble are occasionally burned off to make the ground easier to prepare.

If the ground is dry it may be irrigated two or three days before being worked. Oxen with wooden plows cross back and forth over the field, usually plowing in three different directions. The plows are of European design, consisting, essentially, of a stick set at an angle and pulled through the ground. If there are many stones, or if the soil is heavy, the wooden plow will penetrate only about two inches into the soil; otherwise it may penetrate as much as three or four inches.

To be planted, a field in sod must first be broken up by hand, as wooden plows cannot cut through such resistant turf. A short-handled hoe, similar to a mattock, is used by the Indians for this purpose. After an initial spading the field is worked over a few more times to break up the large clods and make plowing possible. If the turf is heavy, an attempt may be made to burn it. After this lengthy preparation the field is plowed for seeding.

B. Planting and Cultivation

/Planting and cultivation practices differ somewhat from crop to crop. Accordingly, the following discussion will deal with each major crop separately./

CORN. The corn at Vicos, a local flour variety, is grown almost entirely for human consumption. The ears are small, generally less than four inches in length. There has apparently been no selection for color, and a field may contain ears ranging in hue from light yellow to brown and deep red. Some ears have a uniform kernel color pattern; others are mixed.

Corn is generally sown during the last four months of the year and is harvested in May or June. This growing season is dictated by necessity, because only during this period can the corn grow and mature with a minimum of danger from killing frost. The crop is not always dependable, and, in recent years, there have been a number of bad harvests; the last was in May 1954. At such times the stalks may not grow to a height of more than two or three feet. I was unable to determine the reasons for such poor results. Factors possibly involved are: a) late planting due to lack of rain, b) excessive rain, c) dry spring, d) cold spring.

Table 2 presents information on average corn crop yields as suggested by the administrator of the Cornell-Peru Project.

TABLE 2: Average Corn Yields

	Increase (planting rate: 1.0 Bu/Acre)	Yield (in Bu/Acre)
Bad harvest	1-17	1-19
Average harvest	18-30	20-38
Good harvest	31-50	39-60

Recently, a variety of white flour corn, called "Cuzcanea," has been introduced from Cuzco. It did very well the first year -- about double the local corn yield. The second year it did not do nearly as well, and the third year (1954) the yield was still poorer, not much better than the local corn. Other areas have had almost the same experience with the Cuzco corn.

In planting, rows are made about 65 centimeters (26 inches) apart with a wooden plow. Kernels are then sown every 35 centimeters (14 inches) along these rows. If all plants grew, the yield would be about 17,000 plants per acre. Very little guano is applied to corn. In one case in which I saw it being used the application was 100 pounds per acre. Haba seeds (qv) are often mixed in with the corn seed; squash, peas and beans may also be planted in the corn fields. Because Autumn rains may be irregular or not on time the corn fields must often be irrigated.

The plants are weeded once or twice in the first two or three months after they have come up. Later they are hilled, which helps to support the young stalks against the wind. Harvesting is done with a sickle. The ears are gathered, and the animals are allowed to graze on the stalks. Occasionally, a portion of the stalks may be stored in a tree to serve as fodder for later in the year.

POTATOES. Before the Cornell-Peru Project began in 1952, the Vicosinos were growing two kinds of potatoes, the common or "Warko" potato, and a fast-growing variety called "Choucha." The Project introduced three new improved varieties going under the names "Paltack," "Tarma," and "Casablanca." At the same time, the use of spray, improved fertilizer and new methods of cultivation was begun on a relatively widespread basis. With superior potato varieties and enormously changed agricultural practices the crop yield should be excellent (about twice as large as that gained with the "common" potato and traditional methods of cultivation). DDT and copper-compound insecticides, as introduced by the Cornell-Peru Project, are used as soon as insects appear on the plants.

The fast-growing Choucha potatoes are harvested after about four months. The yield is always low, and they are used, therefore, mainly as an emergency crop when other food is short. The major potato planting season is from April to August, although some seeding is occasionally as late as November. These planting dates are probably more the result

of fitting potatoes in with the corn season and the times of greatest food need than to a consideration of the conditions which would give the best potato crop. There seems to be no reason why potatoes could not be planted at any time during the year. It is possible, in fact, that planting dates other than those now observed could result in higher yields.

The following figures (Table 3) were suggested by the Project administrator as somewhat typical:

TABLE 3: Average Potato Yields

	Increase (planting rate: 10 Bu/Acre)	Yield (in Bu/Acre)
Bad harvest	1-5	10-50
Average harvest	6-12	60-120
Good harvest	13-18	130-180

In planting, rows are made 70-90 centimeters (29-37 inches) apart, and the seed is placed every 45 centimeters (18 inches) in the rows. This form of planting gives an ideal yield of about 12,000 plants per acre. The preferred seed is a whole potato weighing 50 grams (1.8 ounces).

The Project has introduced the use of guano as fertilizer for potatoes. The fertilizer is placed in the bottom of the furrow, between the seed potatoes. The amount generally used is half the weight of the seeding. Thus, if 12,000-50 gram potatoes are planted per acre, 600 kilograms (1,320 pounds) of guano is spread in the furrows.

By careful plowing along side of the open furrows the seed potatoes are buried under two to four inches of loose soil. After four to six weeks the potatoes should show above ground, and if it is dry season this will be the time of first irrigation. From then on, the field is irrigated once a week unless there is rainfall. When the plants are about one foot high, the first weeding and hilling are done. At this time, guano is again spread in the rows (in the same amount as the first application) and is mixed with the soil in the hilling. After about two months, the potatoes are again hilled.

Harvesting takes place seven months after planting. The potatoes are dug and pulled by hand. As the Indians traditionally have had rights of gleaning after the harvest, there is a tendency for potatoes to be purposely left or buried in the field. This makes an accurate determination of the actual yield quite difficult.

WHEAT. A variety of wheat known as "Florencia aurora" is commonly grown in Vicos and in most of the Santa Valley. It is a non-bearded wheat, with some susceptibility to orange kernel rust. A common bearded wheat is often sown with it; this local variety seems to have a much greater resistance to the orange rust. Another bearded variety, with a definite bluish head, is sometimes grown.

Wheat requires dry weather for harvesting; planting is arranged, therefore, so that the six-month growing period will end during the summer season. Planting thus occurs from December through April. Wheat is occasionally sown at other times as an emergency crop.

Typical yields, according to the administrator, are:

TABLE 4: Average Wheat Yields

	Increase (planting rate: 1 Bu/Acre)	Yield (in Bu/Acre)
Bad harvest	1-7	1-7
Average harvest	8-15	8-15
Good harvest	16-22	16-22

Rough calculations for the 1954 crop on three fields give the following figures: 1) Lichcapampa, 7 bu/acre; 2) Punco Corral, 12 bu/acre; 3) Rodinurana (a steep and eroded field), 2 bu/acre.

Seed is broadcast in planting, sometimes with guano, which is also broadcast. The field is plowed lightly to cover the seed. If plows are not available the ground may be covered using hand tools. Irrigation water is used only when necessary. Hand weeding is begun, as a rule, one month after planting. At harvest time the wheat is cut with a sickle and is carried in bundles to a smoothed bare space of hard ground for threshing. This process is accomplished by beating with sticks or by herding horses on top of the piled bundles of wheat. Winnowing is done by throwing the straw, chaff and grain into the air, letting them be separated by the breezes.

BARLEY. Barley is grown for both human and animal consumption. Often it is used to fatten pigs. There appears to be only one major type of barley cultivated, a six-row variety. I did see, however, a few patches of hooded barley. The crop is planted from December through March in order that maturation will be reached during the dry season (growing period: six months). Guano is sometimes used as fertilizer during planting. Crop yields, according to the administrator, are about the same as for wheat.

Cultivation practices for barley are about the same as for wheat. It is also threshed and separated in approximately the same manner.

RYE. This crop is grown both on hacienda fields and on individual family plots. There is only one variety, and it is planted during the period, October-January. It is harvested some eight or nine months later, during the dry season. Under good conditions this crop grows very tall; I saw a small patch with heads six feet above the ground. According to the administrator, the yields are about the same as those indicated for wheat, and it is generally cultivated in the same manner.

HABAS. The haba, or "broad bean" (which looks like a lima bean) is a recently introduced legume crop. It is an important item of the Indian diet because of its high protein content. Severe damage by disease has resulted in a nearly complete crop failure at Vicos this year (1954).

Habas are planted in the Fall (September to November) and the harvest is about eight months later.

According to the Project administrator, typical yields are:

TABLE 5: Average Habas (broad bean) Yields

	Increase (planting rate: 1 Bu/Acre)	Yield (in Bu/acre)
Bad harvest	1-6	1-6
Average harvest	7-15	7-15
Good harvest	16-27	16-27

Broad beans are generally sown mixed with corn in the corn fields; occasionally they are grown in pure stands. Cultivating practices are similar to those followed for corn. There is only one weeding, however. At harvest time the whole plant is cut and then threshed in a fashion similar to that used with wheat.

TAURI. This native legume is a variety of lupine. The peas are white and poisonous (unless soaked in water). Tauri is sometimes planted by the patrón and grows for ten or twelve months before it is ripe to harvest. According to the administrator, an average crop should increase yield over seed by a factor of 15-20.

Tauri is often planted on poor fields. It is sown in furrows which are then covered by plowing. The crop is irrigated only if it needs water badly. Little care is required by tauri; it is neither weeded nor fertilized. After harvesting with a sickle, the peas must be threshed out.

OCA, ULLUCO AND MASHUA. The oca is an elongate yellow-orange tuber, stubby, carrot-shaped and irregular. The ulluco has small, perfectly spherical tubers, with a maximum diameter of about two inches. It is of many different colors, including red, purple and green. Mashua is still another tuber and looks much like the oca. The main difference between the mashua and the oca is that the former is naturally bitter and must be exposed to the sun before it can be eaten. These three are generally sown during July and August, and must be left in the ground for about eleven months. Apparently, the main reason that they are planted is that they require no irrigation, are disease resistant, and, thus, are a very sure crop.

These tubers are generally planted on the more distant and unirrigable fields (for example, the puna). The seed is planted at a depth of about two inches and remains in the dry ground, sometimes for months, until rain comes. Harvest takes place, as a rule, nine or ten months after the first rain.

OTHER CROPS.

Quinoa: (Chinopodium quinoa) This is a millet. Many of the families grow a little of it for their own needs.

Alfalfa: It is grown in small patches to feed guinea pigs.

Peas: A number of families grow this crop. One successful field was very acid (pH 5.4).

Beans: Often cultivated with corn.

Squash: This crop is grown in the corn fields or in family garden patches.

TABLE 6: Plants Frequently Cultivated in Indian Garden Patches

1. Alfalfa
2. Arracacha
3. Cabbage (a leafy tree type which does not form a head)
4. Capuli (choke cherry)
5. Coriander
6. Culantro
7. Gewa
8. Kishpiya
9. Lettuce
10. Onion
11. Rakon (or Uacon)
12. Rokoto (a red hot pepper)
13. Perejil
14. Zapallo (squash)

TABLE 7: Crops Grown in the Hacienda Garden

1. Artichoke (two varieties)
2. Beets
3. Broccoli
4. Carrots
5. Celery
6. Head Cabbage (two varieties, one smooth and one rough leaved)
7. Leeks
8. Spinach
9. Strawberries (do not produce much fruit)
10. Tomato (not very successful; easily killed by the frosts)

TABLE 8: Herbs Grown in Garden Patches

1. Achira
2. Borraja
3. Chincha
4. Laurel
5. Manzanilla
6. Mint
7. Oregano

TABLE 9: Flowers Growing Partly Wild in the Hacienda Garden

1. Cala lily
2. Geranium
3. Gladiola
4. Roses

TABLE 10: Fruit Trees Growing in the Patrón's Garden

1. Alligator pear
2. Apple
3. Bitter orange
4. Capuli (choke cherry)
5. Granadilla
6. Lemon
7. Lima
8. Limon "agria"
9. Limon "dulce"
10. Lucumas
11. Manzana
12. Mora
13. Peach (diseased)
14. Pear
15. Quince
16. Tuna (opuntia)

IV. LIVESTOCK AND ANIMAL HUSBANDRY

On Hacienda Vicos the care of livestock is second in importance only to crop culture. In pre-Columbian times the llama was the major domesticated animal in the Andes. Nowadays, sheep have replaced the llama for wool production; mules, donkeys and horses have replaced it as beasts of burden.

Table 11 shows the distribution of domesticated animals among 365 Vicos families in January 1952.

TABLE 11: Number of Families Domesticating Each Type of Animal

Type of animal	Number of families having
Chickens	351
Dogs	332
Cows	324
Sheep	320
Guinea pigs	306
Pigs	292
Goats	122
Oxen	95
Cats	69
Bulls	64
Horses	40
Burros	38

Care of the larger animals consists primarily in seeing that they are staked or fenced in at night and that they have some kind of feed or grazing during the day. Customarily, a woman or child will drive the family livestock to a fallow field or grasses area, remain with the animals for the day, and return them in the late afternoon. Animals driven in this manner include cattle, donkeys, sheep, goats and , sometimes, pigs. At night, cattle and donkeys are staked, sheep and goats are herded into movable thornbush corrals, and pigs are kept in a stone sty.

1. HORSES. Horses are used primarily for riding by mestizos and, to some extent, as pack animals, but are never used in agricultural work. As pack animals they carry 175 to 200 pounds. There are more than two hundred horses on the hacienda, most of them wild, although confined to mountain grazing areas. These animals are the descendants of pack and riding horses brought into the area at various times since Spanish conquest. They are quite variable in conformation, some being leggy, high and thin, while others are extremely low and stocky. Even the heaviest of these Andean breeds, however, are considerably lighter than the common European work horse.

A few wild horses are tamed and broken each year. As they have been raised on very rugged terrain they are quite surefooted and make excellent mounts. Twenty-six Indians owned horses in 1951. 1/

2. MULES. Many of the pack trains that pass regularly through the hacienda use mules. None of the Indians, however, raise or keep any of these animals.

3. BURROS. There are very few burros (donkeys) on the hacienda, probably less than 60. In 1951, 38 Indians owned donkeys. According to Vasquez, they are used as pack animals and carry 150-175 pounds. 2/ When they are not being used they are kept in the mountain grazing areas. The Cornell-Peru Project does not keep any burros.

4. CATTLE. The cattle now on Hacienda Vicos were introduced about seventy years ago. In 1950, 80 per-cent of the families owned at least one head, and one family had approximately 100 cattle; 63 persons had oxen, one individual owning seven pairs. 3/ During 1950, 100 cattle owned by an outside company were pastured in the grazing areas. In 1954 it was estimated that there were approximately 4,000 cattle on the entire hacienda. All of these were owned by Indians.

The cows are fairly small and light and produce little milk. Few cows give more than two quarts at morning milking. The bulls and oxen are also rather slight. Castration is practiced only if the animal becomes ill-termpered. Cattle are kept in the lower, inhabited area of the hacienda as long as there is forage available. When this food source gives out in the dry season, all animals that are not being milked and are not needed for plowing are grazed in the uplands or in the Quebrada Honda.

5. SHEEP. About 90 per-cent of the Vicosino families own sheep, keeping, on the average, 10 to 12 head. This estimate would indicate that there are probably more than 3,000 sheep on the hacienda. The animals are generally small and emaciated. The mixed flocks of black and white sheep are said to produce little wool and of poor quality. Most lambs are born in March, during the rainy season.

6. GOATS. These animals are kept by a few families, primarily for meat. They become a great nuisance at times by eating growing crops.

7. PIGS. Most families keep pigs. They are fattened to be eaten at fiesta or to be sold for cash. The pigs on the hacienda are mostly of one variety, which is black, thin and lanky, and has a razor back; this breed is rather slow growing. A local Danish farmer said that it took four times as long to grow local black pigs as it did to grow his own English breeds to market weight.

8. CHICKENS. A few chickens are kept in the dooryard of most Indian houses. Eggs and meat are sold for cash. The hens must scavenge for their food, and egg production is quite low. The birds are of

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1/ Vasquez, Mario C., La Antropologia Cultural y Nuestro problema del Indio, Peru Indiguia Vol. II, Nos. 5 and 6, June 1952.
2/ Ibid.
3/ Ibid.

many different strains and vary from large to small and plump to rangy. The hens generally incubate during May and June. Periodically, the chicken population of the hacienda is wiped out by disease.

9. GUINEA PIGS. This animal is the main source of meat for the Indians of Vicos. Each family keeps a dozen or more guinea pigs in the house. They are fed greens and, sometimes, fresh alfalfa.

V. THE AGRICULTURAL-ECONOMIC ORGANIZATION ON HACIENDA VICOS

The agricultural organization of Vicos is based upon a merging of two distinct economies, that of the patrón and that of his Indian peones. The patrón rents the hacienda from the Peruvian government with the hope of making a cash profit from the sale of crops produced on hacienda fields. In order to grow crops for profit the patrón needs Indian labor. The Indians of Vicos, on the other hand, have a subsistence economy. In return for their labor the patrón gives them land on which to grow their own food. It is, then, the integration of these two economies which serves as a base for the agricultural organization of the hacienda.

A. The Patrón's Economy

Hacienda Vicos is leased for ten-year periods from the Beneficencia Publica, a branch of the Peruvian government. The rent is 14,200 soles, or about $800 per year (at 1954 exchange rates). With the payment of this rent the patrón receives virtual control of a tract of more than thirty-thousand acres and all the Indians living within its boundaries.

Traditionally, the power of the patrón, over his lands and his peones, goes unchecked. However, in the development of the manorial system at Vicos, many customs and tacit working agreements have come into being. These customs tend to limit, to some extent, the power of the patrón. Any Indian, for example, should be permitted to become a peon on request. In return for his offer of labor, he must receive his three fields for corn, wheat and potatoes.

This system apparently worked rather well until the Indian population became so large that there were no more arable lands for the patrón to give away without relinquishing his own fields on which he was growing cash crops. Furthermore, for many years most of the land operated by the Indians had been passed on within the family, from father to son. Thus, if one peon of an originally contracting family did not provide his required labor for the patrón, all family lands could be taken and given to someone else. The result has been an inequitable distribution of very scattered plots. No matter how large or how small the land holding, each family must provide the same amount of labor to the patrón.

1. LAND USE. The present output of Hacienda Vicos provides a subsistence standard of living for 1,850 Indians and a surplus of agricultural products which are produced by the patrón for market. From the proceeds of the crop sales the patrón must pay the rent, the foreman's salary and other upkeep expenses; beyond this, everything is profit.

The Indian peones now occupy and farm about 4,000 acres, or more than ninety per-cent of all presently cultivated land on the hacienda (see Table 12). Their fields are located, for the most part,

in the eroded hill or cabeceras area. The patrón has left, for his own use, a large tract of alluvial land (43.0 acres) below the casa hacienda and numerous fields in the cabeceras region, another 370 acres. (The fields of the patron and their approximate areas are listed below in Table 13.)

The remaining areas, most of the puna and practically all of the mountainous part of the hacienda, including the Quebrada Honda, are used, traditionally, by both the patron and the Indians. Much of this land is rough and rocky and practically useless for tilling. However, most of the puna and some of the mountain areas are covered with grass, which makes them quite suitable for pasturing animals. As, at the present time, the Cornell-Peru Project does not keep any livestock, all of this grazing land is used exclusively by the Indians. For the privilege of grazing their animals they pay a nominal fee in the form of providing riding horses and oxen for use on the fields of the patrón.

TABLE 12: Estimated Area of Hacienda Vicos
(Planimeter estimates made from an aerial photograph)

	Acres	Hectares
Alluvial plain (Operated by the patrón)	43.0	17.3
Cabeceras (Cultivated, inhabited area)	4,307	1,746
a) patrón's fields: 371.8 acres (150 hectares)		
b) Indian operated: 3,935 acres (1,590 hectares)		
Puna	2,580	1,590
Mountainous region (Including the Quebrada Honda)	28,000	11,300
Estimated Total Area of the Hacienda	34,929	14,103

TABLE 13: The Patrón's Fields (Estimated Areas)

	Estimated Area	
Fields in the alluvial plain:	Acres	Hectares
Saco-Yaco	8.2	3.3
Companilla	6.2	2.5
Polaca pa pampa	1.5	0.6
Pochine pampa	1.0	0.4
Wasca pampa	3.5	1.4
Mester pampa	4.0	1.6
Kuyok	8.7	3.5
Atos pampa	9.9	4.0
TOTAL IN ALLUVIAL PLAIN	43.0	17.3
Fields in the cabeceras:		
Saltana	2.2	0.9
Batan wayta	1.7	0.7
Rangra	24.7	10.0
Palta-Kaka	2.0	0.8
Vicos pachan bajo	8.4	3.4
Vicos pachan alto	9.7	3.9
Alta corral	1.0	0.4
Punco corral	1.7	0.7
Ullmay	2.7	1.1
Chullian pampa	30 ±	12 ±
Wisllock	4.5	1.8
Utas pampa	9.7	3.9
Pillalu pampa	21.0	8.5
Lichcapampa (culluash	3.5	1.4
Atus pucro	16.3	6.6
Potaka	25 ±	10 ±
Rodinurance	8.4	3.4
Paras	12.9	5.2
Cotsan	22.5	9.1
Wiyas	13.0	5.3
Ismush	60 ±	24 ±
Laurel	7.2	2.9
Urancuncha	32 ±	13 ±
Schacllapunco	19.3	7.8
Wayoco	10.3	4.3
Irwa corral (Quekey pampa)	.7	.3
Puyhuan corral	1.7	0.7
Ricokaka	16.1	6.5
Huerta panteon	2.0	0.8
Huerta hacienda	1.5	0.6
TOTAL IN CABACERAS	371.8	150.0
TOTAL AREA OF PATRÓN'S LANDS	414.8	167.3

2. LABOR SYSTEM. To work his lands, the patrón has the labor of about 250 Indian peones. 150 of these work in the fields, usually on a regular schedule: Monday, Tuesday and Wednesday of each week. (Any who miss work on the first three days are required to make up the lost time during the last three days of the week.) The remaining 90 laborers have special jobs.

Field peones assemble at the plaza by 8:30 a.m. and are given their orders for the day. They may be told to prepare nearby fields for planting, or they may be given sacks of fertilizer or seed potatoes to carry to other parts of the hacienda. They work until 12:30, with two fifteen-minute breaks during the morning. At 1:30 work recommences, and there is one more fifteen-minute break before quitting time at 4:00 p.m. If the Indians have been ordered to appear at some distant field the work starts a little later in the morning. As payment for the use of grazing lands, all the peones who own oxen are supposed to bring them to work in the morning whenever it is indicated that they will be needed in the fields. On one day I observed as many as thirty-six pairs of oxen plowing Rangra field.

Division of labor is based upon a squad system. From every ten or twenty peones, one is chosen by the patrón to be a field foreman or mayoral. At the present time there are seven such foremen, each in charge of his own squad, to keep it working and to see that the task is properly done.

There are also a large number of specialized jobs on the hacienda. Ten gardeners work in the patrón's vegetable gardens, in shifts of five every other week. There are two guards who take turns keeping a 24-hour watch over the casa hacienda. Seven tapacos, or field guards, protect the patron's fields; they are charged with supervising irrigation, scaring birds away and preventing the crops from being stolen. They remain in the fields all night as harvest time approaches. Another specialist stands at the portada or gate in the Quebrada Honda. He keeps a record of all traffic passing along the Quebrada trail and collects a small fee. Two Indians are paid to keep watch on the animals in the Quebrada. Still another job requires each peon to serve as mulero or stable man for a month. The mulero is on call 24 hours a day to get horses ready for the use of the patrón. Before the Cornell-Peru Project took control of the hacienda, all unmarried or widowed women were obligated to one month's duty as housemaid, cook, or swineherd; this involved four or five women per month.

For the past eight years the peones have received a "gratification" for the work they do. Vicos was one of the first haciendas to give such a tip to its peones. On a few other haciendas it takes the form of coca leaf (a mildly narcotic herb), but the Cornell-Peru Project paid the gratification in money exclusively. The basic amount is .60 soles per day. Those who have special jobs receive more. The total cost of the gratification is now about 12,000 soles ($600) each year.

3. FARM ORGANIZATION. Agricultural operations at Vicos are supervised by a salaried manager. Before Cornell University took over the hacienda he had two paid assistants. The manager is a mestizo (person of mixed Spanish and Indian blood) who lives in a nearby town. He makes nearly all important decisions about operations and the timing of agricultural work. If the patrón is an absentee landlord the manager is usually given completely free rein, as long as he succeeds in maintaining a significant profit.

Planting and cultivation practices used for the various crops have been discussed already. However, the sequence of crops, where they are planted and why, needs also be considered. The patrón's economy is based upon the production of crops for sale. For the past few years the most important cash crop has been potatoes, during the 1953-54 harvest year 1,189 sacks (150 pounds each) were sold. Corn is the second most important crop; 295 sacks (125 pounds each) were sold in 1954. Smaller quantities of wheat and barley are marketed each year. Some rye and habas may also be sold, depending upon the size of the crop.

The growing of corn is limited by topographic and soil conditions to the lower part of the cabeceras area and to the flat alluvial strip along the Rio Marcara. In any sequence of crops corn will be included only in the lower regions. The only exception to this is Paraš field (on the upper part of the hacienda); results there have been rather poor, however.

Before the Project took control of the hacienda in 1951, the former patrón had organized his production around flax growing, a venture that was not paying off at all. Thus, by 1954 the Cornell-Peru Project manager had had little more than three years to establish a new rotation of profitable crops. On the lower fields he has tended to use a potato-wheat-corn rotation. On the upper fields, an alternation of potatoes and cereals is the general rule, with fallow periods interspersed, and an occasional crop of habas or tauri. The time of planting and the succession of crops is based more upon considerations of available labor and the immediate economic returns than upon a knowledge of what rotations should be used to maximize the total produce and income over a long period. The rotations that are used by the manager are traditional and are probably based on the mere observation that growing the same crop on the same field every year produces less than when crops are changed annually. If there is a preferable rotation, the manager does not seem to be acquainted with it.

4. MARKETING AND PRICES. Products sold by the hacienda are usually trucked to Lima and to other towns along the coast. Sales are made, occasionally, to the city of Huaras in the Santa Valley.

Buyers from firms and markets in the deficit food area of the coast come to the mountains to make their purchases in bulk. In three years (1951-54) Vicos has become the second largest producer of potatoes in the Santa Valley. By 1954 it was well enough known to truckers and merchants that they would come directly to the hacienda. The manager, who has a good knowledge of prices, makes all agreements

with the buyers. The price of potatoes in Lima is highest in January, and the manager tries to harvest and sell as many potatoes as possible during this month.

The hacienda administrator reports that the prices of agricultural products were as follows in the summer of 1954:

TABLE 14: Prices of Agricultural Products and Supplies on Hacienda Vicos and in Marcara

	Price
CROPS	
Potatoes	
Weighting more than 50 gms	60-70 soles per 150 lb. sack
" 30 to 50 gms	40-50 " " " "
" 15 to 30 gms	25-30 " " " "
" less than 15 gms	20-25 " " " "
Seed potatoes 40-50 gms	110-120 " " " "
Dried potatoes	50 " " 25 "
Wheat	
Florencia Aurora variety	90-110 soles per 150 lb. sack
Common	60 " " " "
Corn	
Cuzco	70 soles per 125 lb. sack (ear corn)
Common	60 " " " "
Barley	40-50 soles per 125 lb. sack
Habas	90-110 " " 150 " "
Tauri	14 " " 25 " "
OTHER AGRICULTURAL PRODUCTS	
Milk	1.20 soles per liter
Cheese (home made)	1.50 per 1/4 lb.
Eggs	0.40 per egg
Wool	120 soles per 25 lbs.

(cont'd)

TABLE 14: (Cont'd)

LIVESTOCK	Price
Hen	10-20 soles
Sheep or Lamb	60-70 soles
Goat	40-50 soles
Pigs (fattened about 200 lbs)	800-1000 soles
Pigs (small, 50 lbs)	80-100 soles
Cow, bull or ox	25 soles per 25 lbs
Burro	250 soles
Horse	500-600 soles
Mule	1,500 soles
AGRICULTURAL SUPPLIES	
Burned lime (CaO)	180 soles per 800 kilos (1760 lbs)
Guano (17.34% Nitrogen) from Huaraz	0.49 soles per kilo (2.21 lbs)

B. The Indian Economy

The Indian economy is one of mere subsistence; their standard of living is very low. This is due, primarily, to great population pressure on relatively poor land. There are often shortages of food, particularly severe when harvests fail. Food consumption is quite low throughout the year. This nutritional factor may be one significant cause in a high infant mortality rate, estimated to be about 50 per-cent. Houses are small, averaging 14 feet on the longest side. They are made of stone or adobe and have dirt floors. There is very little furniture, and hides and blankets are laid on the floor for sleeping. The Indian clothes are usually made of homespun wool; the children and the poor are often in rags. Crops and livestock are the basis of a battle for survival: the crops are, for the most part, consumed directly, and the livestock is kept for sale in order to obtain badly needed supplies.

1. POPULATION AND LAND USE. The Indians live in houses widely scattered over the cabeceras region. The houses are generally found in groups of three to six, such groups being occupied by an extended family (a number of related nuclear families). In 1954 there were about 365 nuclear families and a total population of 1,850 (5.1 persons per nuclear family).

The cabeceras area contains a total of 3.935 acres. 60 per cent of this land, or 2,360 acres, is cultivated. This suggests that the average nuclear family has about 6.5 acres of cultivable land, or 1.3 acres per person. (This calculation does not incude the few Indian fields in the puna and other scattered areas.) A study of fifteen families, done in 1954, suggests an average cropland of 3.2 acres per nuclear family. There was an average of 4.3 persons in each family of this sample, giving a figure of 0.75 acres of cropland per person. Although both of the above estimates are somewhat rough, they indicate that there is about one acre of cultivated land per capita.

It must be remembered, however, that the Indians are not living only from the land. They have two other major sources of income. The most important of these is the sale of livestock and livestock products which are produced on hacienda lands (the puna and the Quebrada Honda). A second source of income is the patron's gratification pay and other monies that might be received from work done in Marcara or nearby haciendas.

2. CROPPING SYSTEM. The Indians grow on their plots the same crops grown by the patron, and several more. Corn, potatoes, wheat and ocas are the staple foods. Barley, rye, habas, tauri and some non-commercial crops, quinoa, ullucos and mashua, are also grown. Each Indian family has a vegetable garden, averaging, perhaps, ten square yards, where a few vegetables, such as tree cabbage and squash, are grown. Until the introduction of improved techniques of potato production by the Cornell-Peru Project, corn was the most important crop on Hacienda Vicos. The best land is still reserved for corn; it is generally grown near the Indians' houses, in the lower part of the cabeceras. The principal reason for limiting corn to lesser elevations is that the higher areas are excessively cold. This limitation necessitates a continuous corn rotation on many plots, with only three months of fallow between the harvest in May and September planting.

There seems to be no generally consistent rotation of crops. On the lower fields where corn is not grown continuously, potatoes often follow corn; potatoes are followed by wheat and/or barley. Periods of fallow of various duration are interspersed. This is about the same rotation that is used by the Project. Few Indians, however, adhere to this sequence exactly. What the peón plants seems to depend on tradition, how good the last crop was, and what food will be needed in the near future. Potatoes are sometimes planted immediately after the corn is harvested in May. The potatoes are then harvested in February, and wheat or barley can be planted -- and harvested in time to plant corn again in September. Such an intensive rotation is possible, of course, only if the soil can support all three crops. If this is not the case, the crop which does the worst must be left out.

In the puna and in other high fields away from the houses, where corn cannot be grown, various sequences of the other crops must be used. On some fields, particularly those that are unirrigable, ocas, ullucos and mashua are planted every year.

TABLE 15: Indian Rotation Practices: A Typical Sequence

	Plant		Harvest
Field 1a approx. 0.6 acres			
Barley	Dec.1952	-	June 1953
Corn	Sept.1953	-	May 1954
Field 1b approx. 0.6 acres			
Wheat	Mar. 1953	-	July 1953
Corn	Sept. 1953	-	May 1954
Field 2 approx. 0.5 acres			
Fallow	------		------
Potatoes	June 1954	-	Oct. 1954
Field 3 approx. 1.5 acres			
Potatoes	July 1953	-	Jan. 1954
Wheat	Mar. 1954	-	July 1954

Planting and cultivation practices of the Indians differ little from those used by the patrón, as described above. If a family does not have access to oxen and a wooden plow, all preparation and planting is done by hand with a short-handled hoe. Sticks, rather than horses, are used by the peones in threshing. The Cornell-Peru Project has arranged to sell guano and spray to the Indians at cost; it also rents spray equipment, which the Indians have begun to use on their own plots. No Indian farmer has yet purchased spray equipment.

3. ANIMAL HUSBANDRY. Livestock plays a very important role in the economy of the Indians. Keeping animals is one major method of storing wealth. If there is a bad crop year, they can always be sold and the cash gained will help tide the family over until the following harvest. Thus, the number of animals an Indian owns is some indication of his economic condition and is, accordingly, a sign of prestige. One Indian, for example, owns over one hundred horses, few of which are ever used; one or two are ridden, and several may, perhaps, be rented out or sold as pack animals.

Some donkeys are raised to carry cargo. Cattle are kept by many families; oxen and bulls are used in the fields for plowing and milk from the cows is sometimes sold fresh, but is usually made into cheese. Meat and hides are sold. Most families keep sheep in order to have badly needed wool to make clothes, grain bags and ponchos. These animals also provide meat and hides for market. Goats are sold as meat

or are eaten on festivals. Pigs, also, are fattened, primarily for cash sale. Chickens are kept for the production of eggs, which are sold at market. The meat staple of the Indians is guinea pig.

4. INDIAN FOOD CONSUMPTION. As a result of population pressures, poor land resources and weak agricultural technology, food is scarce on the hacienda. A nutrition survey has been done at Vicos,as part of a program of dietary investigations in Peru, by the Department of Nutrition of the Harvard School of Public Health. Vicos and Chacan (another hacienda) were chosen to represent rural communities in the Andes. According to this survey, the average number of calories consumed per day per capita is about 1,500, or just 70 per-cent of that recommended for good health (see Table 16). In some periods during the year, particularly soon after harvest, food is abundant. Vasquez 1/ says that May, June and July are the months of abundant food and that December, January and February are the months of greatest scarcity. The Harvard Nutrition Survey samples were taken in July, 1952 and in February, 1953, and, contrary to Vasquez's suggestion, the calorie intake appears to be almost the same during the two periods of the year. However, the Nutrition Survey findings may be a direct consequence of the recent introduction of improved potato varieties into Vicos by the Cornell-Peru Project.

The first sampling of the Vicos diet (July) was made by observing the kind and amount of food prepared for 40 families (211 persons). The second survey (February) included 37 families (196 persons). Table 16 shows the average intake per person per day of the various nutritional elements. Note should be taken of the extremely low intakes of calcium and Vitamin A (carotene); all families in both samplings consumed less than 75 per-cent of the recommended amounts. The finely ground limestone rock eaten while chewing coca leaves and the carotene in the leaves themselves were not included in the Nutrition Survey reports. It is possible that these sources may compensate somewhat for the otherwise very low intake of these two factors. The survey also found that corn, wheat, potatoes and habas are the most important foods, in terms of calories and protein. 15 per-cent of protein intake is from animal sources. Calories come 80 per-cent from carbohydrates, 5-8 per-cent from fats, and 9-12 per-cent from protein.

Table 17 shows the change in importance of various major foods in the diet according to season. Note that potatoes completely dominate the diet in February. During that month they supply 38 per-cent of total calories and 31 per-cent of total protein intake.

5. MARKETING. Marketing takes place on Sunday morning, a custom familiar in many South American countries. Marvara is the marketplace for the Vicosino Indians. Early Sunday morning, before it is light, the Indians start for Marcara with the products they wish to sell. He also does his buying in this street market.

1/ Vasquez, op. cit.

TABLE 16. NUTRITIVE VALUE OF THE "TYPICAL" VICOS DIETS[1/]

Food	Avg. per person per day	Calories	Protein	Calcium	Iron[1]	Vit. A[1]	Thiamine	Riboflavin	Niacin	Vitamin C
	gm.	gm.	gm.	mg.	mg.	I.U.	mg.	mg.	mg.	mg.
1st Survey, July '52										
Barley	50	171	3.7	30	2.7		.17	.10	3.70	
Corn, dry	190	582	11.6	8	4.2		.91	.38	5.14	
Wheat	70	230	6.4	25	3.2		.21	.06	1.99	
Broad beans, dry	70	227	18.1	41	4.5		.30	.26	1.61	
Oca (tuber)	235	134	2.6	5	2.3	84	.05	.07	1.01	57.5
Potatoes	100	100	2.0	10	0.4		.17	.05	1.77	13.1
Sugar	5	20								
Lard	5	45								
AVERAGE INTAKE		1509	44.4	125	17.3	84	1.81	.92	15.22	70.6
AVG. RECOMMENDED INTAKE		2150	58.0	1000	10.1	3860	1.10	1.40	11.00	62.0
PERCENT OF RECOMMENDED		70	76	13	171	3	165	66	138	117
2nd Survey, Feb. '53										
Corn	115	352	7.0	5	2.5		.55	.23	3.10	
Wheat	130	425	12.0	47	6.0		.39	.10	3.70	
Broad beans, dry	20	65	5.2	12	1.3		.09	.07	.46	
Potatoes	550	550	11.0	56	2.2		.94	.27	9.75	72.0
Cabbage	5	3	.2	16	.1	50	.01	.02	.08	4.9
Sugar	10	40								
Lard	5	45								
AVERAGE INTAKE		1481	35.4	138	15.3	50	1.98	.69	17.09	76.9
AVG. RECOMMENDED INTAKE		2155	59.0	1000	10.2	3890	1.10	1.50	11.00	65.0
PERCENT OF RECOMMENDED		69	60	14	120	2	180	46	156	120

[1]1mg. carotene = 1670 I.U. of Vitamin A.

TABLE 17: Foods Consumed by 25 Per Cent or More of the Families in One or More of the Sierra Surveys 1/

Food	1st survey -- July 1952		2nd survey -- Feb.1953	
	families consuming	average consumption	families consuming	average consumption
	per cent1/	gm/day2/	per cent1/	gm/day2/
Barley	68	390	22	160
Corn, dry	100	980	97	600
Quinoa	5	65	0	0
Wheat	85	420	97	700
Habas (broad beans dry)	73	490	49	250
Bread	3	130	8	120
Potatoes	65	775	100	2900
Ocas (tuber)	78	1600	0	0
Ullucas (tuber)	18	640	3	60
Onions (with stems)	70	20	95	35
Rocoto (hot pepper)	48	15	57	30
Cabbage	28	40	27	90
Herbs,various	35	5	97	25
Sugar	38	100	40	115
Lard	93	25	97	25
All meats	23	345	19	90

1/ 40 and 37 families were included in Vicos, 1st and 2nd surveys, respectively.

2/ Averages calculated considering only families using each item; weights are those for edible portions.

Some trading is also done at small stalls set into the ground floor of many houses lining the main streets. The townspeople are nearly all mestizos. They have been to school, are able to read and write Spanish, and feel themselves quite superior to the largely illiterate Indian population of the area. The mestizo shopkeepers all know the Quechua language, which facilitates trading activities. The Indian is sometimes at a disadvantage in mestizo stores. Because he does not understand Spanish, and because the shopkeepers are occasionally unscrupulous, he will often come out on the short end of a bargain.

A third kind of market takes place on some Sundays, when out-of-town buyers come into Marcara. They are usually looking for animals to ship to distant cities and towns.

Much of the actual exchange in the markets is by barter, animals for potatoes, potatoes for tools. As a result of this, it is very difficult to obtain any figures of total Indian sales through these markets during the period of a year. Vasquez has estimated that the Indians of Vicos sell 100 grown cattle during a typical year 1/. It is probable that the sale of animals and eggs represents the greatest single source of market income. Other products sold for profit include wool, charcoal, ice, vegetables and field crops. The products bought in largest quantity are salt, sugar, coca, aji (red pepper) and rice. Other products traded for are: fruit, bread, alcohol and kerosene, dyes, thread, tools and various articles of clothing.

In addition to their trade in Marcara, the Indians do some selling and buying in other nearby towns and haciendas. Many Vicosinos make at least one business trip a year to the mountain town of Chacas, two or three days away by foot.

C. Summary of the Efficiency of Present Agricultural Production

In the following discussion, efficiency will be taken to mean the extent to which present knowledge and advantageous production practices are applied to the resources of the hacienda. If the application of known techniques is as great as possible, production will be considered efficient. In other words, is an appreciable increase in production possible, given current agricultural practices?

In considering the 35,000 acres of Hacienda Vicos, the patrón's portion and the Indian portion together, the following may be said:

1. The mountainous four-fifths of the hacienda contains pasture lands and a small amount of flat arable valley area in the Quebrada Honda. At the present time, the grazing areas are being exploited fairly extensively. Much of the flat valley land, however, is not being used for crop cultivation, as it well might be.

1/ Vasquez, Mario C. Personal communication.

2. The remaining fifth of the hacienda, including the lowland alluvial, cabeceras, and puna areas, is being used, for the most part, efficiently, given present technology and social organization. The Indians farm most of their land as intensively as might be expected, considering their meagre knowledge of sound agricultural practice. However, some of the areas operated by the patrón might be further exploited without necessitating a significant change in the techniques of production.

3. In summary: Some increase in production is possible on the areas cropped by the patrón and on the land in the Quebrada Honda. With present techniques little improvement is possible on the rest of the hacienda. Maximizing available resources and knowledge, total increase in production probably would not exceed 25 per-cent. Thus it may be said that, given the technology in use and the existing social organization, present agricultural production on Hacienda Vicos is fairly efficient.

VI. SUGGESTIONS FOR AGRICULTURAL DEVELOPMENT AT HACIENDA VICOS

A. The Basis of Approach

Prior to submitting a specific proposal for increasing agricultural production at Hacienda Vicos, the purpose for which this higher production is to be used must be discussed. The means of development has a very direct relationship to the end in view.

I will assume that the purpose of agricultural development at Vicos is, most immediately, to increase the Indian standard of living as rapidly as possible, without necessitating a decrease in the total amount of agricultural goods contributed by the hacienda (Indian and patrón) to the Peruvian economy. I will also assume the purpose of development in Vicos to be, in the long run, the maximizing of output and contribution to the economy of Peru, in a manner consistent with the play of normal economic forces.

The short-term proposals are made under the assumption that the present institutional organization of the hacienda, including the patrón and the labor tax, will be retained. This must be done for a number of reasons. Considerable agricultural development can occur by employing advantageously the present organization at Vicos. The patrón's economy can, in fact, be of direct benefit to the hacienda by bringing in and trying new agricultural techniques and equipment, thus teaching and serving as an example to the Indian peons. Another reason for not hastily abolishing the hacienda system is that by simply dividing the 415 acres of the hacienda land operated by the patrón among 1,850 peons, the Indian income will not be raised to any great extent. A final reason for framing the short-run proposals within the existing institutional arrangements at Vicos is that, due to the present nature of the political situation in Peru, there is little possibility of abolishing the hacienda system, even if it were desirable.

The long-run proposals look for the disintegration of the hacienda system as it is presently in operation at Vicos. The most important reason for changing the relationship between the patrón and the peon is not actually economic, but, ultimately, will have a very marked effect upon the entire hacienda economy. What is the reason? To put it simply: no people can develop their full potentialities, economic or otherwise, when they are subserviant, dependent, and continually deprived of taking initiative in concerns which are vital to their own welfare. The Indians must, eventually, be freed from the social and economic restrictions which the hacienda system imposes and which hamper their easy growth into modern life. The people must become independent of the hacienda, free to come and go and do as they please. Strangely, it may be the Indians themselves, at first, who will feel that they are losing something in their emancipation. In a sense, that is true; for their security will not be as great as before.

The foregoing is not to imply that it is necessarily desirable to divide up the lands presently operated by the patrón, when the hacienda

system is abolished. The patrón's lands, if left intact, would logically form an agricultural economic unit, which could provide, efficiently and continuously, large quantities of agricultural products to the Peruvian national market.

* * *

This is the framework within which recommendations are being made. It remains, however, to suggest also the underlying economic philosophy behind the recommendations and the mode of economic analysis employed.

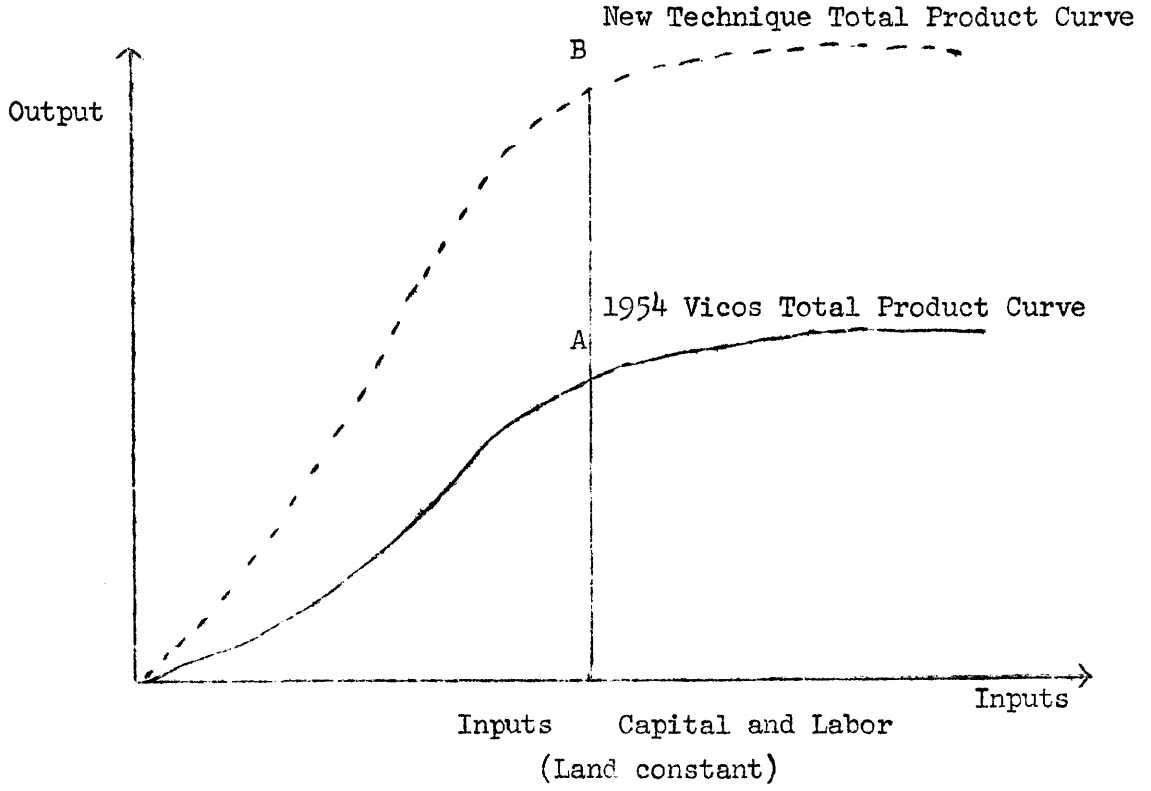
An increase in productivity of the land is the most direct attack upon the problem of increasing the Indian standard of living. To use the analogy of a pie, the pie represents the total agricultural production of the hacienda. In order to gain a substantial increase in Indian income, the pie must be made bigger, that is, the productivity of the land must be increased. The policy of distributing hacienda lands among the Indians would be like cutting the pie into nearly equal pieces; but, as stated above, this would not result in a very significant increase for each of 1,850 Indian peons. The real goal must be to increase the productivity of the whole hacienda, in other words, to increase the size of the pie.

From an economic point of view, any decision about modifying the social organization of the hacienda should depend upon which arrangement will most encourage largest total output. Many land reform movements are based on the naive assumption that greater production will result automatically from turning the land over to the cultivators. That this is not necessarily the fact is witnessed by the many unsuccessful "liberal" programs currently being pursued in a number of countries today. Land reform can result in greater output, but, usually, the new owners need considerable aid, advice, and encouragement to keep them moving towards increased productivity.

New technology is the major need of Vicos in achieving a productivity increase. This is emphasized by the fact that most of the hacienda land is presently being used as intensively as is possible, given the existing production function, which included the manorial organization of labor. Thus, there is little possibility of proportionately increasing the total product, to any great extent, by bringing more land under cultivation. To increase total output appreciably, the production function must, itself, be changed.

Given the present technology in use at Vicos, and the fixed land resource base, little additional product will result from adding more labor or adding more capital (in the form of tools currently in use and livestock). This concept is represented diagramatically in the figure below. An assumed total product curve for Vicos in 1954 is shown (solid line). Point A suggests the level at which the hacienda is now operating. It can be seen that an increase of inputs, under these conditions, will not increase output substantially.

FIGURE 1: Hypothetical Production Functions for Vicos



Viewing the problem in another manner, an appreciable increase in production on the fixed land resource of the hacienda must be accompanied by a qualitative change in one or more of the resource factors mentioned above. Labor productivity, for example, might be changed by Indian education or by changing the social organization and the labor system. Capital productivity might be increased by introducing new implements or more productive animals. New techniques or methods of work may be introduced in the form of better crop rotations and planting schedules, or better irrigation practices. Experience in Production Economics shows that substantial increases in output can often be achieved more easily by changing the production function than by moving along it. In Figure 1, the new technique production curve for thehacienda (dotted line) shows a production function which might result, typically, from the use of new techniques or qualitatively improved labor and capital factors. To increase output appreciably on the hacienda, the aim must be to reach such a point as B on the new technique total product curve. In other words, holding land, capital, and labor constant, emphasis should be put upon changes in technique and organization to gain a significant output increase.

The introduction by the Cornell-Peru Project of new potato varieties, spray, and the use of guano fertilizer in growing the potatoes is an example of changing the nature of the production function. This introduction has been very successful at Vicos, as the new potatoes and the new growing techniques have been accepted by a large percentage of the Indians. It is generally agreed that the new practices have more than doubled the yeild of potatoes for the hacienda. Spreading the use of this new system of production among the remaining Vicosinos will result in a further significant increase in total potato production.

The economic questions emphasized in the preceeding paragraphs concerns the types of changes in production which are most likely to increase output appreciably. The proposals which are presented below follow directly from the preceeding analysis. They are specific suggestions for changing the production function. They consist, primarily, of the introduction and the application of new techniques, both in the patron's and in the Indian agricultural production processes.

B. Proposals

Some changes can be made immediately which will increase the total production of the hacienda without altering its organization. Other, more fundamental, changes, however, may require profound modifications in the social organization of the hacienda.

The distinction between the patrón's economy and the Indian economy will be retained in the following presentation of proposals. It is true that some problems are common to both the Indian and the patrón's economy. However, the same kind of development, at the same pace, is neither possible nor desirable.

1. IMMEDIATE CHANGES

I. The Patrón's Economy

a. soils

1) Increase the fertility of the soil. Most soils on the hacienda are low in organic matter. An increase in organic matter would mean two things, more available nitrogen and phosphorous and better soil structure, both of which would serve to increase crop yields. Rather than letting fields lie fallow, grasses and/or legumes should be planted and plowed under at the succulent stage, or be used as forage for animals. In addition, the accumulation of organic matter would be more rapid if a nitrogen fertilizer were applied at the time the crop is plowed under. The cover can consist of any of the common grasses: barley, rye, or wheat. But generally, the most desirable cover crops are legumes, such as alfalfa or clovers. These legumes, however, have critical growth requirements: acid soils would need liming and, perhaps, potassium fertilizer; if the legume were new to the area it would also require innocalation. (Note: a sod crop demands the introduction of a steel plow and ox yokes.)

2) Erosion control. Much top soil and, hence, valuable organic matter is now being lost through erosion. More terracing is needed to stop the growth of gullies. Diversion ditches should be constructed in most fields. Proper irrigation techniques are required to prevent the soil from being washed away; often irrigation water is allowed to wash down over the fields in torrents.

b. crops

1) Emphasize the most profitable cash crop, which is, at the present time, potatoes. (A check should be made on the areas of Peru which might compete for the January and February potato market in Lima. It is possible that the Santa Valley has a potential natural monopoly in this market.)

2) Experiment with the use of lime and fertilizers, particularly those containing nitrogen, phosphorous, potassium and magnesium. Records should be kept of the responses of different crops and soils.

3) Determine a good rotation of crops, and use it. (Include a sod crop.)

4) Continue trying new garden and crop varieties on a small scale. Artichokes, for example, may be a commercial possibility on the Lima market.

5) Keep careful records, particularly of the planting rate, cultivation practices used, and yields obtained from each field.

6) Continue experimentation with insecticides, fungicides, etc.

7) Experiment with amount, frequency and technique of irrigation, particularly for potatoes.

c. livestock

1) Buy and keep a small number of top grade animals (beef cattle, milk cows and sheep). Demonstrate controlled breeding and controlled grazing by using shepherds and/or fencing. (Consider the practicability of electric fencing.)

2) Try to determine the possibility of disease control in poultry. Some attempt should be made to improve the breed by keeping a few top grade roosters.

3) Keep pack animals for transport to outlying fields.

d. other suggestions

1) Better use should be made of the puna and other grasslands by irrigating the grass during the dry season.

2) Land use must be adjusted to land resources; give some consideration to cropping of the good quebrada soils.

3) Simple farm machinery, such as steel plows and the harrow, may be introduced. These will require ox yokes and improved harnesses.

4) A record should be kept of all animals grazing on the patrón's lands and a feww be charged the Indians.

5) Trees should be planted on the non-cultivable glacial outwash and moraine areas. (See Appendix III for specific recommendations.)

II. The Indian Economy

a. soils

1) Institute an intensive program of erosion control. The use of proper irrigation practices, terracing and diversion ditches should be encouraged.

2) Stress the use of a good crop rotation. Try to move away from continuous corn, and, if possible, introduce the use of a sod crop instead of fallow.

b. crops

1) Continue and expand the use of lime and fertilizer.

2) Continue and expand the use of pesticides.

3) Develop cash crops for market.

c. livestock

1) Upgrade Indian animals with the improved breeds kept by the hacienda.

2) Arrange a system of joint herding among the poenes so that fewer persons are involved in this activity each day.

3) If the poultry disease problem can be solved, emcourage the improvement of poultry flocks.

4) Experiment with the growing of rabbits for food.

d. other suggestions

1) Emphasize the cultivation of improved kitchen gardens.

2) Share-crop some of the patrón's fields that are not now being used to their fullest extent.

3) Establish a cooperative store, run by Indians if possible, to buy and distribute fertilizer and other agricultural supplies.

4) Set up a marketing organization to sell Indian products to large buyers. (This organization may be combined with the cooperative store.)

5) Introduce practical agricultural instruction (particularly with regard to new techniques) into the school curricula.

6) Hold an agricultural fair.

7) Encourage the Indians to plant and cultivate trees on the borders of their plots.

2. LONG-RUN CHANGES

1) Bring to an end the feudalistic agricultural organization of the hacienda. This will require the definition and consolidation of Indian lands, which should then be sold to the peons for a nominal price. A proportion of the grazing lands which they are now using should also be included in the sale. This will define the lands that the patrón (now in name only) has available for use. After reorganization, he will, of course, pay his workers.

2) Attract a portion of the Indian population away from agriculture and into manufacturing. The small area of arable land available cannot support all those on the hacienda. The loss of even a great number of agricultural laborers will not reduce production significantly, particularly if new farm techniques are being introduced as the cutback occurs. Local manufacture could include agricultural product processing, such as cheese and butter making or hand-weaving on improved looms. Non-agricultural cottage industries may also be developed (for example, tile, brick or pottery making.)

3) The Indian school should play an increasingly important role in the life of the hacienda, taking over the demonstration of animal breeding, new agronomic practices, and, perhaps, setting up model gardens. Agricultural subjects and homemaking should be emphasized in the school curriculum.

4) The patrón should continue to emphasize profitable cash crops and go into meat or wool production, as his land permits.

5) If the Quebrada Honda should prove valuable for crop production, a road should be built to the area.

APPENDIX I. WEATHER DATA, HUARAZ, ALT. 3050 METERS, COLLECTED AT COLLEGIA NATIONAL de LA LIBERTA for the MINISTERIO de AERONAUTICA, DIRECTION de COMMUNCACIONES y METEROLOGIA de AERONAUTICA
(Weather records kept since 1947 in Huaraz)

1953	Monthly averages Temp. - degrees centergrade			Total rain millimeters	Lowest temperature Degrees centergrade	Average sunshine per day hours
	Daily maximum	Daily minimum	Daily average*			
August	24.4	3.9	14.14	1.0	0.0	10.6
September	23.7	6.4	15.03	67.5	3.0	8.6
October	22.2	6.6	14.42	87.6	2.4	7.33
November	21.6	7.1	14.34	144.6	4.2	7.47
December	22.7	6.7	14.69	58.6	1.7	8.4
1954						
January	21.1	7.5	14.24	157.4	4.5	6.7
February	20.1	7.3	13.84	66.6	4.0	6.9
March	21.6	7.0	14.41	114,4	3.0	7.7
April	22.9	7.7	15.33	53.4	5.4	9.2
May	22.3	5.8	14.04	46.3	3.5	9.56
June	23.1	4.0	13.49	0.0	1.5	10.6
July	22.9	2.8	12.85	0.0	0.4	10.8
Year			14.24	797.4		

*Maximum / Minimum
2

The highest rainfall in one day was 33.3 mm on the 26th of September.

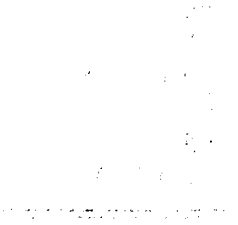
Avg. soil temp.	25 cm	50 cm	100 cm		25 cm	50 cm	100 cm
April	17.5	18.2	17.5	June	15.3	16.3	16.3
May	15.9	17.1	17.0	July	14.7	15.5	15.4

APPENDIX II. WEATHER DATA, 1954, HACIENDA VICOS, MARGARA, ANCASH, PERU. ALTITUDE APPROX. 9,000 FT.

Taylor maximum-minimum thermometer. Screwed on inside of post on the porch on the second floor. The porch is on the south side of the house and receives no sunlight. Readings to be taken every morning.

1954	Temperature - Farenheit	
	Maximum	Minimum
July 3	73	46
July 4	73	44
July 5		42
July 6		
July 7	70	42 slight frost
July 8	71	41 slight frost
July 9	68	41
July 10	70	42
July 11	71	42
July 12	72	41
July 13	73	46 cloudy
July 14	71	45 cloudy
July 15	73	45
July 16	73	44
July 17	75	44
July 18	68	47
July 19	74	42
July 20	75	42
July 21	73	43
July 22	72	43
July 23	73	44
July 24	73	44
July 25	73	43
July 26	72	42
July 27	74	44
July 28	72	42
July 29	74	42
July 30	73	44
July 31	73	45
August 1	72 cloudy	44
August 2	72 cloudy	48
August 3	73	48
August 4	72	50
August 5		
August 6		46 no frost
August 7	68	46 no frost
August 8	73	43 frost
August 9	72	43 no frost
August 10	72	46 no frost

August 11	73	43	
August 12	72	42	frost
August 13	73	42	slight frost
August 14	72	44	no frost
August 15	72	44	
August 16	74	42	slight frost
August 17	74	43	slight frost
August 18	72	42	frost
August 19	72	42	frost
August 20	72	43	
August 21	73	44	
August 22	74	44	
August 23	72	45	no frost
August 24	73	44	
August 25	74	43	
August 26		43	frost



APPENDIX III

COPY

INSTITUTO INTER AMERICANO DE CIENCIAL AGRICOLAS
Zona Andina
Lima, Peru

September 7th, 1954.

Messers.
Cornell-Peru Anthropological Studies Program
Hacienda Vicos
Marcara, Ancash.
Attention: Mr. Allan Holmberg
Mr. Robert Stevens

Dear Sirs:

I am summarizing below the details concerned with the ecological characteristics of the area in which Hacienda Vicos is located and some suggestions for suitable tree species for plantations in this area, in accordance with the request made by Mr. Stevens on September 6th.

Ecological Characteristics (climate):

Precipitation (millimeters)	Elevation in meters	Formation Represented	Mean Annual Temperature
Annual Precip.	2000-3000	Lower Montane Dry Forest	17°-12° C.
between	3100-3900	Montane Moist Forest	12°- 6° C.
500 - 1000 mm.	3900-4300	Subalpine Wet Formation (on its drier side).	6°- 3° C.

On good soils - (deep) - with irrigation or irrigation leakage:

from 2700-3100 meters elevation: Cupressus lusitanica (has excellent wood and good rate of growth).

Pinus pseudo strobus: with irrigation leakage alone or in deep colluvial pockets of soil near streams without irrigation (good wood, good growth rate, a "hard" pine).

On poor soils, without irrigation, from 2600-3400 meters:

Pinus montezumae (good wood, good growth rate, considering the conditions).

(cont'd)

COPY (p. 2)

On all soils, without irrigation, from 2700-3400 meters:

Pinus insignis (radiata) (good wood, good growth rate, considering the conditions).

Pinus patula

On all soils - 3100-3500 meters: Pinus rudis

Without irrigation - 3400-4300 meters: Pinus hartwegii

Harwoods:

Eucalyptus globulus: excellent growth on moist deep soils with irrigation, and nominal growth without irrigation from 2500 to 3800 meters. Seed can be obtained from trees growing within the area. This is the best Eucalyptus known for this elevation and region. Grows very rapidly with irrigation or irrigation leakage, or along permanent streams. Wood quality not exceptional but excellent for farm and home construction and general use, including firewood, fence-posts, windbreaks, etc.

Polylepsis sp.: a native tree of slow growth but very useful for general purposes and well adapted to rigorous conditions of the sierra between 3000 and 4300 meters. Grows best on deeper colluvial and alluvial soils near streams, but will grow on any site. It is reproduced by means of cuttings, which should be rooted in nursery before transplanting.

Buddelya sp.: same as Polylepsis.

(note: all plantations should be fenced against grazing animals, at least until trees reach a height of 20 ft. or more, and fire must be kept out completely. This is one reason there is little forest in the sierra today, -- grazing and fire.)

Seed Sources:

Cupressus lusitanica

Ing. Mario Lopez
Servicio Forestal
Ministerio di Agricultura e Industrias
San Jose, Costa Rica

(cont'd)

APPENDIX IV.

Plants collected in Peru in 1954 by Robert D. Stevens

Hacienda Vicos

Malvaceae (1)

Cruciferae (2)

Polygonaceae
Polygonum (sp.?)

Cactaceae (2)

Gentianaceae
Gentiana (sp.?)

Solanaceae
Solanum (sp.?)

Rosaceae
Prunus capuli Cav.

Leguminosae
Mimosa revoluta (Kunth) Benth
Cassia helveola Macbr.
Lupinus mutabilis Sweet
Dalea weberbaueri Ulbr.
Lathyrus crassipes Gillies.
unidentified legume

Compositae (12 species, including 1 Gnaphalium and 1 Galinsoga)

Gramineae (5 species)

other dicotyledons - still unidentified - 12

Tuyu School

Rutaceae
Citrus (sp.?)

A complete report will be made later. Many identifications still are necessary.

R. T. Clausen
Mar. 21, 1955

APPENDIX V. SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date Planted	Date Harvested	Quantity planted sacks	Quanitity harvested sacks	Field size paces	Field size hectares	Good fair poor	Sowing rate sacks/H
(1) Basilio	1	pot.	14 May 54	11/54	1.5		33x58 ft.	.2		
		pot.		11/20/53		8.0			fair	
4	2	barley	3/3/54	8/8/54	.1	2.0	25x20	.05	good	2.0
		pot.		11/53		7.0			poor	
3 adults	3	pot.P fallow	5/1/54	10/54	.16		30x10	.04		
(2 men)	4	wheat	4/10/54	10/54	.08		20x52	.1	fair	.8
		pot.		1/54	4.0	2.0			poor	
	5	corn	9/15/53	5/54	.2	2.0	39x40	.1	fair	2
		ocas		7/53		4.0			fair	
	6	corn fallow		5/54	.05	.5	30x15	.04	poor	1
	7	fallow					20x60	.1		
								.6		
(2) Coleto	1	pot.P.	5/3/54	10/54	1.0			.2		
	(1/2/3/4)	corn	9/24/53		.2	1.6		(.2/.4/.3)	poor	.2
3	2	(corn, see above)						.4		
	(1/2/x)	corn		5/53	.5	10.0		(.2/.4 .x)	good	
	3/4	pot.p.	1/23/54	12/54	1.24			.3		
2 adults?		corn (see above)								
	5	centana	12/53	7/15/54	.08	.6		.2	fair	
		pot.p.	7/53	12/53	1.0	15.0			good	
(1 man?)	6/7	barley	12/53	7/30/54	.2	.2		.3	poor	.7
		barley							fair	
	8/9							.4		
	((8/9))	wheat fa	12/53	7/54	.08	.33		.1	poor	.8
	10	pot. (less than half a field)						.5		
		fallow						2.4		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
(3) Quinto	1	wheat FA pot.	Jan.	8/4/54	.08	.16	56x43	.2	fair	
5										
3 adults	2	rye	Jan.	8/1/54	.16	.50	30x22	.1	fair	
1/ 2		wheat FA		7/30/53	.24	.33	86x65	(.2/.1)	poor	
4 children	3	corn	10/7/53	5/54	.30	1.00		.4	fair	
		"			.30?	.50			poor	
(2 men)	4	pot.P	5/54		.24			.2	good	
		corn		4/30/54		.10			poor	
		corn		5/53						
	5	ocas	8/53	7/54	.08	.08		.2	poor	
		"	8/52							
	6	Pot.L	8/54		.08			.3		
		"		7/54	.08?	.08?			poor	
		"			.08?	.50			fair	
								1.4		
(4) Capitan	1/2	corn	Sept.Oct.53	5/54	.10	2.0?		.5/.2	fair	
15		"				4.0?			good	
	2	wheat FA	6/54		.08			(.2)	fair	
3 adults	3a	barley	12/53	7/54	.10	1.0		.3	good	.3
	3b	pot.Ch	6/54	(Oct.)	.08					
2 children	3a	corn		5/53	.04	1.5			good	
(2 men)	4	pot.P		5/25/54	1.0			.3		
		corn		5/54	.10	.5			poor	
		barley		6/53	.10	1.4			good	.3
	5a	wheat	12/53	6/54	.03	.33		.15	good	
		"		June		.33				
	5b	barley		51	.10	1.20		.15	good	.7
	6a	wheat		8/1/54	.03	.33		.15		
	6b	fallow						.15		
	6a	wheat			.03	.50				
	7	barley	3/54	8/20/54	.04			.2	good	
		pot	8/53	2/54					good	
								2.1		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
(5) Tadéo	1	wheat	2/54	8/5/54	.08	.16		.2?	poor	
20	2	habas	9/53	5/54	.24	.16	30x40	.3	poor	
	1&2	pot.T			1.00	6.00			fair	
4 adults	3	ocas	8/53		.25	1.00	50x50?	.4	poor	
	4a	pot.T.		6/1/54	1.00		30x70	.2		
(2 men)	4b							.2		
	4a&4b	corn			.4	.40			poor	
	"	corn			1.6				fair	
	5	ocas	8/53	6/54	.25	1.00	60x70	.3	poor	
		fallow								
	6	pot.P	4/1/54	8/54	.16-.33		30x40	.1	poor	
		fallow					60x60	.3		
	7	barley		7/54	.20	.30			poor	
		"				.50			fair	
								2.0		
(6) Sanchez	1	corn	9/53	5/54	.04	2.4		1.1	poor	
21	1a	"	9/52	5/53		5 with cob		(.8)	fair	
	1b	pot.		2/53				(.3)	fair	
	2	Pot.L	8/30/53	4/54	.5	1.5		.2	fair	
3 adults	2	fallow								
	3	fallow						.2		
4 children	3	fallow								
	4	wheat	1/54		.02	not yet harvested		.1	poor	.2
(2 men)	4	wheat		8/53		.33			fair	
								1.6		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
(7)										
Reyes	1a	corn	9/24/53	5/54	.2	3 with cob		.3	fair	
	1b	pot.ch.	5/54				40x20	.1		
10	1a & 1b	corn		5/53		6 with cob			fair	
		corn		5/52						
	2a	pot.ch	9/54	5/1/54	.24			.1	fair	
2 adults	2a	peas		8/30/53	1/2 acroba				poor	
	2b	peas	9/54	2/27/54	1 acroba			.1	good	
(1 man)	2b	pot.ch.	May	9/53	.41	2.0			good	
	3a & b	wheat FA	2/1/54	8/1/54	.16	.5		.2	good	.8
	3a	pot.	8/8/53	12/53	.33	3.0		(.1)	good	
	3b	bloc wheat		July				(.1)		
	4	bloc wheat	12/8/53	8/1/54	.16	.33		.2	poor	.8
	4 & 3b	"		7/53		1.00		(.2/.1)	good	
	7	ocas						.3		
	5	pot.L	7/29/54	1/55	.16			.1		
		corn	9/53	5/54	.05	1 1/2 with cob			good	
		barley		July		.6			good	
	6a	fallow						.1		
	6b	ocas	8/10/54		.33			.1		
		wheat FA	2/54	7/25/54	.05	.42			fair	.5
Heavy Fert.		pot.L	8/53	2/54	.33	5.00			good	
	6c	wheat,bloc fallow	12/15/53		.08			.1	failure	
	6d	ocas	7/53	June & July 54	.42	4.00		.1		
		pot.L							good	
								1.8		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
8 Reyes	1	corn	9/53	5/54	.4	.6		.5	poor	
	1a	barley	12/52	6/53	.1	.6		(.25)	fair	.5
7	1b	wheat	3/15/53	7/53	.08	.08		(.25)	poor	.1
	2	pot.	6/54	10/54				.2		
2 adults		fallow								
		fallow								
2 children	3	wheat FA	5/54	7/54	.16	.42		.6	fair	.3
(1 Man)	3	pot. L	7/53	1/54	1.0	3.0			fair	
								1.3		
9 Cruz	1	wheat	2/54	8/54	.07	.16		.2	poor	.4
		habas							failure	
11	2	pot. W	6/54		.16			.1		
		corn	9/53						failure	
	3	barley	12/53	8/15/54	.1	.5		.15	poor	.7
4 adults		barley				2.0			good	
		barley								
(2 men)	4	ocas	7/15/54		.08		5x35	.05		
		ocas		June					poor	
		ocas								
	5	Pot.	6/54	12/54	2.0			.1		
		fallow								
		wheat								
	6	corn	9/53	5/54	.2		15x50	.1	failure	
		corn				1 1/2 sack with			fair	
		corn								
								.7		

SURVEY OF 15 FAMILIES, AUGUST 1954

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	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
Sanchez	1	grass					21x67	.1		
Nestor 1	2	corn		5/20/54	.4	2.5		.2	fair	2
		corn							good	
Adults 3		corn								
Children 2	3	corn		5/20/54	.3	2.5		.2	fair	1.5
		corn							good	
(2 men)		corn								
	4)-	habas		6/15/54	.16	1.0	(22x53	.1		
	5)						(7x60	.04	fair	
		barley		6/53		1.0			fair	
	6	barley	1/54	6/10/54	.2	1.0		.1	fair	2.0
		wheat FA			.	.33		.	poor	
	7	ocas	8/15/53	7/28/54	.33	2.00		.1	poor	
		potatoes				1.00			fair	
	8	wheat	1/5/54	6/5/54	.16	.33		.2	poor	1.0
		habas		5/30/53		1.00			fair	
	9	wheat	2/20/54	8/2/54	.16	.83	30x47	.1	fair	1.6
		barley		6/53		1.00			fair	
	10a	corn	9/24/53	5/54	.4	2.4		.4	poor	1.0
	10a,b,c	corn			.6	8.0	80x85	(.6	good	1.0
	10b	pot.p.	11/54	5/5/54				.1		
	10c	pot.		7/54	1.0			.1		
	11	rye	12/53	8/54	.24			.2	poor	
		rye				1.0			fair	
		rye								
	12	ocas, etc.						.1		
								2.0		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
(11) Sanchez	1	pot.tarma	5/10/54	12/54	1.5		70x13	.1		
		wheat		May		1.5			fair	
Y	2						36x28	.1		
	2a	wheat FA	4/26/54	9/54	.16			(.05)	fair	3.0
		pot.		3/54		2.0			fair	
2 adults	2b	pasture								
1 child	3							.2		
(1 man)								.4		
(12) Leon	1	corn	9/25/53	5/54	.1	1.6		.1	fair	1
	(1/3)	wheat		8/53		.42		(.1/.1)	fair	2.0
6	2	wheat	2/1753		.08		25x22	.1	good	.8
		pot.	6/22/53	10/53	.42	3.0			good	
	3	barley	12/53	7/8/54	.1	1.2		.1	good	1.0
2 adults		wheat		8/53		See Field I				
		potatoes								
(1 man)	4	pot.P.	5/30/54	10/54	1.0		30x43	.14		
		corn	9/9/54	5/54	.4	.5			poor	
		corn							good	
	7a	rye	10/53	8/15/54	.08	.33		.2	fair	
		rye								
		rye								
	7b	ocas						.1		
	7c	fallow						.3		
	8	fallow						.1		
		fallow								
		fallow								
	9	ocas, potatoes								
		wheat						.1		
								1.2		

SURVEY OF 15 FAMILIES, AUGUST 1954

	Field	Crop	Date planted	Date harvested	Quantity planted sacks	Quantity harvested sacks	Field size paces	Field size hect.	Good fair poor	Sowing rate sacks/H
(13) Lazaro	1	corn		5/54	.3	3.2	45x35	.2	poor	1.5
		corn				4.0			good	
13		corn								
	2	pot.p.	5/54	11/54	1.3		45x35	.2		
3 adults		corn		5/54		.8			poor	
3 children	3	bar.&wh.	12/53	8/1/54	.2	.4		.1	poor	2.0
	4	corn	12/1/53	5/54	.02	.5	24x60	.2	poor	.1
	(3/4)	bar.&wh		8/53	.4	.4			poor	1.0
(2 men)	5	ocas	8/8/54		.08		15x20	.1		
		pot.L.		5/54		1.0			poor	
								.8		
(14) Gutiers	1	pot.ch.	6/12/54	11/54	.08		9x8/ 18x7	.02	fair	
		pot.L	7/1/53	3/54	.08				poor	
X	2	fallow					17x23	.04		
		corn		5/54	.02	.1		.02	poor	1.0
3 adults	3	fallow					22x7			
		pot.				.16				
1 child	4	corn		5/54	.1	.8	30x23	.06	fair	1.4
(2 men)								.2		
(15) Leyba	1	wheat	1/26/54	7/28/54	.20	.24	58x28	.1	poor	2
		pot.L	6/3/53	12/53	.66	2.00			poor	
2	2	pot.	6/24/54					.1		
		fallow								
3 adults	3	pot.	6/54		.66		24x50	.1		
		corn		5/54		.6			poor	
3 children	4	corn	9/25/53	5/54	.1	1.0	38x30	.1	poor	1
		corn				2.0			fair	
(2 men)		corn								
	5	pot.	4/28/54		.16			.1		
		corn						.5	failure	