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## A Food Production System in the Southern Central Andes

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## A Food Production System in the Southern Central Andes

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Since Murra's ethnohistorical studies [MURRA 1968, 1972] on the nature of environmental exploitation among Central Andean populations, a number of contemporary studies of "verticality" have appeared. Although those studies emphasized that the internal organization of the Central Andean economy is based on reciprocity and redistribution, the complementarities of the production system resulting from verticality is of minimal interest in them. As a result, Andean specialists have paid little attention to the production system of the self-sufficient agropastoral subsistence pattern. Nevertheless, this type of production system is common throughout the southern Central Andes, and appears to be an ancient response to the ecological exigencies of the region. In this article, the food production system of a self-sufficient agropastoral subsistence pattern is analyzed using data from the District of Marcapata, Cuzco, southern Peru. A tentative model is developed to demonstrate how the southern Central Andean environmental and exploitative variables may have interacted to produce some of the later food production systems of the self-sufficient agropastoral pattern.

### INTRODUCTION

Until recently, it appears that Andean specialists among anthropologists have been interested more in social relationships rather than in the relationship between Andean culture and environment. As a consequence, Andean subsistence systems or strategies have not been a focus in their research. Since Murra [1968, 1972] published his ethnohistorical studies on the nature of environmental exploitation among Central Andean populations, however, "vertical control" or the model of "verticality", has been a major theme in Andean ecological and economic anthropology. According to Murra's model of verticality, Andean populations attempt to control the largest possible number of ecological elevations, in an effort to achieve their ideal of self-sufficiency.

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An earlier version of this paper, presented at the Symposium, was based on a relatively short period of fieldwork, conducted for some eight months in 1978-1979. This revised version includes data obtained at that time, plus additional information derived from a further four months of field research, conducted in 1981. Both periods of fieldwork were made possible through grants from the Japanese Ministry of Education. I would like to thank my colleagues, Hiroyasu Tomoeda, Tatsuhiko Fujii, and Kenneth Ruddle for their thoughtful comments with the contents and style of this paper.

Although Murra's studies were concerned with early societies, particularly in the pre-Inca and Inca periods, many ethnographers suggest that contemporary groups may also demonstrate the survival of verticality [e.g., WEBSTER 1971, BRUSH 1976b, ORLOVE 1977]. That is to say, a sociopolitical unit still maintains access to a number of different ecological zones and membership in the units affords individual access to the products of the different zones through the mechanisms of reciprocity and redistribution [ORLOVE 1977: 88]. Thus, the Andean economic system has been defined in terms of the interdependent relationships among three elements: (1) vertical control of ecological "floors"; (2) the principle of reciprocity; and (3) the principle of redistribution [SANCHES 1978: 214].

Recent comparative studies of high altitude environmental adaptation in the Alps, Andes, and Himalayas [RHOADES and THOMPSON 1975, BRUSH 1976a] also suggest that the inhabitants of these mountainous zones have been made remarkably similar adaptations to their environments, despite their location in widely separated parts of the world. Brush [1976a] summarized these similarities as follows. In all three mountainous regions, peasant village economies revolve around the exploitation of multiple production zones, and household subsistence strategies are developed to provide access, through either production or exchange, to the products of these different zones. Beyond this general similarity of cultural adaptations to mountain ecosystems, two striking congruences may be observed on a more specific level. Two such congruences noted are (1) the native peasant population of each area has a mixed agropastoral economy; (2) different zones of production are integrated on a regional level through trade [Brush 1976a: 127].

Although those studies emphasized that the internal organization of the mountain region economies is based on reciprocity and redistribution, the complementarities of the production system resulting from verticality is of minimal interest. Orlove [1977: 87-90] makes the criticism that substantivist economic anthropologists have focused on distribution rather than production, in the Andes as well as elsewhere, and that although the model of verticality readily permits an examination of production, cultural and economic anthropologists have ignored it. As a result, Andean anthropologists have tended to stress the importance of verticality with respect to complex trade networks but have paid little attention to the self-sufficient production system of the mixed agropastoral economy.

However, Webster [1971, 1973] emphasizes that this type of mixed agropastoral strategy is widespread in the southern Central Andes, and that it seems likely to be an ancient response to ecological conditions. He suggests further that loss or absence of control over staple resources of several different altitudinal zones, which may result in the specialization of agriculture or herding, is a primary cause of peasantization and acculturation in that area. Rhoades and Thompson [1975: 547] also suggest that some cases of highland specialization may have developed in response to the loss of lower zones. For example, the Spanish conquest of the lower Andean areas and the coast totally disrupted the pattern of vertical control by the Inca Empire and forced many Indian groups into specialized activities at higher

altitudes [MURRA 1968: 121–125]. Moreover, Orlove [1977] demonstrates for a self-sufficient agropastoral community of the southern Central Andes that the upper herding zone and the lower agricultural zone are integrated via production rather than by distribution.

Therefore, it is considered that the self-sufficient agropastoral strategies are traditional, or at least important for the study of indigenous production systems in the southern Central Andes. Thus, in this article I illustrate a production system based on the principle of verticality, using data from the District of Marcapata, Peru. Focusing on the food production system, a self-sufficient agropastoral economic system is then analyzed from the perspective of how peasants utilize the resources of the multiple ecological zones, and why they use them in the way that they do.

### MARCAPATA: ENVIRONMENT AND NATURAL RESOURCES

The District of Marcapata is located in the eastern Cordillera of southern Peru, at the eastern extreme of the Department of Cuzco, bordering on the Department of Puno. As shown in Figure 1, it lies in the basin of the R. Marcapata, on the eastern slope of the snow-covered mountain chains of the Cordillera Oriental, where some peaks reach 6,000m or more, as does Nev. Auzangate (6,336m), for example (Photo 1). The District has an area of some 1,700 km<sup>2</sup>, ranging in elevation from 1,000

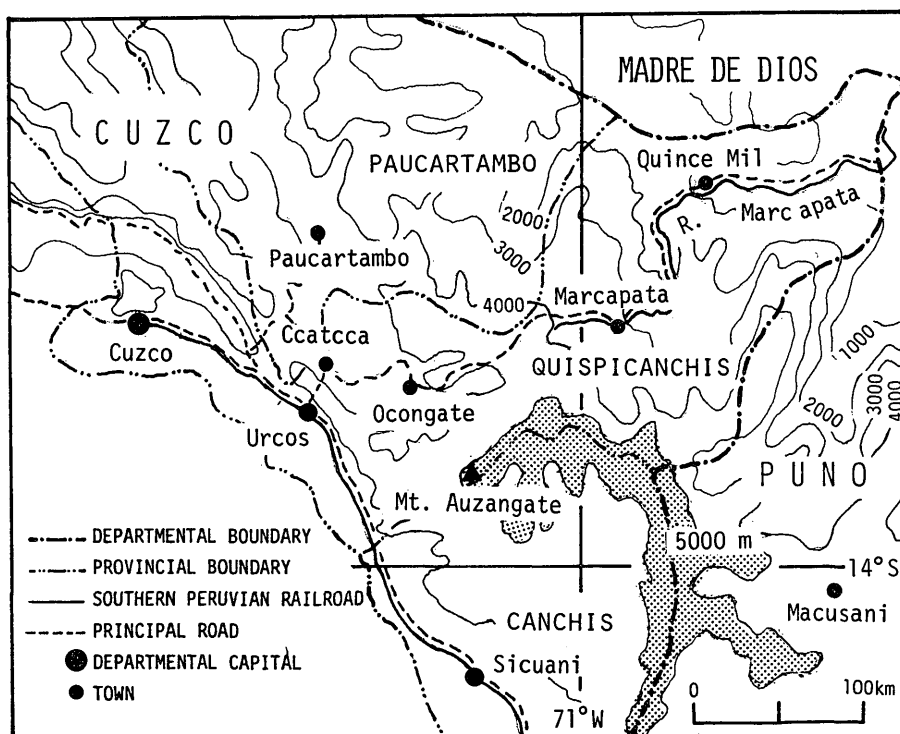


Fig. 1. Marcapata and vicinity

to 5,000 m above sea level, and supports a widely scattered population of about 4,000 Marcapata people (*Marcapateños*). Except for a small group of in-migrants, the population consists of Quechua-speaking peasants. Agriculture and herding are the major productive activities of the area.

Socioculturally and administratively, the region of Marcapata is divided into four communities: Marcapata Collana, Puica, Sahuancay, and Collasuyo. The territory of each community is divided vertically by four upper tributaries of the R. Marcapata or by the watersheds between them. Of these communities, only Puica is divided into two parts; Puica Alta (Upper Puica) and Puica Baja (Lower Puica). Puica Baja is situated in the lowest part of the District ranging from 1,000 to 2,000 m above sea level, and has a population of some 400, mainly recent in-migrants from regions such as Puno and Sicuani. These people have had little social and economic impact on the original inhabitants of Marcapata. The inhabitants of each community are dispersed in settlements in four upper valleys, and exhibit a high degree of social, economic, and political independence.

The central and largest village of the District is Pueblo Marcapata (*llaqta* in Quechua), located at the convergence of the four upper valleys. It has a Catholic church, municipal offices, a national police station, a sanitary post, some stores, and approximately 100 dwellings (Photo 2). In Pueblo Marcapata items such as salt, coca leaf, sugar, kerosene and so on, which the local population cannot produce for itself, can be purchased. Each community holds a monthly meeting (*asamblea*) on which communal work (*faena*) is arranged. The joint fiesta of all the four communities also takes place here. Thus, Pueblo Marcapata functions as the ceremonial and administrative center of the each community, as well as of the District as a whole. It is not, however, a commercial center, since most households are economically self-sufficient, and some necessities, such as coca leaf and salt, are distributed through the exchange system.

In general, about 350 inhabitants of this pueblo are known as *llaqtarunakuna* or "town people". According to the *Marcapateños* themselves, the term *llaqtarunakuna* corresponds approximately to *mistis* or *mestizos* in Spanish, whereas the people living in the upper valleys are known as *punarunakuna*, "people of the highlands", a term corresponding to the Spanish *indígenas* or *campesinos*. Since most of the *mestizos* cannot maintain a self-sufficient economy, they can compensate for some shortages either through relationships which they maintain with *campesinos*, via bonds based on spiritual kinship (*compadrazgo*), or from the stores. Most of the *campesinos* are economically self-sufficient, with each family engaged in both agriculture and herding. But some families specialize either in agriculture or in herding. Since such families cannot be economically self-sufficient, products from different zones must sometimes be exchanged among the *campesinos* also. Patterns of interzonal exchange in Marcapata are treated in more detail elsewhere [YAMAMOTO 1981].

The climate in this region is relatively wet as a consequence of the orographic effect of the high mountain ranges. The radical differences in altitude, however, cause a wide range of micro-environments, particularly in climatic elements and

vegetation, within the zones. No climatic data are available yet for the Marcapata District except for temperature data from Pueblo, but using the data from Quince Mil and in Ccatcca, radical differences in ecological conditions as a consequence of altitudinal change can be demonstrated. As shown in Fig. 1, Quince Mil is a small town (620 m, a.s.l.) close to the lower limit of the Marcapata District. It has an annual rainfall in excess of 6,000 mm, an average annual temperature of around 22°C, and an annual relative humidity of about 90 percent. The climate of Quince Mil is hot and humid. Ccatcca (3,700 m, a.s.l.), on the other hand, is close to the upper zone of Marcapata. It has a dry and cold climate, with an annual rainfall averaging only about 590 mm, an annual average temperature of around 10°C, and an annual relative humidity of 70 percent. In general, the higher the altitude, the drier, sunnier, and colder is the climate.

Since there are marked seasonal changes in precipitation (Fig. 2), the local population recognizes two main seasons: the rainy season (*poqoy*) and the dry season (*chirau*). The rain begins gradually in September or October and increases in intensity, reaching a maximum in January and February (*mamapoqoy*), after which it tapers-off, around April. The dry season begins in April and lasts until September

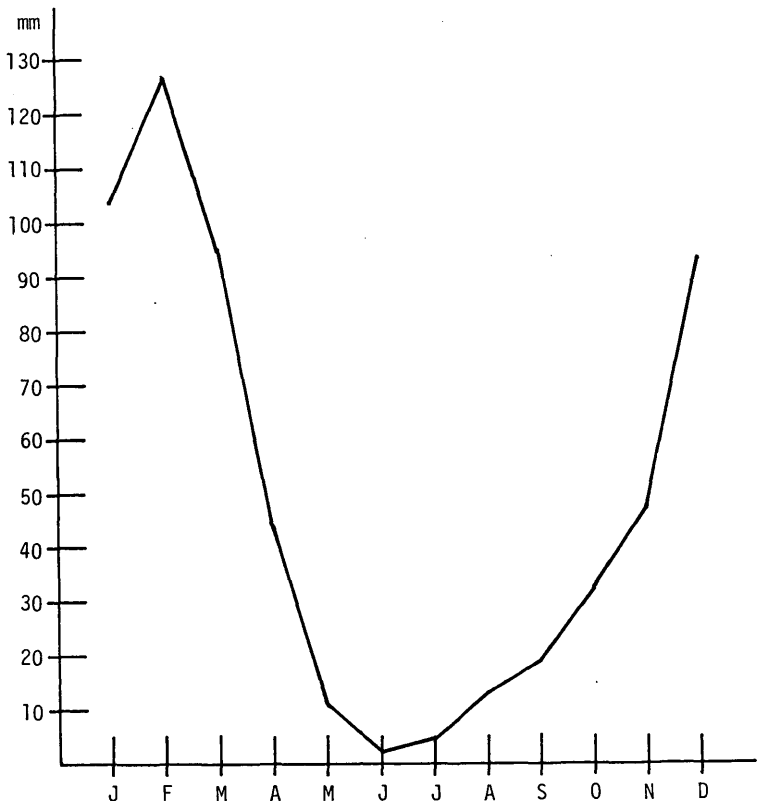


Fig. 2. Annual rainfall in the town of Ccatcca, Quispicanchis, Cuzco (Data from Servicio Nacional de Meteorología e Hidrología, Perú [1964-1976]).

or October. Seasonal fluctuation of temperature is slight, but the diurnal range is great, particularly during the dry season in the upper zone, where frosts are frequent and intense (Table 1).

The effects of altitude on temperature and moisture produce various ecological situations as well as natural resource assemblages. Within the area of the District of Marcapata are six principal ecological zones [ONERN 1976]: (1) subtropical rainforest (*bosque pluvial subtropical*); (2) subtropical temperate rainforest (*bosque pluvial montano bajo subtropical*); (3) *ceja* or *ceja de montaña* vegetation zone (*bosque pluvial montano subtropical*); (4) subalpine wet paramo (*páramo pluvial subalpino subtropical*); (5) alpine rain tundra (*tundra pluvial alpino subtropical*); and (6) the snow zone (*nival*).

The alpine rain tundra (4,200–5,000 m) is the highest life zone of the District. This zone is cold and relatively dry (but with occasional snow in the rainy season) and where temperatures are too low to support agriculture. The vegetation consists of alpine sedges and grasses which provide natural pasture for llama (*Lama glama*), alpaca (*Lama pacos*), and sheep. The alpine moors in the valley bottom, in particular, are well-suited to the alpacas, owing to the animal's narrower habitat requirements. The llama is more tolerant of varied pasture and rugged terrain, so that it can be pastured over a wider altitudinal range, from the alpine rain tundra to the *ceja* vegetation zone. In addition to being a primary source of protein, all these animals provide wool. Their dung is also an important resource, being the most widely used fertilizer [WINTERHALDER, LARSEN and THOMAS 1974] and the principal source of fuel in this treeless zone. Of these herd animals, the llama is important in agricultural activities as the indispensable beast of burden available to transporting the harvested maize and potatoes in the steep valleys.

**Table 1.** Mean Temperature (°C) in Ccatcca and in Pueblo Marcapata, Quispicanchis, Cuzco, Peru

Month	Ccatcca (Alt. 3,726 m) <sup>1)</sup>			Pueblo Marcapata (Alt. 3,100 m) <sup>2)</sup>	
	Average	Maximum	Minimum	Maximum	Minimum
January	9.5	14.3	3.9	15.1	12.7
February	9.4	14.1	4.1	— <sup>3)</sup>	—
March	9.3	14.5	3.4	14.9	12.8
April	9.4	15.7	3.4	—	—
May	8.6	15.6	−1.0	14.3	5.3
June	7.9	15.5	−2.8	13.3	5.0
July	7.2	15.1	−3.6	14.0	3.8
August	7.9	15.3	−1.3	14.3	4.8
September	8.7	15.6	1.2	15.2	5.6
October	9.9	16.1	2.9	16.2	5.3
November	10.4	16.3	3.3	—	—
December	9.8	15.0	4.0	14.6	4.0

<sup>1)</sup> Data from *Servicio Nacional de Meteorología e Hidrología, Perú* (1964–1976). <sup>2)</sup> Data from author's observations in Pueblo Marcapata (1978–1979, 1981). <sup>3)</sup> Not observed.

The subalpine wet paramo (3,600–4,200 m), which is characterized by *ichu* grass (*Stipa* sp.) and some shrubby areas, lies below the alpine tundra zone. It is somewhat warmer than the higher zone, so such tuber crops as *oca* (*Oxalis tuberosa*), *olluco* (*Ullucus tuberosus*), *isaño* (*Tropaeolum tuberosum*), as well as the potato (*Solanum* spp.), are cultivated there. Since snow or frosts occur sometimes in the upper part of this zone, frost-resistant species of potato, such as *papa ruki* (bitter potato, *S. curtilobum*), are grown toward the upper limits of agriculture. *Papa puna* (*puna* potato) is the general term for a wide variety of potatoes grown in this zone, except for *papa ruki* grown in the upper zone. The category *papa puna* contains at least 5 distinct species (*S. ajanhuiri*, *S. phureja*, *S. goniocalix*, *S. stenotomum* and *S. andigena*), and as many as 100 local varieties. The other tubers, *oca*, *olluco*, and *isaño* also include several varieties. These tubers, plus potatoes, provide the bulk of the year-round dietary staples for the people. Potato fields in fallow are used frequently for grazing llamas and sheep. Although cattle, horses, and pigs are raised here and also in the lower zone, these animals are rarer and of less importance.

As mentioned above, most of *campesinos* live in dispersed settlements in this zone and each family raises about 10 to 20 guinea pigs or *cuy* (*Cavia porcellus*) in their kitchen huts, using some grasses together with the residue of foods prepared for human consumption. *Cuy* meat is an indispensable food in Marcapata, as elsewhere throughout the Andes, consumed extensively on festive occasions, and which serves as a protein source, together of the meat of herd animals [BOLTON 1979].

The *ceja de montaña* (2,600–3,600 m), characterized by small trees and shrubs, is a transitional zone between the hot, humid lower valley and the cold, dry, upper valley, and is a zone of cloudiness which forms the moss forest in the lower parts. The four upper tributaries of R. Marcapata, which divide the land into the four territories of the communities of the District, converge in this zone. Pueblo Marcapata is located at an intermediate altitude (approximately 3,100 m) in this zone and is situated just between the zone of maize cultivation and that of potato, i.e., potatoes are grown immediately above Pueblo Marcapata and maize cultivation begins immediately below it. Therefore, two subzones, for maize and for potato, can be distinguished (Photo 3).

Potatoes grown in this zone are grouped under the general term *papa maway* (*maway* potato). This category contains fewer varieties than *papa puna*, but *papa maway* is characterized by early maturation, by virtue of cultivation in the lower and warmer zone. As with the potato, the people of Marcapata divide most local varieties of maize cultivated from this zone to that of the subtropical rainforest into three groups which are adapted to separate altitudinal environments. The three groups of maize are *llaqta sara*, *wari sara*, and *yunka sara*. The *llaqta sara* group is adapted to the altitudinal range near the Pueblo, of approximately 2,600–3,100 m, and is characterized by late maturation, smallness of ear, and the best taste of all the varieties cultivated. The *wari sara* group is adapted to the lower zone of *ceja de montaña* or to the upper zone of subtropical temperate forest, an altitude zone ranging approximately from 2,000 to 2,600 m. The *yunka sara* maize group is adapted to



the subtropical rainforest zone. Although it is characterized by having the largest ear among locally grown varieties, and by early maturation, it is considered unsavory and is less important for the original inhabitants of Marcapata. Both *llaqta sara* and *wari sara* varieties of maize are used mainly to make *chicha*, the indispensable drink accompanying ceremonial and religious meetings, as well as for consumption during agricultural work. In addition to potato and maize, *haba* or broad bean (*Vicia faba*), *tarwi* (*Lupinus* sp.), squash, and some temperate zone tubers such as *llaqón* (*Polymnia edulis*) and *viraka* (*Arracacia xanthoryza*), which furnish the inhabitants with supplementary foods, are also cultivated in this zone.

The subtropical temperate rainforest zone (1,500–2,600 m) begins below the convergence of the four tributary valleys, where the main valley becomes narrow, thus reducing the area of cultivable land in comparison to the upper zones. Tropical or subtropical crops such as coffee (*Coffea* sp.), papaya (*Carica papaya*), avocado (*Persea americana*), chili pepper or *rokoto* (*Capsicum pubescens*), as well as *wari sara*, are grown here, along the bottom and/or on the steep sides of the valley. The most important crop among them is chili pepper, an indispensable material for seasoning, and significantly this zone is named *uchu uray*, “the zone for growing chili pepper”. However, apart from *wari sara* maize, most agricultural crops in this zone are cash crops cultivated by the recent in-migrants.

The subtropical rainforest (1,000–1,500 m) is the wettest and hottest zone in the narrow valley. Tropical crops like sugarcane, citrus, plantain, sweet manioc,

Table 2. Marcapata: ecological zones and natural resources

Ecological Zone	Elevation	General Characteristics	Climate	Community Territory
Alpine Rain Tundra	5,000 – 4,200 m.	Major grazing zone of llamas and alpacas	Cold, dry, sunny  ↑  ↓	↑ ↑ ↑ ↑ ↑
Subalpine Wet Paramo	4,200 – 3,600 m.	Major tuber cultivation zone ( <i>papa ruki</i> , <i>papa puna</i> ) Major population zone of <i>campesinos</i>		↑ ↑ ↑ ↑ ↑
<i>Ceja de Montaña</i>	3,600 – 3,100 m.	Cultivation of <i>maway</i> potato		↑ ↑ ↑ ↑ ↑
	3,100 – 2,600 m.	Pueblo Marcapata and major population zone of <i>mestizos</i> Major maize cultivation zone		↑ ↑ ↑ ↑ ↑
Subtropical Temperate Rainforest	2,600 – 1,500 m.	Major chili pepper and coffee cultivation zone		↑ ↑ ↑ ↑ ↑
Subtropical Rainforest	1,500 – 1,000 m.	Major cultivation zone of cash crops, e.g., sugarcane, citrus, plantain, etc. Major population zone of in-migrants	Hot, moist, cloudy	↑ ↑ ↑ ↑ ↑

and pineapple, as well as *yunka sara* maize, are grown here. This, the lowest part of the District, is occupied by recent in-migrants, and these agricultural products are commercial cash crops.

To summarize, a great variety of tubers, legumes, grains, and fruits, as well as a number of varieties of animals, are raised in Marcapata. Important among these domesticates are beans, such as *tarwi* and broad bean, tubers like *oca*, *olluco*, *isaño*, and many varieties of potato, maize, chili pepper, animals such as the llama, alpaca, sheep, and the guinea pig. Although some crops and animals have been successfully introduced into Andean agriculture, except for the broad bean and sheep these introduced domesticates are of little importance in Marcapata, the original inhabitants of which still depend mainly on the native Andean domesticates, well-adapted to specific and diversified ecological conditions. As a whole, the upper altitudinal zones are exploited by the original populations of the District mainly based on native domesticates, whereas the lower altitudinal zones are occupied by recent in-migrants who engage in the cultivation of market crops. Since all four communities of the District have a similar altitudinal range, approximately from 2,000 to 5,000 m, however, all can produce the subsistence staples, with the exception of coca and salt (Table 2).

## A FOOD PRODUCTION SYSTEM IN MARCAPATA: AGRICULTURE AND HERDING

Herd animals, potatoes, and maize are the three foci of the Marcapata subsistence economy. Lands for agriculture and herding in the upper zones are controlled by the community, whereas the lower altitudinal zone of the District, i.e., the territory of Puica Baja, is subject to individual land tenure, as elsewhere throughout the mountain areas [RHOADES and THOMPSON 1975, BRUSH 1976a, GUILLET 1981a]. Virtually all households in each community cultivate maize and potatoes in discrete collective or communal fields, known as *banda chakra*. The collective field is enclosed by a rock wall (*pirqa*) or fence using spiny shrub to protect the crops from the herd animals. Three groups of potatoes, *papa ruki*, *papa puna* and *papa maway*, are cultivated according to altitude, and a specific *banda chakra* is devoted to each group. There are also two *banda chakra* for maize; one for *llaqta sara* and the other for *wari sara*.

Although maize fields are used every year, potato lands are farmed on a system of sectorial fallow, according to which all members of a community cultivate potatoes in a single section (*muyu*) of the communal land. After one year of using a particular section they move to a new plot. A four year fallow is the minimum employed, requiring a community to divide its potato lands into at least that number of sections. All members of the community work independently on their individual plots within the *muyu*.

Communal control over the *muyu* involves the repair or reconstruction of fences by communal work or *faena* before planting, and land management via the community meeting or *asamblea*. Community control over land for both maize and potato

facilitates the scheduling of subsistence tasks, since the fences enclosing the communal field permit periodic care of fields in the lower zone and make possible sustained care of herds in the highland. According to Brush [1980: 163], moreover, the system of sectorial fallowing associated with community control is ecologically adaptive in two ways: (1) it minimizes the exposure of soil and helps maintain a high organic content, thereby reducing the threats of soil erosion and loss; and (2) a long-time fallowing appears to effectively control one of the potato's chief predators in the Andes, the golden nematode. During the fallow periods, as mentioned above, land is used for the grazing of the herds, so that this system is essential also to the regeneration of land in the tuber cultivation zone. Guillet [1981a] notes that private control threatens the regenerative base by allowing individual whim to govern cultivation and grazing practices.

Apart from that communal control over land, all the households perform their subsistence activities independently within the territory of each community. Most households in Marcapata are engaged in both herding and agriculture rather than specializing in only one activity, and they maintain economic self-sufficiency. This type of production entails access to various ecological zones, and is facilitated by the contiguity of land at different altitudes [ORLOVE 1977]. As mentioned above, herd animals, potatoes, and maize are the three foci of the each family of the Marcapata, requiring the constant movement or transhumance of the people between zones.

Fig. 3 shows one example of this exploitation pattern in the community of Marcapata Collana. All of the zones for agriculture as well as for herding are accessible, within a reasonably short travel time, to inhabitants of this valley. The dwellings of the *campesinos* are situated between the herding and the potato cultivation zone. The location of the permanent residences in the upper valley head permits all zones to be reached within 1 day. However, the maize fields are further away from their houses, and the herds must be moved when pasture becomes scarce to the upper zone, where permanent pasture is available. To facilitate these activities, people of Marcapata maintain a temporary residence in each zone: the *sara ch'uklla* in the maize field and the *astana* in the herding zone. Using these temporary residences as well as permanent residences, their annual cycle of the subsistence activities is conducted.

The principal limiting factors for agriculture and herding are drought and frost. Although irrigated farming is not practiced, the spatial and temporal arrangement of the following activities compensates for the limiting factors. One of the most notable features of the annual cycle is the coincidence of these activities with rainfall; cultivated fields are located on slopes rather than on flat areas, the latter being more prone to frost; and frost-resistant species of tuber crops are grown in the highland.

Because the climate becomes drier and colder with increasing altitude, the three groups of potato and two of maize are planted at intervals, in a similar ladder sequence, starting with *papa maway* potatoes at the lower altitude, in August, followed by *papa puna* in the intermediate zone, in September or October, and finally *papa ruki* in the upper part, in October. Finally, maize is sown in October, at the beginning of the rainy season, since maize is less drought-resistant than potato.

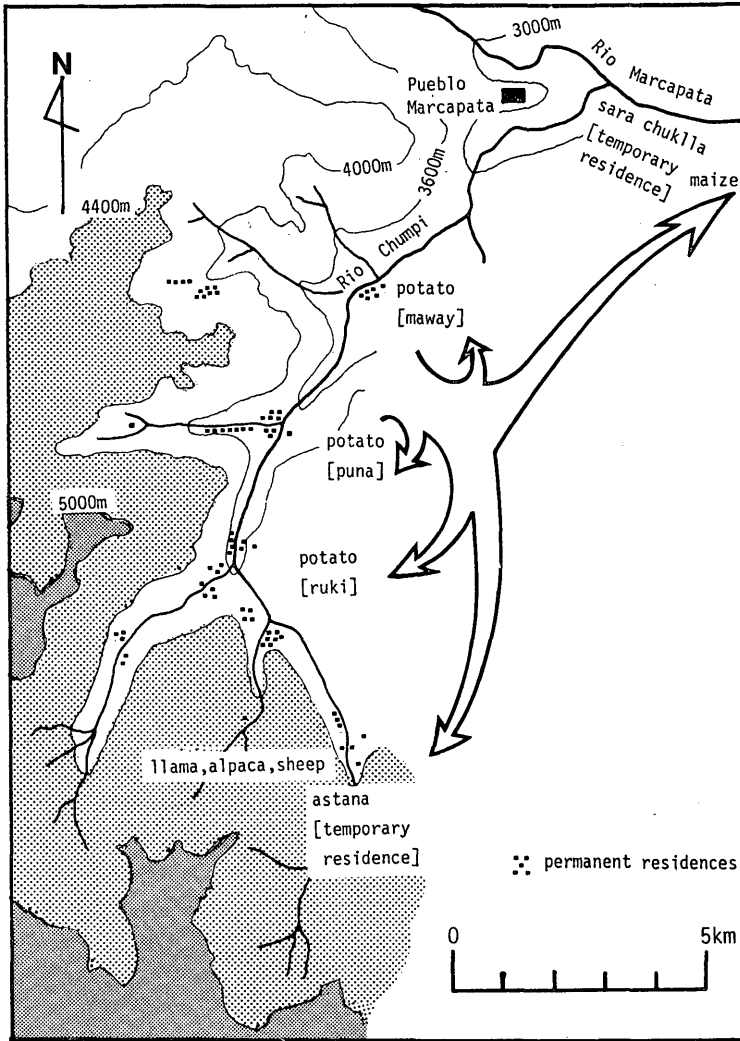


Fig. 3. Annual movement of agropastoralists in the Chumpi valley of Marcapata.

Although these crops are sown from the late dry to the early rainy season, the methods of land preparation differ among them. Fallow ground where *papa maway* is to be planted is turned over with a foot-plow (*chakitaklla*) late in the rainy season and then left for several months after the rains end, during which time the weeds are destroyed. Late in the dry season the dried weeds are burned and potatoes are planted, fertilized by weed ashes (Photo 4). The soil for *papa puna* and *papa ruki* is furrowed sometime after potato-planting, and dung from the herd animals is given as fertilizer. Preparation of the maize fields is somewhat similar to that for *papa maway*. Since maize fields are used each year, and thus there are relatively few weeds from which to produce ash fertilizer, chemical fertilizer together with animal dung, brought from the upper zone, are used to fertilize the maize crop. Moreover, such nitrogen-

fixing legumes as *tarwi* and broad bean are often planted together with maize. It seems that legumes function as a green manure. As suggested by Sauer [1950: 498] and Donkin [1979: 2], the interplanting of maize and nitrogen-fixing legumes reduces the need to fallow.

The differences between the clearing and furrow system may be understood as a method of adaptation to the limiting factors of climate. The furrows for potato and for maize run vertically up- and downslope. This pattern of high furrows on sloping ground allows the fields to drain in the season of heavy rainfall and to provide moisture at the rootzone level [ORLOVE 1977]. Striking evidence for this is provided by the difference in the use of furrows and ditches. Maize seeds are planted in the deep ditch between the furrows to facilitate the concentration of the moisture, which is abundant in the *ceja de montaña* zone. On the other hand, potatoes are grown on the high furrows and the ditches between them are deepened, the soil removed being heaped-up on the ridges with a mattock (*raukana*). Thus, in the season of heavy rainfall moisture is readily drained. The delayed furrowing for *papa puna* and *papa ruki* compensates for the more intense drought that characterizes the highland, compared with the zone in which *papa maway* is cultivated.

Although maize is cultivated every year in the *banda chakra*, crops are rotated according to a fixed cycle in the communal potato field. A field that has been fallowed for several years is first planted with potatoes, often together with other tubers like *oca*, *olluco*, or *isaño*. In the following year broad beans or *tarwi* are sown, after which the field is left fallow from four to six years. This sequence might suit the nutritional requirements of the crops. For example, potatoes deplete the soil nutrients and may lead to either fertility problems or pest infestation, especially nematode, or both. However, minimum tillage combined with a long fallow cycle cause minimal environmental perturbation. And the practice of fertilization seems to play an important role.

As with planting, so the crops are harvested sequentially, starting with *papa maway*, in February or March, followed by *papa puna* and *papa ruki*, often with other tubers, such as *oca*, *olluco*, and *isaño*, in May and June, and finally maize, in June. Tubers are dug from the earth with a mattock and are taken home for storage on the same day, because the houses are relatively close to the potato field. As suggested by Sauer [1959: 2] and Jensen and Kautz [1974: 47], tuber crops are not completely harvested at one time and many tubers can be stored in the ground, reducing the period of storage and the quantities stored. As a consequence, it is considered that the mode of prolonged harvest of potato is heavily oriented toward providing people with the year-round dietary staples. Maize is cut by hand, threshed using small wooden or bone sickles (*tipina*) and then winnowed in the fields near the *sara ch'uklla* (Photo 5). Since the maize field is relatively distant from the dwellings, planting and harvest of maize requires more intensive labor, so that the people stay for at least several days in the *sara ch'uklla*. The winnowed maize is carried to the permanent dwellings by llamas or horses brought from the upper zone (Photo 6). Maize and tubers are stored in bins (*tage*) at the dwellings. Storage at higher altitudes reduces spoilage.

July and August, after all crops have been harvested, besides being the coldest and driest time of the year, are also the months of greatest diurnal temperature range in the upper zone, and frost frequently occurs at night. Certain characteristics of the climate are taken advantage of during this period in the manufacture of several foodstuffs. One such foodstuff is *chuño*, made from potato. Usually, more than 30 percent of the potato harvest is made into *chuño*. In general, in order to benefit from more intense frost and the coldest temperatures, stored potatoes are transferred to the upper zone, where the *astana* can be used as a temporary dwelling.

To make *chuño*, potatoes are exposed in the open air to heavy frosts for several days and nights. Alternately, they are frozen by the nightly frost and warmed by the hot sun, a process which gradually makes them watery. Then the liquid is expressed by trampling them underfoot, and the crushed potatoes are left on the fields for several days to dry in the air (Photo 7). Another variety of *chuño*, prepared somewhat differently, is called *moraya*. To make *moraya*, the potatoes are put in a pit (*t'oqo*) with water to soak or ferment for a week or two. The water is changed often. The potatoes are then dried as for the preparation of *chuño*. Since *oca* does not keep for a long period, most *oca* tubers also are processed by a method similar to that used for making of *moraya*, to produce *kaya*.

Since properly prepared dehydrated tubers will keep indefinitely, *chuño* serves not only as a dietary staple but also as a reserve food for use when fresh potatoes are used up. Since the shrunken, concentrated, almost cork-like tuber is small in size and light in weight, these foodstuffs are easy to transport. Thus they are important foods for fieldworkers' and herders' lunches, as well as for taking on journeys. It should be noted also that the *chuño* elaboration process makes edible such bitter but frost-resistant tubers as *ruki* (bitter potato) and *kaya oca* (bitter *oca*).

Freeze-dried meat (*ch'arki*) is also prepared in the dry season. Fresh meat of herd animals is first salted and then dried by exposure to sun and frost. Like *chuño*, this freeze-dried meat can be stored for a long time without significant spoilage. The development of these preservation techniques minimizes short-term production failure and irons out the seasonal fluctuations in productivity [JENSEN and KAUTZ 1974: 51-52]. In addition, I wish to point out that the elaboration method of bitter but frost-resistant tubers permits the use of the inhospitable highland for agriculture, resulting in the maximization of the production potentials as a whole [YAMAMOTO 1976].

Unlike the cultivated fields, which can be left unattended or cared for only periodically, herds require sustained care and supervision. Although the herding of alpacas is restricted to the upper valleys, available pastures vary by season. Therefore, transhumance is practiced coincident with the seasonal appearance of certain grasses. In the rainy season, when pasture is abundant, the alpacas as well as llamas and sheep can be grazed around the primary houses. In the dry season, when pasture is scarce, the herds must be moved to the upper zone, where permanent pasture occurs in moist areas (*bofedales* in Spanish or *oqo* in Quechua). At that time the temporary residence (*astana*) is used. This is a small, one-room stone house,

with several corrals, situated only 1–2 km from the primary residence in the upper valley. When the family stays in the maize field for a several days at planting and harvest time, old people or children, often just one girl or boy, remain behind to care for the herds.

Spinning and weaving are done throughout the year. Although birth, shearing, breeding, and gestation of the herd animals were not observed within the short period of my research, I was informed that these activities are concentrated in the rainy season. According to Orlove [1977: 93], in the Andes the growth and reproductive cycles of the herd animals follow the transhumant and seasonal cycle, except for sheep introduced from the Old World. Hay-making, which is practiced elsewhere throughout the Andes as well as in the Himalayas and the Alps, is not essential in Marcapata, because of transhumant herding, thus resulting in reduction or minimization of the input of labor for herding.

The labor of the household is sufficient for routine daily activities of agriculture and herding, but sometimes closely integrated and short periods of intensive labor are required, as at planting or harvesting time. In such cases, a work team is organized to obtain a larger labor force. Two forms of reciprocal labor exchange, *ayni* and *mink'a*, are used. In *ayni*, a household organizes a work team by requesting other people to provide additional labor, that will be repaid later by the performance of an equal amount of the same kind of work (Photo 8). In *mink'a* a household organizes a work team by requesting others to provide labor, but repayment is made in tangible items rather than labor. The organizer may provide such items as foodstuffs, together with a large amount of *chicha* and/or *coca*, or he may give other products in payment. *Mink'a* exchanges tend to occur more frequently between *campesino* and *mestizo*, whereas *ayni* exchanges tend to occur among *campesinos*.

In summary, virtually all households of the *campesinos* in Marcapata engage in both herding and agriculture rather than specializing in only one activity, and thus they maintain self-sufficiency. This production system is facilitated by the vertical continuum of land in this steeply inclined environment and through the use of social relationships. This subsistence strategy pattern is characterized by a production system composed of two interacting factors, minimization and maximization. That is to say, this system is oriented heavily toward minimizing a set of risk factors common to mountain environments [CAMINO 1980, GUILLET 1981b] and to minimizing the input of labor resources of each family, through the use of a spatial and temporal arrangement via the practices described above. In turn, such minimization permits the population to exploit the maximum number of ecological zones, and to maximize the productivity of the limited labor resources available to each family.

## A FOOD PRODUCTION SYSTEM IN THE SOUTHERN CENTRAL ANDES

As noted above, agropastoral adaptations of the type reported here are common in the southern Central Andes. So here I will attempt to ascertain the common

features of self-sufficient subsistence adaptations in that region using the data from Marcapata. To do this I will first outline the environment and resource exploitation patterns in the southern Central Andes.

The Central Andes, especially the southern area, is characterized by the steep flanks of the high Cordillera and spacious high plateaux which are much higher and wider than in the northern and southern Andes. The area is characterized by tropical alpine climates which permit utilization of the highlands throughout the year. Thus, the great altitudinal differences in this area provide an ecological diversity and so several different natural resources have been exploited by the native population.

Setting aside such large sociopolitical units as the Lupaqa Kingdom, which has provided for ethnohistorical examinations [MURRA 1968, 1972], it appears that the environment of the Central Andes confronts the inhabitants on a household level or small social unit level, in the high plateaux and on the mountain flanks, with completely different ecological conditions. The steep flanks of the high Cordillera provide the inhabitants with several different natural life zones, whereas on the high plateaux it is difficult for the population to reach the flanks. Although Webster [1973: 129] focuses on pastoralism, he suggests that a key determinant of the subsistence pattern in the southern Central Andes appears to be whether the herding is carried out in a *ceja* or *puna* habitat, respectively, i.e., either the Cordillera flanks or the highland plateaux as follows:

Whereas in a *ceja* habitat a community can exploit both herding and cultivation potentials through a variety of altitudinal zones in relatively close proximity..., a community in a *puna* habitat has limited access ... or no access ... to cultivable zones, and so must specialize more exclusively in pastoralism and the exchange of its products.

Brush [1976b: 161–164] also points out that one can find mixed agropastoral types of exploitation, which he calls “compressed type”, in a valley characterized by a steep environmental gradient that places different zones very close to one another, on the eastern slope of the Peruvian Andes, in which the people of the village can exploit the entire valley complex for subsistence items without major migration or extended trade networks. One representative of the self-sufficient agropastoral adaptation is the community of Q’ero, in the southern Central Andes of Peru, near Cuzco [WEBSTER 1971: 174–182]. There are many striking similarities of subsistence adaptation in the patterns of Q’ero and Marcapata. In Q’ero, as in Marcapata, each community exploits a vertical range of 3,000 m, which extends from a subtropical forest to a glaciated peak, and they maintain a self-sufficient economy at the household level, engaging in both herding and cultivation.

Why, then, are such self-sufficient agropastoral adaptations common, and why have they exhibited great durability in the Cordillera flanks of southern Central Andes? In addition to the environmental factors mentioned above, other reasons must be considered. According to Guillet [1981b: 21], a mixed agropastoral subsistence is one of the household subsistence strategies that is a basic Alpine adaptation



and which is essential to the regeneration of the lands through the recycling of organic matter. Orlove [1977: 96] also demonstrates that agricultural productivity in the lower zone would be greatly reduced without dung from the upper herding zone.

Furthermore, just one activity of agriculture or herding does not suffice to maintain a population's nutritional balance. In fact, it should be noted that no separate pastoral economy had developed anywhere in the Andes away from the tuber cultivation [TROLL 1931: 263-264, MURRA 1965: 188]. The autonomy of pastoralism in the Andes may be limited by the absence of milking or bleeding from the herding regime, precluding milk or blood from the pastoralist diet [WEBSTER 1973: 117]. On the contrary, the agriculturalists depend on tuber crops for their staples, which are deficient in oil and proteins, so that they must be complemented with proteins of herd animals together with the meat of guinea pigs.

To date, we have neither archaeological nor historical data concerning the self-sufficient agropastoral subsistence pattern in the southern Central Andes. However, a series of articles by Lynch [1971, 1973] and Jensen and Kautz [1974] may shed light on this subject, since preceramic food production systems have been discussed in relation to transhumance from the coast to the sierra zone in the Central Andes. Using their suggestions I will now construct a provisional model, demonstrating a way in which the southern Central Andean environmental and exploitative variables may have interacted over several millenia to produce some of the later Andean production systems of the self-sufficient agropastoral pattern.

Lynch [1971: 139] suggests that seasonal transhumance of the hunter-gatherers in the sierra zone may bear on the beginnings of Andean agriculture as follows:

If the transfer of potential cultigens of their native environments can be a precipitating factor in the beginnings of domestication..., it would be of some value to establish a pattern of seasonal transhumance coincident with the appearance of incipient agriculture on the coast of Peru.

In addition, Lynch [1973: 1256] states that in association with the seasonal transhumance,

... "non-optimal" or poorly timed harvests might have played in promoting plant transfers, domestication, and improvement of crops in mountainous zones.

... areas of high relief and environmental diversity favor both transhumance and non-optimal harvests; these two factors work together to encourage domestication and improvement of crops by selecting out, transporting, and recombining genetic traits in the most effective manner possible.

Although this feature has been discussed only in terms of data from the Peruvian coast, it is more likely in the highlands or on the eastern flanks of the southern Central Andes, since all scholars agree that the initial impetus of Central Andean agriculture may have been within the highlands, or to the east of Andean crest [e.g., WILLEY

1971, PATTERSON 1971]. Moreover, most of the important crops and animals for the Andean subsistence adaptation, such as potato, *oca*, *olluco*, perhaps *isaño*, llama and alpaca, might have been domesticated in the southern Central Andes [HAWKES 1941, UGENT 1970, HODGE 1951, GILMORE 1963, WING 1975]. The cultivated potato, for example, must have originated in the Lake Titicaca-Cuzco regions of southern Peru and northern Bolivia [HAWKES 1941: 101–103]. Besides, the distribution of triploid and pentaploid cultivated potatoes is limited to that area, and the widest varietal range of cultivated potatoes is concentrated here [HAWKES 1941: 99–102, UGENT 1970: 1161–1166].

If seasonal transhumance plays a role in promoting domestication and improvement of crops in mountainous zones, and if areas of high relief and environmental diversity favor transhumance and non-optimal harvesting, following Lynch's reasoning, these crops and animals might have been domesticated or improved through transhumance in the steep gradients of the southern Central Andes. Of these domesticates, Jensen and Kautz [1974: 47–48] point out that one interesting feature of root crops in general, and the potato in particular, is that they can be quite easily managed by non-sedentary people, since the timing of harvests is less critical than for some other plants, and many of the tubers can be stored in the ground without cultural elaboration. They go on to note that:

... although root crops are valuable for their starch, they are deficient in oils and proteins, and must have been supplemented from the beginning with complete animal proteins... during the period of transhumance, highland exploitative systems may have become increasingly oriented toward use of high caloric-yielding rhizomes and high protein-yielding ungulates.

As a result, they demonstrate that the utilization of root crops coupled with hunting in the highlands was subsequently amplified to such an extent that domestication of the potato and llama resulted. This mode of environmental exploitation must have been required in order for each group to maintain economic self-sufficiency. Contemporary Andean ethnographies demonstrate the durability of the self-sufficient subsistence pattern based on herding of native camelids and cultivation of tuber crops throughout the southern Central Andes.

As noted above, this area has been proposed as a center of domestication and diffusion for these herd animals and crops. The life cycle of such animals as the llama and alpaca follows the transhumant pattern of human population in that area. Moreover, the great variety of tuber crops grown is adapted to specific altitudes. This evidence, as a whole, strongly suggests that the self-sufficient agropastoral subsistence pattern is an ancient adaptation to the biological and physical environment of the southern Central Andes. Therefore, it must be recalled that an understanding of the production system of the self-sufficient agropastoral pattern also is essential to an understanding of the relationships between Andean culture and environment.

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**Photo 1.** Potato field at the foot of snow-covered Nev. Auzangate.



**Photo 2.** Pueblo Marcapata, the central and largest village of the District.



**Photo 3.** Fallow ground for *maway* potato (u.) and *llaqta* maize fields (l.).



**Photo 4.** Land preparation for *maway* potato. Late in the dry season the dried weeds are burned and potatoes are planted, fertilized by weed ashes.



**Photo 5.** Maize harvest: maize is cut by hand, threshed, and then winnowed in the fields near the *sara ch'uklla*.



**Photo 6.** Transport of harvested maize by llamas.





Photo 7. Manufacture of the dehydrated potato, *chuño*.



Photo 8. Reciprocal labor exchange, *ayni*, at the time of maize planting.