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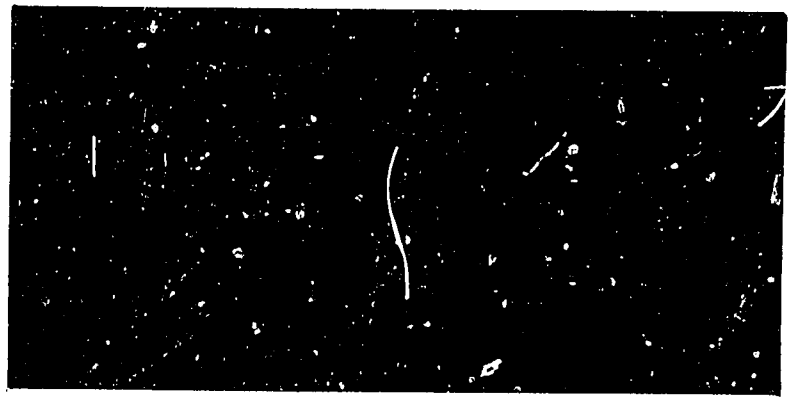

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LOS POBLADORES DE LOS DESPOBLADOS*:

GOAT HERDERS IN PIURA, PERU

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ABSTRACT

This report describes and analyzes the complex ecological, social, economic, and political context of goat husbandry in Piura, Peru. An overview of herd composition and dynamics, management practices, production, and marketing is first provided. Then nine types of goat production systems are delineated. Factors such as land tenure, political organization and control over resources, social relations, and alternative sources of household income are found to be critical in defining and explaining the differences among production systems. In particular, social relations between farmers and goat herders are examined in depth--again, within their larger ecological and economic setting. These farmer/herder relationships are shown to be mutually beneficial and to represent an adaptive response to the land, labor, fodder, and climatic constraints under which both groups subsist. These constraints are also linked to herders' production emphasis and marketing strategies.

The report further outlines the history of goat raising in Piura, paying particular attention to how herders' rights to land, animals, tree resources, and to their own labor have changed from early colonial times through hacienda and plantation regimes to the agrarian reform and now the post-reform period. The study concludes with a sensitive examination of the debate over goats' role in overgrazing and resource degradation. Evidence is adduced that casts considerable doubt upon the claim that goat herding has caused irreversible environmental damage in Piura. Instead, it seems that the extensive herding system of Piuran goatkeepers, plus their marketing strategies, strike a balance with the region's irregular climatic regime in such a way that forage resources and herds co-vary. The study concludes that the notion that goats seriously damage the environment seems to derive not from any empirical evidence (which is notably lacking) but rather from a congeries of ingrained socioeconomic and cultural prejudices against goats and their keepers, scientific biases and international development "fad-isms," production-related conflicts, and bureaucratic politics.

RESUMEN

Este informe describe y analiza el complejo ecologico, social, economico, y politico del pastoreo caprino en los "despoblados" de Piura, Peru. Primero se presenta un cuadro general de la composicion y dinamica de los hatos, de su manejo, y de los sistemas de produccion y comercializacion. Despues, son definidos nueve tipos distintos de produccion caprina. En examinar y explicar las diferencias entre esos nueve tipos, los factores criticos aparentes son: la tenencia de la tierra, la organizacion politica y el control sobre recursos naturales, fuentes alternativas de ingresos familiares, y las relaciones sociales.

Con respecto a este ultimo factor, el presente trabajo analiza en detalle las relaciones entre los cabreros de los despoblados y los campesinos de los valles agricolas vecinos--siempre dentro de su contexto ecologico y economico. Resulta que estas interrelaciones cabrero/campesino son mutuamente provechosas; ademas, representan una adaptacion apropriada a las realidades de tierra, mano de obra, foraje, y clima que los dos grupos viven. En su conjunto, esta misma realidad tambien figura en la determinacion de los objetos principales de la produccion caprina (sea para venta de cabritos, carne, queso, o mas raro, de leche) entre los chivateros, y en sus estrategias de comercializacion.

El informe tambien trata la historia y desarrollo del pastoreo caprino en Piura. Describe los cambios tras el tiempo de los derechos de los cabreros sobre tierras, animales, recursos arboreos, y su misma mano de obra. Esta vista retrospectiva comienza con los tempranos anos de la colonia, y procede por las epocas de las haciendas y las grandes plantaciones, a la reforma agraria y el periodo post-reforma de hoy dia.

Finalmente, se presenta una investigacion profunda del debate sobre el papel que desempenan los caprinos en el sobrepastoreo y la degeneracion ecologica. Aqui se aducen datos para demonstrar que los hatos no han causado dano permanente a los terrenos de pasto o a la flora de Piura. Al contrario, parece que, en combinacion con sus padrones de comercializacion, los sistemas de produccion no-intensiva de los chivateros crean un equilibrio con el clima extremamente variable (gracias a "El Nino") de la region. El resultado es que la poblacion caprina y los recursos naturales de foraje co-varian. El informe subraya que la afirmacion que la especie caprina es sumamente destructiva del medio ambiente deriva no de datos empiricos--los cuales son notablemente ausentes--sino de una variedad de factores que abarcan: viejos prejuicios culturales y clasistas contra el cabrio y su dueno; ciertas a priori suposiciones cientificas y manias pasajeras entre investigadores del desarrollo economico internacional; conflictos entre la produccion caprina y otros sistemas de produccion, p.e. de bovinos; y la politica burocratica.

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Finally, the goat herders who generously taught me what later became the thrust of this report, are too numerous to list. However, it would be unjust to not mention Don Santiego Pena, Don Julio Carillo, Sr. Humberto Zapata Cruz and his mother, and Sr. Pedro Cruz Montelban for their openness, assistance, and hospitality.

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CHAPTER 1

INTRODUCTION

A common saying describes Piura, a region along the northern Peruvian coast, as "the land of algarrobo, burros, and Seminarios." Algarrobo (Prosopis juliflora) is the most common tree in the region, burros (donkeys) are the favorite means of transportation of the Piuran peasants, and the Seminarios are a well-to-do and large local family. This saying seems to be a fairly accurate characterization of the region; however, it overlooks one very important feature: goats. There are goats everywhere in Piura: in the small rural villages and on the streets of the cities; on agricultural fields and in remote corners of the despoblado (semi-arid scrubland plains); on the coastal plateau; and on the slopes of the mountains. Peru became renowned for its native Andean livestock, the llama and alpaca. Sheep have dominated the Andean pasture land ever since the Spanish conquest in 1532, while beef is typically the most sought-after meat on the Peruvian markets. Goats thus seem to play only a very marginal role in the national livestock story. Nevertheless, their local importance to the northern coast is beyond question. This has been the case since the Spaniards introduced goats to the region in the late 1530s, and it seems that goats' meat and dairy products will continue to play a major role in the economy of northern peasants.

Despite its importance in the regional economy, little information concerning goat raising has been gathered or published. Most of the available material deals with livestock production and management. A few sources describe pasture and forage resources while the remainder suggest ways to intensify meat and milk production. But very little is known about the goatkeepers themselves, despite the fact that it is they who make the decisions on management and production, and on adoption or rejection of any development scheme. How do they perceive the place of goat raising in their economy? What is the rationale behind their decisions on livestock and range management? How do they cope with the harsh and extremely fluctuating environment in which they live? What marketing strategy do they commonly follow? What relations have they established with fellow herders and with farmers? These and many other related questions need to be answered before new technologies and improvement programs are implemented. Some of these issues are discussed in the following pages. The principal goal of this report is to shed some light on the human element in Piuran pastoralism; livestock production and management are discussed in their, social, economic, and political context, as well as their natural ecological setting.

Most of the available information on traditional pastoralism has been gathered in the Middle East and East Africa. It primarily consists of ethnographic descriptions emphasizing sociocultural and ecological analyses. As a result, the few existing generalizations and models concerning livestock raising and pastoral societies rely heavily on traditional nomadic tribal groups (e.g., Goldschmidt, Monod, Spooner). However, in a recent review on nomadic pastoralism, Rada and Nevil Dyson-Hudson (1980) argue that "there is an enormous variability in herd management strategies, in social organization, in land tenure, degree of

dependency on agricultural products, interactions with outside groups..." among peoples who are principally dependent on livestock for subsistence. The presumed similitude across these groups largely ends with the fact that they are all nomadic pastoralists. The observed variability among traditional livestock-raising groups, and the consequent difficulty of constructing a general model to predict their behavior, increases significantly when less traditional, non-nomadic pastoralists --like the goat herders of Piura--are taken into consideration.

In sum, differences among pastoral groups are too extensive to be included in any single model. Research on any contemporary pastoral group therefore has very little in the way of a theoretical basis on which to draw--despite the voluminous literature on the subject. With this limitation in mind, a researcher seeking to understand a given livestock husbandry system is obliged to begin with a detailed inquiry into all significant environmental, economic, socio-political, and cultural variables related to the system. Only after acquiring a substantial familiarity with these variables can one move on to more specific problems, especially those which concern factors limiting the production or the economic return of the system ("bottle necks"). This was the approach I took in studying goat husbandry in Piura. This approach has determined not only the methodology and direction of my fieldwork, but also the organization of this report.

Environmental factors play a significant role in the production and management of goat herds in Piura. A thorough description of these factors is therefore essential to understanding the production process and to critically examining the utilization of natural resources in the region. Chapter 2 provides the necessary background information on the environment--climate, soils, vegetation--in Piura. More detailed comments on specific environmental factors are presented in subsequent chapters, as they pertain to particular topics under discussion.

Chapter 3 presents a general, introductory account of goat herding in Piura. Demography, production, management, reproduction, and marketing are among the themes covered. This information was derived from a questionnaire applied to more than 200 pastoralist households. This questionnaire was designed additionally to elicit information about the natural resource base, climatic changes, availability of labor and capital, and certain aspects of the local socio-political system. An attempt was made to obtain as much quantitative data as possible. Most of the data were acquired through informal conversations along the lines of the questionnaire and only later filled into the formal forms. In many cases, participant observations and repetitive visits were made. Informal conversations increased data credibility while repetitive visits helped to clarify obscure points or problematic issues. Repeat visits were also important because management and production were not constant throughout the year; extra visits at appropriate intervals provided the opportunity to observe changes in production system variables and producers' adjustments to these changes. Very little was known about Piuran herding when the first questionnaires were developed, so unavoidable changes and additions were made as new aspects were revealed.

Because data-gathering techniques were evolving as research progressed, it was necessary to collect most of the information personally. Only in a few cases was information gathered by others. Students of animal science from the University of Piura were hired to conduct formal interviews in their own communities; and detailed descriptions of two pastoral communities in Lambayeque--Naupe and Salas--were conducted by an SR-CRSP sociology student in conjunction with a locally hired team consisting of a sociologist and an anthropologist. When a more specific questionnaire dealing with farmer/herder relations was applied, student assistance was employed more frequently.

As the data base grew, so did the complexity of the emerging picture. The information was categorized according to ecozones--regions differing in vegetation, potential pasture, water availability, and agricultural opportunities and crops. But this was not enough to explain the variation recorded for production values and observed management practices. Only by organizing the data along three dimensions--environmental, economic, and socio-political--was a workable definition of the various Piuran goat production systems achieved. Chapter 4 discusses the dimensions used in this analysis and provides a characterization of the nine production systems defined in Piura.

Four operations, each representing different production systems, were chosen for more detailed study. In each case, strong personal relations were established with the herder to enable a more profound insight into the management and decision-making process. Monitoring of production and productivity was facilitated by long stays with these four families and their herds. This provided more insight into the social, cultural, and political aspects of goat rearing in Piura. Each time a potentially important new fact or perspective surfaced in the course of these case studies, it was examined more closely--whether by developing a new set of questions to probe the new finding, or by initiating a literature survey.

1982 was a year of severe drought in Piura. It was a year of hardship for the local herders, but it provided an opportunity to observe the measures that chivateros ('goat herders', also called ganaderos or cabreros) employ in coping with extreme conditions. Indeed, the drought revealed a complex net of socioeconomic and cultural interactions between agricultural communities and pastoralists. These relations serve as adaptations to the dramatic environmental changes the region undergoes as a result of the El Nino phenomenon. The web of interactions, interrelations, and exchanges between these two sectors is described in Chapter 5, along with El Nino and its impacts on the region.

The drought also disclosed significant features of the marketing strategy practiced by goat keepers in Piura. Detailed slaughterhouse records made possible an analysis of marketing strategies in dry versus abundant years and in different geographical zones. The overall analysis of goat marketing strategies is presented in Chapter 6. A follow-up study carried out in the summer of 1983 allowed me to examine the dramatic impact of the very rainy winter of 1983 on goat herding in

Piura (Perevolotsky 1985). In particular, it helped in testing assumptions about herder/farmer relationships, marketing strategies, and overgrazing.

There is no doubt that access to both natural and agricultural resources is important to livestock production. Chapter 7 provides an historical overview of the evolution of land tenure systems in Piura, together with a discussion of contemporary land-use organization and its effect on goat herding. The impact of agrarian reform on both land tenure and goat husbandry is also discussed in this chapter.

The last theme addressed in this report is the grave accusation that goatkeepers (or their goats) overexploit and severely overgraze the Piuran rangeland. This issue is examined both biologically and socially. The extent of overgrazing, its controversial nature, and relevant socio-political factors are discussed in Chapter 8. A brief summary chapter of conclusions concludes the report.

CHAPTER 2

AREA DESCRIPTION

Geography[1]

Piura is one of the northern-most departments[2] of Peru. To the north it borders Ecuador, to the east the department of Cajamarca, to the south the department of Lambayeque, and to the west the Pacific Ocean. Piura is located within latitudes S4°05' and S6°22' and longitudes W79°17' and W81°17'. Thus, it is very close to the Equator, well within the tropical zone.

Piura is administratively divided into seven provinces: Sullana, Paita, Piura, Morropon, Ayabaca, Talara, and Huancabamba. These seven provinces contain 48 districts. Piura extends over 33,067 square kilometers and is divided geographically into two main regions: the mountainous sierra which includes the provinces of Ayabaca and Huancabamba; and the coastal plains, or costa, containing the rest of the provinces. The sierra constitutes 22% of the department's area while the costa accounts for 78%.

The costa is crossed by two major river systems, Rio Piura and Rio Chira. Agriculture has flourished in these river valleys since early history. Agricultural lands in the Rio Piura and Rio Chira valleys occupy 13% of the departmental area or 17.3% of the costa. The remainder of the costa is composed of arid or semi-arid plains which are scarcely inhabited and are utilized for livestock herding.

In many of the coastal departments of Peru, only one significant urban center has evolved. Piura is an exception in that it includes four cities of more than 40,000 inhabitants: Talara, the center of a big oil field; Sullana, a commercial center; Piura, the department's capital; and Paita, a traditional port. Piura also has four smaller urban centers of over 10,000: Ayabaca, Huancabamba, Morropon, and Chulucanas. Figure 2.1 exhibits the principal geographical outlines of Piura.

Climate[3]

Two principal factors determine the climate of Piura: the department's geographical position within the tropical zone, and the cold Peruvian, or Humboldt, sea-current. As in other tropical regions, temperatures in Piura tend to vary little over the year. As a result, seasonality is not a function of sharp changes in air temperature but rather of timing of precipitation. Figure 2.2 displays the annual temperatures (average and range) in different geographical locations in Piura. In general, both the annual average temperature and the extremes (the maximal and minimal temperatures) in the various regions of the Piuran costa (A-D) are quite similar. The region close to the sea (A) is more strongly influenced by the cold Humboldt current, making temperatures there a bit milder. Temperatures in the mountains (region E) are of course lower. The overall change in temperature during the

Figure 2.1
DEPARTMENT OF PIURA

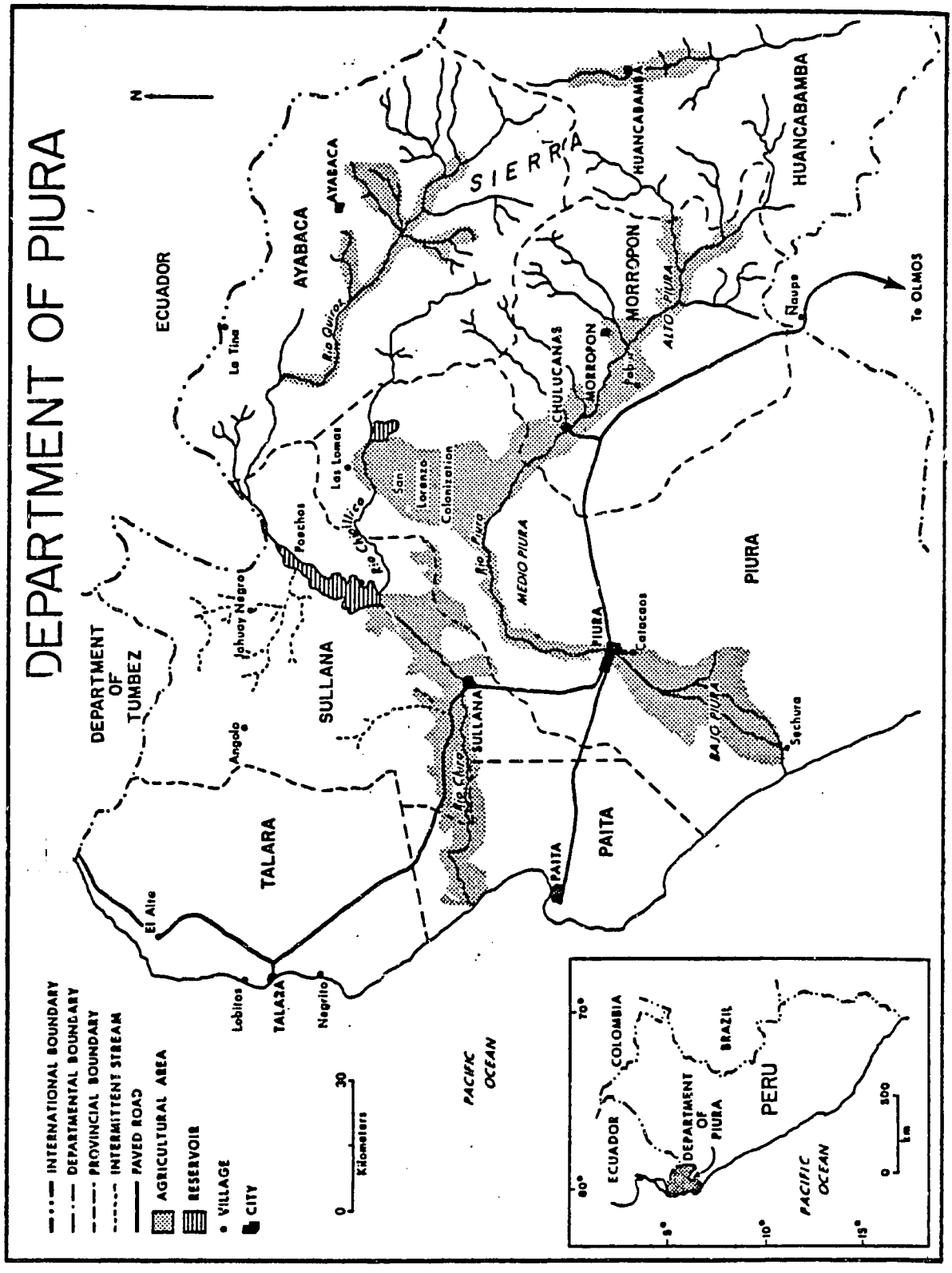
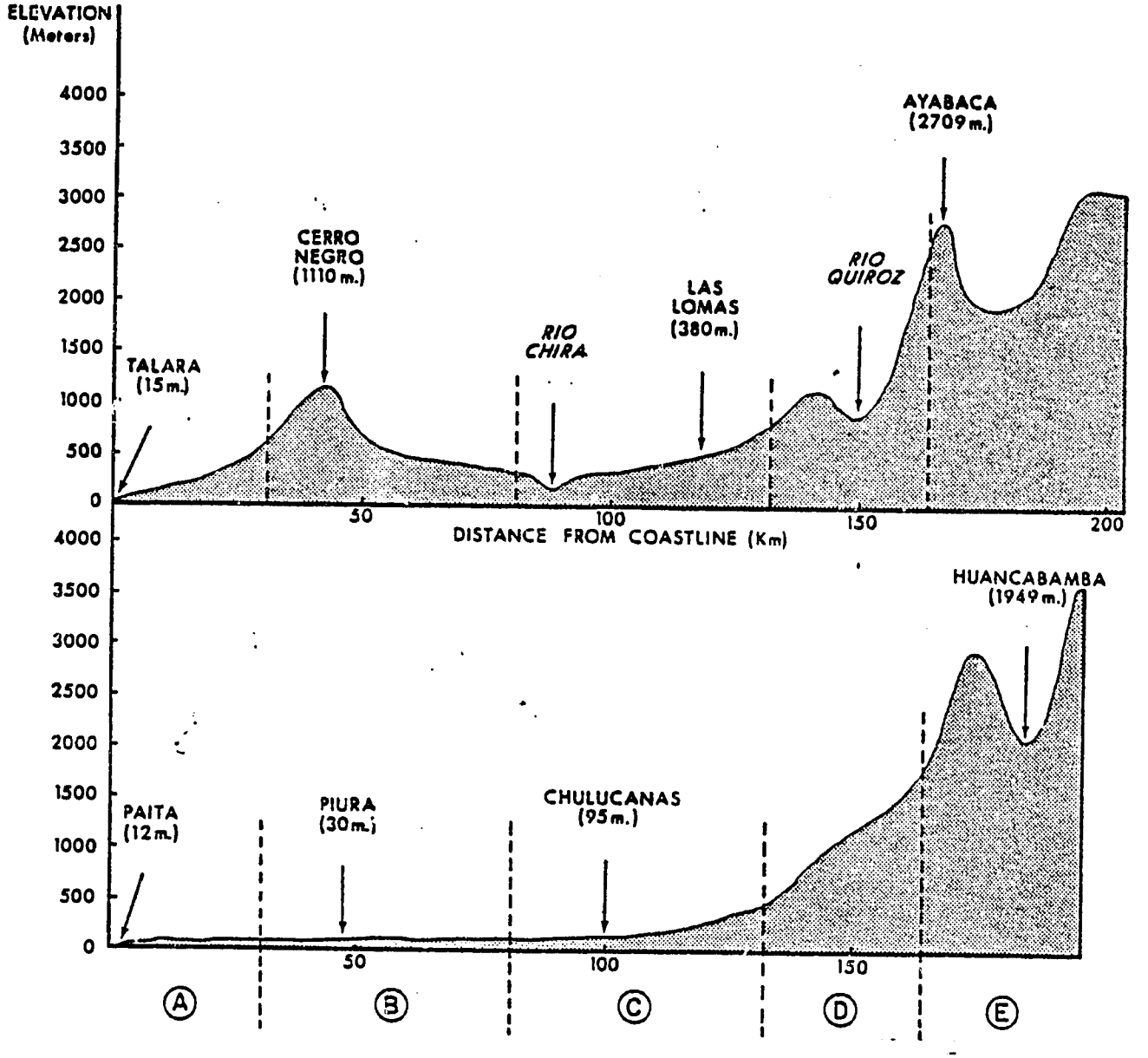


Figure 2.2

TEMPERATURES IN PIURA.



no. of stations	3	2	4	1	2
no. of years	26	18	34	9	25
mean annual temp. ±s. d	22.8±1.0	23.4±0.8	23.8±0.8	23.7±0.8	12.4±1.2
mean ann. max. tem. ±s. d	29.2±1.2	30.5±0.5	31.1±0.8	30.6±0.9	16.7±1.4
mean ann. min. tem. ±s. d	18.9±1.0	19.1±0.8	18.7±0.7	17.9±1.1	9.1±2.5

year in the costa of Piura is only 4° C, an evident indication of its tropical location.

The annual climatic cycle in the tropics is divided into a dry winter (May-October) and a wet summer (November-April). In the driest part of Piura, the costa, rains mostly fall between January and March. In the sierra, rain storms occur over a longer period--October to May. Along the costa of Piura, the question is not when rain will fall, but whether it will rain at all. The costa's parched, dry landscape stands in striking contrast to commonly-held notions of tropical environments. How is it that one of the driest deserts in the world--the Sechura--came to be located in the heart of this tropical region?

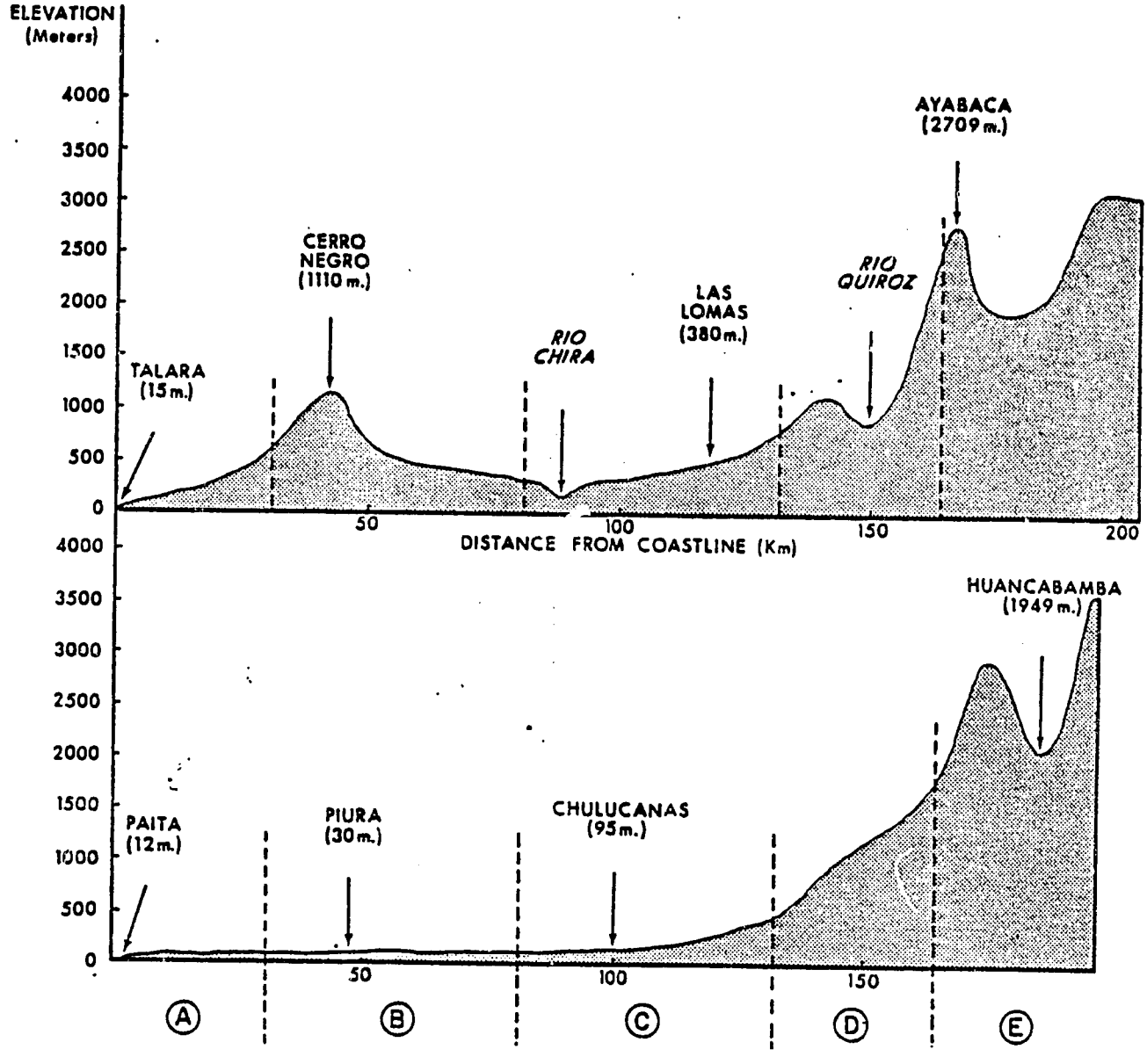
The answer to this climatic riddle lies in the relationship between the cold sea-current and the continental coast. Generally, in tropical environments solar radiation is very intense and generates high evaporation from lakes, rivers, or the sea. The warm humid air ascends until its temperature drops enough to cause the moisture in the air to condense into rain. Thus, a high annual average of precipitation is the norm in most tropical regions. But this is not the case along the Peruvian coast. The cold sea sharply reduces the temperature of the humid air above it. This humid but rather cold air is carried by winds to the coast, where it forms a stable, cloudy-misty cover --called garua--some 400-800 meters above the ground. Because its temperature is low, this air rarely rises high enough for its moisture content to condense into rain. The formation of this stable, cloudy air cover is more noticeable during the dry and cold season (May-October). As the sun moves into position directly over the southern tropics in about November-December, the added radiation warms the moisture-laden air mass, causing it to rise. It eventually reaches an altitude high enough to cool off and to generate some rain, mostly on the western slopes of the Andes.

Most of the Peruvian coastal region is confined to a rather narrow strip (50 km) extending between the seashore and the western slopes of the Andes, and it is usually covered by garua. The coastal plains of Piura, however, extend inland 150 km and more. The stabilizing, drying effect of the cold current decreases with increasing distance from the seashore, leading to a gradient of humidity accross Piura. Proximity to mountains also tends to increase precipitation due to the orographic effect. As shown in Figure 2.3 and in Table 2.1, this gradient is dramatic, ranging from around 40 mm annual rainfall near the sea, to more than 200 mm at a distance of 100 km from the coast, and more than 500 mm on the lower slopes of the Andes. On average, the sierra enjoys almost 1000 mm of rainfall per year.

Annual average precipitation is not the only indicator of moisture, especially with regard to biological components. Output of water from the ecosystem is no less significant than input into it. The importance of output in Piura is illustrated in Figure 2.3, which presents evaporation and water deficit data. These data clearly show that water deficiency decreases with distance from the coast and proximity to the mountains, whereas relative air humidity, although high, varies only slightly across the whole of Piura.

Figure 2.3

RAINFALL IN PIURA



no. of stations	3	2	4	1	3
no. of years	26	18	36	9	26
mean rainfall(s.d) variability coeff.	39.3± 31.3 79%	70.1±55.2 79%	229.5±186 81%	533.5±280 53%	918±347 38%
evaporation	1392± 266	1650± 213	1570±261	1579±343	765±201
water deficiency	−97%	−96%	−85%	−66%	+20%
relative humidity	74.8±3.1	69.2±2.3	71.4±2.8	74±4.6	84.5±3.4

Table 2.1

Natural Ecozones in the Lowlands of Piura

CODE[1]	LOCATION	AVERAGE[2] ANNUAL RAINFALL	VEGETATION[3] CHARACTER	VEGETATION[3] COVER	DOMINANT[3] PLANTS	FREQUENCY OF[4] ANNUAL VEGETATION OCCURRENCES
A	From seashore to Sullana & Piura. (40 - 70 km)	30 mm	Very dispersed, low shrubs, xerophytes.	5%	Zapote (Capparis scabrida), Bicheyo (Capparis avicennifolia), Algarrobo (Prosopis sp.)	VERY LOW
B	1. Mallares - Angolo - Poechos.	80-120 mm	Dense groves in dry rivers. Disperse shrubs and trees on hills.	20%	Algarrobo, Overal, Charan, Hualteco (Laxopterygium huasango)	MODERATE
	2. Nomala, Piura - San Lorenzo. (60-70 km)		Diffuse perennial vegetation Medium-size trees. Low and medium-size shrubs. Intensive tree cutting.	17%	Falque (Acacia sp.), Overal (Cordia rotundifolia), Zapote, Algarrobo	
C	From Chulucanas & PanAmerican Highway to the slopes of the mountains (40 km).	200-250 mm	Diffuse cover of high shrubs and trees. Dense herbaceous cover after rains.	40%	Overal, Zapote, Algarrobo	GOOD
D	From San Lorenzo & Poechos to the border with Ecuador. (40 km)	250-500 mm	High cover of many shrubs and trees. Dense herbaceous cover almost every year.	75%	Charán (Caesalpinea corymbosa), Overal, Mosquera (?), Añalque (?), Pasayo (Bombax sp.), Ceibo (Bombax sp.), Palo Santo (Burcera graveolens), Borrachera (Ipomaea carnea), and many more.	HIGH

[1] The code refers to the labeled regions in Map 1.

[2] Data obtained from SENAMHI (Servicio Nacional de Meteorologia y Hidrologia) and from the Chira-Piura project.

[3] Data obtained by a vegetation analysis using SVIM--soil-vegetation inventory method developed by the Bureau of Land Management.

[4] Based on interviews with herders living in each ecozone.

Proximity to mountains also seems to have a stabilizing effect on annual precipitation. Expressing variations in regional annual precipitation by standard deviation or by the variability coefficient (standard deviation as a percentage of the means) shows that variations are quite high in the western Piura and decrease near the sierra (Figure 2.3). The implications of these "precipitation belts" for the natural vegetation and for the availability of pasture will be discussed later.

It should be emphasized that annual average precipitation values provide little information about the frequency of very dry or very wet years. However, such years are critical from the biological point of view. Deserts typically experience high fluctuations in annual rainfall and consequently in biological production. The northern coast of Peru is subject to even more dramatic variations than most desert areas due to the phenomenon called El Nino--torrential rains which strike the region roughly once each decade in a quasiperiodical pattern. These storms can bring rains of up to ten times the annual average or more. The biological implications of these storms are obvious; however, they cannot be discerned from data such as those of Figure 2.3, which on the average are collected over only one or two decades. The El Nino phenomenon is discussed at length in Chapter 5.

Geology[4]

As in many other Andean regions, the geological structure of Piura is quite complex. Because our interest in the region's geology is limited to its impact upon soil and vegetation, a rather schematic description is presented here. Essentially, Piura can be divided into three geological units.

- The Sechura Desert consists of extensive sandy plains (tablazos) primarily composed of alluvial and eolic deposits of the Quaternary period. Parts of the region are covered by moving sands.

- The northern unit (north of Rio Chira to Tumbes and the border with Ecuador) consists of rolling hills and rough heights. Three distinct types of rock formations are found here:

  - a region of mesas (table-shaped hills); and deep dry river beds (quebradas) built of Tercerial sedimentary rocks (the formations of Talara, Parinas, and Chira)

  - long ridges rising to 1000-1300 meters built of Silurian/Devonian sedementary rocks

  - a region of cleft hills made of metamorphic rocks of the Cretaceous era. Because these rocks erode readily, most of the region is covered by quite thick soil and alluvial layers.

All three of the above rock units have been dislocated by tectonic activity over an extended period of time, resulting in a current geological picture resembling a complex mosaic.

- o The sierra--the mountainous ridge, this is also composed of three different types of rocks:
  - intrusive rocks--mostly grandiorite of the Cretaceous and Tertiary ages--with much exposed surface and very little soil
  - the central region, which is composed of sedimentary Cretaceous rocks on which a thick cover of soil has evolved
  - the mountainous valleys (Ayabaca and Huancabamba) where Tercerial volcanic rocks dominate the scenery and give rise to a very fertile soil. These long valleys were formed along large geological faults.

Soil[5]

A thorough analysis of soils is central to any study of livestock production systems. Together with climate, soil types determine the quality and quantity of pasturage in a region. Generally speaking, soils in the costa of Piura are arid; they are shallow, light-colored and low in organic matter. Plant growth on such soils is possible only during those few months when adequate moisture is available. Some plants with special adaptations (e.g., deep roots) can cope more successfully with this harsh environment. Piura can be divided into five major soil units.

- o The river valleys. These valleys are constituted mainly of alluvial soils. These are well-developed soils which have been transported from different locations across the drainage basin and were actually formed from a variety of parent materials. A considerable proportion of these soils are Solonchak soils--poor soils with excess salts due to a high water table (1.5 meters) and high evaporation. This unit covers 170,000 hectarees or 5.1% of the department area.
- o The arid plains (<u>despoblados</u>) of Pabur. These are a soil formation belonging to the regosol group. These are azonal soils formed mainly of clay and silt sediments deposited by a shallow sea and later covered by layers of mobile sand. This unit extends over 495,000 hectarees, or 15.0% of Piura.
- o The arid plains of Sullana and Las Lomas. This region is composed of lithosols, shallow soils formed by the weathering of sedimentary rocks where the topography is moderately steep and the climate is arid. These soils have a low organic content, and are light colored and rocky. They can support considerable vegetation if enough water is provided. This unit covers 370,000 hectarees, or 11.2% of the department.

- The low hills east of San Lorenzo and Las Lomas. Here, vertisols predominate. Their clay component is greater than 30%; they are characterized by a tendency to cracks during the dry season. These soils support relatively dense vegetation due to their high capacity for absorbing water. Such soils cover 250,000 hectarees, or 7.6% of Piura.

- The mountain slopes. Deep soils, mostly vertisols, developed on this very steep topography. These soils are rich in clay, sand, and limestone, and they support dense bushy vegetation. This unit accounts for 8.2% of Piura's soils, and is 270,000 hectarees in extent.

Taken together, these five soil units, which cover 47.1% of Piura, support almost all the department's natural pasture. Most of the pastoral activity in Piura therefore occurs on these soil unit. Figure 2.4 shows their location within Piura.

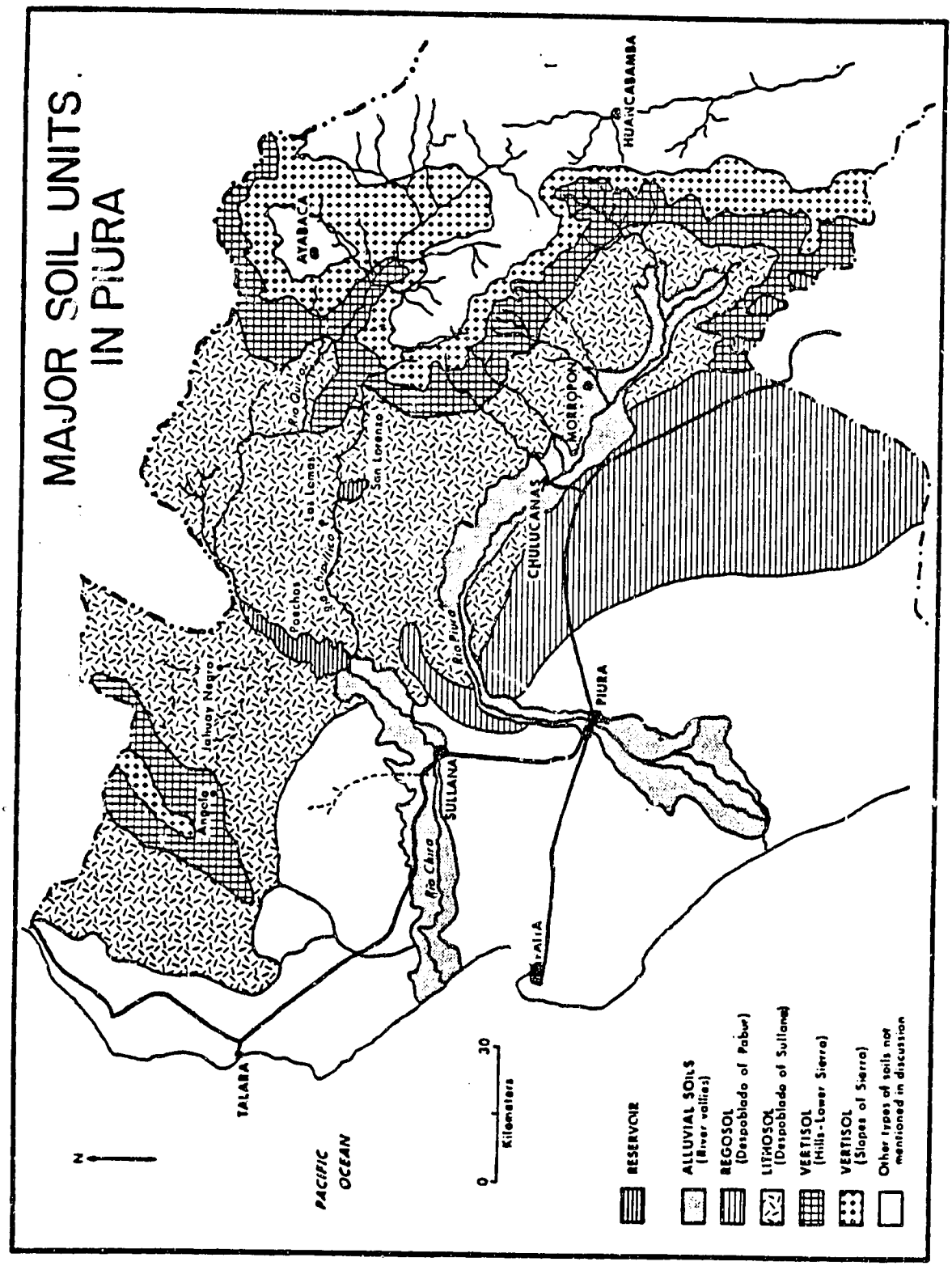
Hydrology

The department of Piura is drained by two major rivers--Rio Piura and Rio Chira--and their tributaries. The Rio Piura basin extends for more than 15,000 km^2 along the west-central slopes of the Piuran sierra. It lies completely within the dry, highly variable climatic zone of western Piura. As a result, only the upper reaches, which drain from the mountains, support permanent streams; flows in the lower part are ephemeral, varying dramatically with rainfall. In dry years peasants plant vegetables in the riverbed; in very wet years, however, the river overtops its banks, flooding fields and sometimes even villages and cities located near its ravine. These fluctuations in water flow are responsible for the Rio Piura's folk epithet, el rio loco 'the crazy river'.

Rio Chira drains an area of 18,000 km^2 and flows constantly during dry and wet years alike. The main reason for the difference in the two rivers' flow is that Rio Chira drains great portions of the mountainous valley of Ayabaca--which enjoys a more humid and stable climate than the Rio Piura basin--plus a region in southern Ecuador which receives much more rainfall. The San Lorenzo water reservoir was created in order to divert water from the Rio Quiroz (the main tributary of Rio Chira, coming from the Ayabaca mountains) to irrigate lands within the Rio Piura basin. A new reservoir--Poechos--was created by damming the principal stream of Rio Chira, and some of its water is used to irrigate agricultural land in the Piura area.

Very little is known about ground water in Piura. Wells seem to be widespread throughout the department except in the Sechura Desert. However, the depth and reliability of the water table vary considerably from place to place. These wells are of great importance to pastoralists, since they open up new grazing grounds and permit a fuller utilization of forage resources. However, digging wells more than ten meters deep is a complicated task and requires resources unavailable to most goat herders.

Figure 2.4


MAJOR SOIL UNITS IN PIURA
AYABACA
HUANCABAMBA
MORROPON
CHULUCANAS
PIURA
SULLANA
TALARA
Río Chira
Río Piura
Río Quiroz
Chamaco
Poechos
San Lorenzo
Tambo
Jahuay Negro
Angolo
PACIFIC OCEAN
N
0
30
Kilometers
RESERVOIR
ALLUVIAL SOILS (River valley)
REGOSOL (Despoblado of Paboi)
LITHOSOL (Despoblado of Sullana)
VERTISOL (Hills-Lower Sierra)
VERTISOL (Slopes of Sierra)
Other types of soils not mentioned in discussion

Florae[6]

As we have seen, the geological, topographical, edaphic, and climatic situation of Piura is very diverse and complex. The region's vegetation can be characterized by its association with these environmental features. Tosi (1960) constructed an ecological map of Peru based on the Holdrige concept of correlations between climatic conditions and vegetation. The Holdrige model attempts to predict the nature of a region's flora based on the area's average annual precipitation and temperature. However, the ecological taxonomy suggested by Holdrige and Tosi suffers from several shortcomings. The most significant of these--especially for any discussion of range conditions or pasture potential--is its failure to account for edaphic factors and for the ongoing impact of human activity (especially livestock rearing) on the natural vegetation.

Since there are no detailed descriptions or maps of vegetation in Piura, an attempt was made to establish a very schematic division of soil-vegetation units in the region. The results are presented in Table 2.1. The cover and composition of the perennial species were determined by the SVIM method, developed by the U.S. Bureau of Land Management (BLM) to characterize range potential. Extensive travels in the region permitted identification of the major vegetation-soil units, and three to four representative sites were chosen for further study. In each site, vegetation was monitored along four to five transects of 1000-1500 meters, crossing the various topographical structures (wash, hill, etc.). Ground cover, vegetation cover, and composition in three height levels were determined every five meters. Every 30 meters, a more thorough description of each species was conducted, including estimations of current phenology, form, age, degree of utilization, and availability for grazing. However, throughout the fieldwork period in 1982, a severe drought plagued the entire region. There was almost no germination of annual vegetation, and most of the deciduous trees and shrubs remained dormant. Thus, there was no reason or way to monitor "average" range productivity. The data collected by the SVIM method were used merely for more accurately describing the vegetation cover and composition in the Piuran associations.

Fauna

Only the two species of Piuran wildlife which interact closely with livestock are discussed here. One is the white-tailed deer (Odocoileus virginia, venado gris). This species constitutes the principal natural herbivore of the despoblados, and directly competes with livestock for natural pasture. However, deer meat is considered very tasty in the despoblados, and intensive hunting has greatly reduced the deer population. Pastoralists living in remote areas are the most effective hunters.

The second species which interacts with livestock is the mountain lion (Felis concolor, puma, or leon). It is the most common predator in Piura. The puma preys on deer and other wild herbivores, and also causes much damage to goat herds. The significance of losses by predation among herds grazing the slopes of the sierra will be

demonstrated in Chapter 4, where factors limiting production in different systems are discussed.

Demography[7] and Economy

According to the 1981 national census, 1,168,442 people inhabit Piura, or 6.9% of the population of Peru. 61.5% of Piura's population is urban and 38.5% rural. Most of the latter are peasants (campesinos) engaged in agricultural tasks. Between 1972 and 1981 the rate of population growth in Piura was 3.5%--much higher than the national rate of 2.6%. The population of the principal urban centers in Piura is as shown below in Table 2.2.

TABLE 2.2
POPULATION OF PRINCIPAL PIURAN CITIES

Piura - 359,370	Chulucanas - 39,110
Sullana - 148,267	Morropon - 16,890
Talara - 88,685	Ayabaca - 11,870
Paita - 45,920	Huancabamba - 8,329

According to the 1981 census, 37.5% of Piura's population is illiterate. The majority of the illiterates (65.9%) reside in the rural sector.

49.9% of the economically active population (EAP[8]) in Piura is engaged in agriculture and/or livestock raising. 12.9% are involved in service tasks, with the government as the primary employer; 7.6% are engaged in commerce. In the sierra region--the provinces of Ayabaca and Huancabamba--agriculture is almost the exclusive economic activity, involving more than 80% of the sierran EAP. Non-agricultural work is strongly correlated with urban centers. For example, in Talara Province less than 2% of the EAP pursues agriculture, while 56% occupy industrial or service jobs. Moreover, almost all the EAP resides in the city of Talara or in other urban centers.

Agriculture[9]

Historically, Piura has been a rich agricultural region. Intensive, irrigated cultivation of maize and native cotton has been the norm since pre-Columbian times (Laning 1967). After the Spanish conquest, new crops were introduced and the land tenure system was drastically altered, but the region continued to produce many agricultural crops marketed locally, nationally, and, in the case of cotton, internationally. Three principal agricultural regimes can be identified in Piura. Each is further divided into units by geographical setting (see Figure 2.5).

- River valley agriculture

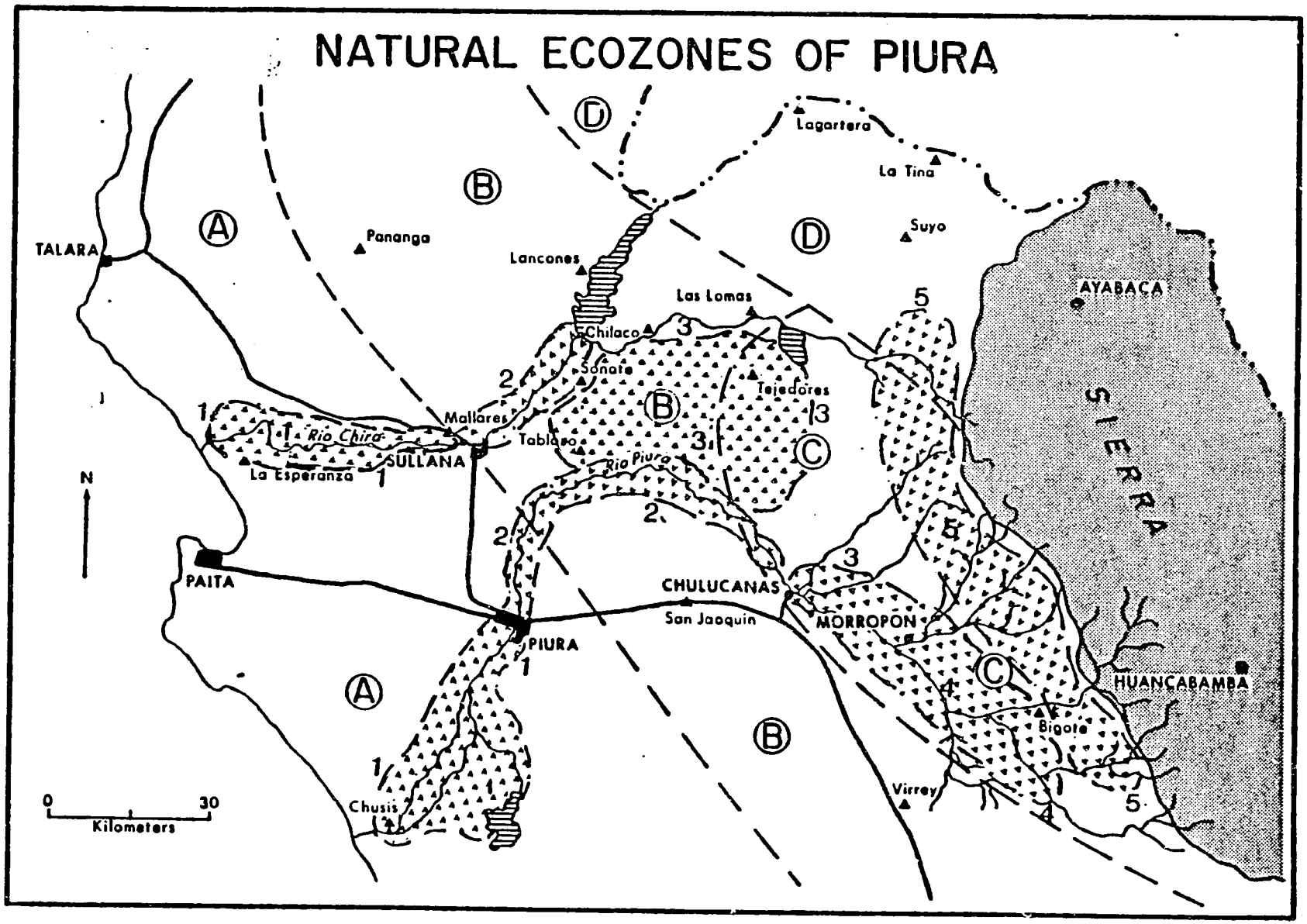

NATURAL ECOZONES OF PIURA
TALARA
Pananga
Lancones
Lagartera
La Tina
Suyo
AYABACA
Las Lomas
Chilaco
Sonate
Tejedores
Malleres
Tablazo
Rio Chira
SULLANA
La Esperanza
Rio Piura
PAITA
PIURA
CHULUCANAS
San Joaquin
MORROPON
HUANCABAMBA
Bigote
Virrey
Chusis
SIERRA
N
0
30
Kilometers

Figure 2.5

- Small (0.5-5.0 hectarees) farms run largely by members of indigenous communities (comuneros). The main crops on these farms are foodstuffs (pan llevar) such as maize, beans, and squash, and cash crops such as cotton or rice.

- Big farms previously owned by rich landlords (hacendados) and later transferred to the workers during the agrarian reform of 1969. These farms, though supervised by state agencies, are commonly managed by the workers and referred to as cooperatives.

o New colonizations

- The San Lorenzo and Chira-Piura irrigation projects opened up new agricultural possibilities in the region. They helped maintain and secure existing agricultural irrigation in the Chira and Piura valleys and to convert grazing grounds to cultivable land. Along with a number of international development agencies the government invested considerable sums of money in these irrigation projects and in various credit schemes. The outcome has been flourishing colonization by successful, moderate-sized farms (5-50 hectarees). Their main crop is fruit (lemon, mango, avocado, papaya); if more water is available, cotton and rice are also grown.

o Sierra agriculture

- In valleys along the lower western slopes of the mountains, a warm climate prevails; here, a productive agriculture of tropical crops has evolved. Most of the farmers are comuneros who individually own moderate-size parcels. There are some small-scale cooperatives as well, though. The dominant crops here are coffee, sugar cane, and fruit trees (annona, granadilla, oranges, etc.).

- Temporary, non-irrigated agricultural plots (rastrojo) were established by cutting and burning the dense shrubby vegetation on the slopes of the sierra. These plots are located above 500 meters, where the soil contains enough moisture to support temporary agriculture. The almost exclusive crop here is maize--a fast-growing cultigen and a very important traditional foodstuff.

- In the inter-montane valleys (Ayabaca and Huancabamba), favorable water conditions and fertile soils promote a prosperous agriculture. The low temperatures limit crop choice to mainly potatoes and cereals, but maize is also common. Some land is allocated to cultivated pasture and supports a milk/cheese industry (especially in Huancabamba).

The area devoted to each crop in these geographical regions is shown in Table 2.3. Data from three years--1968, 1975, and 1980--are presented in order to identify cropping changes and trends.

Lower/middle Piura is clearly devoted to cotton and maize--the former as a cash crop and the latter as a foodstuff. Only a small change in preferred crops has occurred between 1968 and 1980 in this area. Upper Piura, on the other hand, has undergone drastic changes; originally a cotton region, it is now dominated by sorghum and maize. These shifts mainly result from the drought in this region during the last few years, combined with the cooperatives' inability to maintain and operate existing infrastructure (e.g., deep wells) because of insufficient capital and credit.

In the Chira and San Lorenzo regions, the trend is to replace cotton with rice and maize due to declining cotton prices on the international market. The decreased profitability of cotton coupled with the increased demand for rice on the national market has created a strong incentive to convert cotton fields to rice fields. In the agriculture of upper Piura and San Lorenzo, fruit trees are clearly very important--especially where water is limited. Finally, it is also evident that sierra and costa agriculture are quite different. In the mountains, cereals, legumes, maize, and potatoes are the prevailing crops. These are the staples of the centuries' - old subsistence-oriented agriculture of the sierra.

Table 2.3
Principal Crops in Various Geographical Regions
of Piura (1968, 1975, 1980)

CROP	LOWER/MIDDLE PIURA			UPPER PIURA			CHIRA		
	1968	1975	1980	1968	1975	1980	1968	1975	1980
Cotton	26,600	26,800	29,400	9,400	2,000	1,800	18,500	17,300	12,600
Rice	300	0	2,200	1,600	3,800	2,000	4,100	7,900	10,000
Maize	1,500	3,700	1,640	600	7,400	6,800	2,900	4,000	5,600
Sorghum	0	2,300	5,400	600	2,700	4,600	0	400	4,400
Cereals	0	0	0	?	?	1,500	0	0	0
Potato	0	0	0	?	?	260	0	0	0
Beans	900	500	590	200	100	870	400	100	1,500
Sweet potato	100	200	0	100	100	0	0	200	340
Coffee	0	0	0			370	0	0	0
Fruit trees (banana, lemon, orange, mango, etc.)	1,400	0	400	4,500	5,800	5,800	3,200	1,400	1,700
Yucca	100	100	0	120	700	850	0	300	270
Onion	?	?	0	?	?	280	?	?	640
Cultivated forage	500	0	?	800	700	?	1,100	1,000	?

Sources: Revesz 1980 and PDAPCHP 1975.

Table 2.3 (cont'd)
Principal Crops in Various Geographical Regions
of Piura (1968, 1975, 1980)

CROP	SAN LORENZO			HUANCABAMBA			AYABACA		
	1968	1975	1980	1968	1975	1980	1968	1975	1980
Cotton	12,300	11,000	4,500	-	-	-	-	-	-
Rice	700	4,700	6,000	?	?	410	?	?	12
Maize	1,600	4,600	5,600	?	4,100	?	?	?	1,500
Sorgom	0	0	520			0			-
Cereals				?	?	3,500			100
Potato			0			1,000			120
Beans	2,000	500	750			3,600			200
Sweet potato	400	0	20			250			0
Coffee	0	0	0			3,400			1,000
Fruit trees (banana, lemon, orange, mango, etc.)	2,200	7,800	6,700			630			800
Yucca		800	200			500			230
Onion			100			900			130
Cultivated forage	300	900	?			?			?

Sources: Revesz 1980, and PDAPCHP 1975.

CHAPTER 3

GOAT RAISING IN PIURA: A GENERAL DESCRIPTION

This chapter provides an overview of goat raising in Piura. However, this general description naturally differs somewhat from any actual operation, in the same way that a population's statistical mean differs from the individual situation of any one member of that population. The next chapter will examine specific goat production systems in Piura.

History

Like many other species, goats were introduced to the New World by the Spaniards. Accounts of exact dates or deeds relating to the introduction of livestock in Peru are not available, but it is widely accepted that goats were on board the first ships to reach Peruvian ports after the conquest in 1532. Following Cobo, Keith (1976) estimates that the first goats arrived in Peru in 1536. Goats had traditionally served as a source of meat and milk in Spain (Foster 1960), and the Spanish worked to establish a vigorous goat industry in the new colonies. Keith also suggests that new types of livestock were introduced earlier than Old World crops because of the scarcity of livestock products (favored by the Spaniards) in the New World.

Cobo (1653) explains how the Spaniards forced the native population to begin raising exotic livestock. He claims that the Crown obliged Indians to pay part of their mandatory tax in livestock or livestock products. The only way the natives could do so was to raise the exotic species themselves. Nevertheless, in the 16-17th centuries most livestock production in Peru generally, and in Piura particularly, was in the hands of Spaniards who owned big estates (haciendas) or ranches (estancias).

Goat Breeds

Obviously, the first goats introduced to Peru were of Spanish breeds or races. Consequently, the genetic character of the native (criollo) goat largely derives from its Spanish ancestors. The Spanish breeds (Murcian, Granadian, and Malagian) are good milk producers. All have short mohair of no industrial value. It has been suggested that the relatively small Spanish milk goats derived from the wild Capra prisca and not from the mountain goat Capra aegagrus (Cole 1966). The former seems to be more efficient in utilizing feed, especially concentrates, and to produce as much milk as other goats while consuming less fodder (Mackenzie 1967). The Spanish breeds also have an arched back and chest and a more rounded udder, which help them cope more successfully with scrubby environments (ibid.).

In the 20th century owners of large estates (haciendas) who also maintained large goat herds attempted to improve production by introducing new breeds from various parts of the world (Nolte 1973). Anglo-Nubian goats--large animals with shiny, fine short hair, black-brown color, and big, wide ears lying close to the face--were

imported from the U.S. during the 1920's (Jack 1978). The medium-sized Toggenburg goat--characterized by short to medium hair, light color and lack of horns--was introduced from Europe because of its famous milk-producting capacity. Swiss Alpine and Sannen goats have also been introduced from Europe, but they played only a minor role in molding the genetic character of the present criollo breed.

Calle (1968) reports that the average weight of an adult crillo doe in Piura is 31.74 kg; reproductive males reach 65.10 kg. Height, body length, and thorax circumference of females are: 66.49, 76.26, and 70.50 cm respectively. For males, these measurements are: 76.35, 84.95, and 74.90 cm respectively. Calle also found that the carcass of kids 6-12 months old constitutes 40.4% of the total weight, while in adults (5-6 years) it is 38.9%

The mixed genetic sources and the lack of systematic selection techniques created a notable diversity of phenotypes among criollo goats. Table 3.1's list of common goat names used by Piuran herders illustrates this morphological diversity. Often a complex color description is also given, e.g., blanco negro mita mita (half white, half black) or negra berijos moros (black with gray flanks), and so forth.

Selection. "Traditional" peasant herders are generally thought to practice no conscious selection for features or types among their livestock. Yet when asked, Piuran herders will almost always reveal a knowledge of the notion of selecting for features--albeit without understanding the inherent mechanism. They also employ this knowledge in actual practice.

Capps (1983) reports the results of an extensive survey of 200 Piuran herders which disclosed that 50% of goatkeepers select female goats to remain in their herds according to particular features; and 65% of the surveyed population select for particular male goats.

The characteristics most often selected for females were: size (50% of all respondents), good udders (37%), color (32%), big ears--a sign of Nubian blood (30%), daughter of a good (productive) mother (26%), and conformation (26%). The characteristics most often selected for males were: size (40%), big ears (40%), son of a good (productive) mother (39%), separated testicles --a sign of fertility, (35%) lack of horns prevents damage while fighting (26%), and conformation (25%).

An interesting fact was revealed by inquires on color preference among goat herders. Out of 132 ganaderos, 58% preferred a particular color among their goats. 30% favored black, while dark colors (different types of black, gray and brown) are generally preferred to light colors (76% vs. 24%). This preference may be related to an energy-saving mechanism which is crucial in an environment with limited natural forage (Daniel et al. 1980). However, the reasons cited by herders themselves for preferring dark colors were: more aesthetic or beautiful (40%), producing more kids (20%), producing more milk (14%), reaching a bigger size (14%), easier to locate (12%), and more disease-resistant (8%).

It is important to understand Piuran ganaderos' definition of "productive". The most critical feature for a goat is to produce many kids, preferably twice a year. A "productive" doe also has enough milk

to support the kids' growth even in dry conditions. The size and conformation of the goat (together with the history of its mother) reflects its capability to reproduce successfully even in Piura's harsh environment.

TABLE 3.1
COMMON TERMS FOR GOATS IN PIURA

Morphology or Behavior

cachora - horny
muca - hornless
aborrecelona - abandoning her kids
huacha - abandoned by her mother
salsillona (haretona) - developed neck ruffles
barbona - bearded goat
cachos cerrados - convergent horns
cachos abiertos - divergent horns
cachos aguados (puntados)- sharp horns
cachudo - with very big horns
teta larga - oblong teats
teta campanuda - big, round teats
teta bolsicona (quesillera) - good milk producer
ubre chiquita - small teats
lechera (lecherosa, vaquita, la tetona) - good milk producer
amorosa - easily adopts others' kids
penera (queda luna) - tends to stay overnight on the range

One Color

blanca - white
amarilla - light beige (yellow)
plomiso - light gray
baya - light beige
barosa - beige
mogaso - dark beige
canela - light brown (cinnamon)
colorada - reddish
mora - berry
marona - dark red
mulata - chocolate
megra - black

A Mixture of Colors

chaipa (silgada) - black + white spots
granisa - black + gray spots
frontina - white spot on forehead
bandera peruana - two white & one reddish strips
huraco - big round spots on dark background
bringa blanca - white belly
carta menga - dark brown with light brown spots
cevu - black with brown lines on back and belly

For most herders "good udders" means moderate-sized and separated teats. This definition relates to a preference for increased kid survival rather than improved milk yields. Large udders are more susceptible to injury in the Piuran scrubland. They also make suckling more difficult. In contrast, medium-size, rounded udders and separated teats help kids suckle more easily and prevent injuries which may lower milk production. This is a good example of intentional selection aimed at ganaderos' primary goal of kid survival, even at the expense of their secondary goal, of increasing milk yields. Nolte and Arauzo (1973) report a selection preference for reproductive males (machos) according to the conformation/weight and high production of kids by the macho's mother. Goat herders in Piura also practice a selection scheme through their marketing strategy. The herder determines the fate of each goat in his herd according to its reproductive potential. Thus, at any given time, goats with high reproductive potential constitute the bulk of a herd.

An development implication of the selection preference described above is that techniques to improve milk production may not be accepted by Piuran herders unless they also increase kid production. This attitude will persist so long as meat (kids) has a higher economic value for the campesino.

Caprine Demography

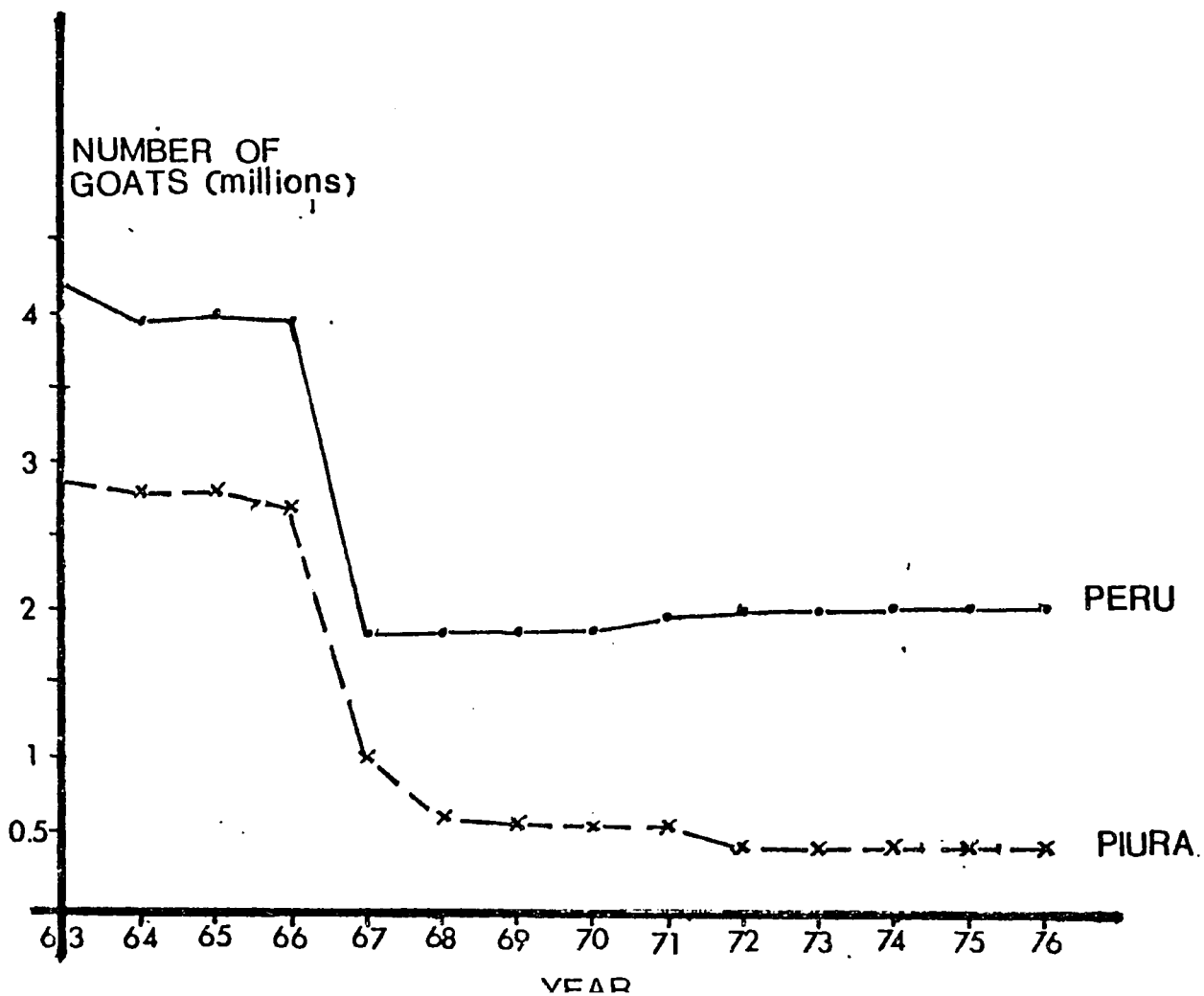
Goats are not the most common livestock of Peru. Sheep, llama, and alpaca dominate the Andean pasturelands, while cattle and pigs are common peasants in the coastal agricultural valleys. Nevertheless, goats do play an important role in dry, marginal environments. According to the agrarian census of 1972 most of the goats in Peru are found in the coastal departments of Piura (27.9% of the national population), Lima (14.6%), Ayachucho (12.2%), Huancavelica (7.4%), and Apurimac (7.1%). By and large, Piura is the capital of the goat industry in Peru. However, a boom in goat-raising is currently taking place near Lima. The endless demand for cheap meat and dairy products by the growing metropolitan population encourages entrepreneurs to establish new livestock operations in every available site. The notable adaptation of goats to marginal environments makes them a favored species for these new operations.

Figure 3.1 presents changes in the goat population in Peru and in Piura during 1963-1976. Unfortunately, more recent data are not available. The first question arising in regard to this Figure is: what generated the dramatic drop of more than 60% in the goat population in 1966-68? Nolte and Arazuro (1973) suggest that this decline was a result of a drought. However, 1965 was one of the best years in the scrublands (despoblados) of Piura as far as water and pasture are concerned. Indeed, locally this year is called el campeon del siglo 'the champion of the century'. Moreover, ganaderos interviewed about this time made no reference to any special diseases or plagues. Finally, this decline in goat population occurred three years before the agrarian reform, in a relatively stable political situation. What, then, caused such a substantial decline?

I believe the answer suggested by the PDAPCHP study (Plan de Desarrolo 1975) is the right one. I.e., the decline was a result of mistakes in censusing. It is important to understand how the goat

Figure 3.1

GOAT POPULATION IN PERU AND PIURA



population of Piura is estimated in order to evaluate the accuracy of the census. The Ministry of Agriculture divides the department into distinct agricultural provinces and districts. In each district technicians (sectoristas) are in charge of agricultural assistance or extension services. These technicians are the main source of statistical information. They pass their accounts on to the provincial headquarters where regional estimates are made. The provincial figures serve the departmental office in estimating livestock populations within the whole region.

For most livestock species, technicians are able to provide accurate figures obtained during vaccination campaigns. Since the Piuran peasants are obliged by law to vaccinate their livestock and since they usually seek the help of the technicians, the latter have a good estimate of most livestock populations. However, this is not the case with goats. There is no regulation obliging goat herders to vaccinate their stock; so no help or supervision is offered to them by the Ministry. Consequently, when a technician is called upon to estimate the number of goats in his sector, he can provide no more than a very vague guess. One might claim that the technician's acquaintanceship with peasants will help him more accurately determine herds' size. Again, though, while this may be true for livestock raised in the agricultural areas technicians frequently visit, most goats are reared far away from the cropping areas in the despoblados. Time, cost, and transportation difficulties minimize technicians' familiarity with goatkeepers and their operations. And the technicians' few visits to the despoblado are usually carried out while the herd is grazing out on the range. Direct observations or reliable counting are carried out very rarely.

The staff of the Ministry of Agriculture's statistical unit is aware of these problems. In an effort to overcome them, the unit uses a second source of information--the quantity of livestock slaughtered in departmental abbatoirs. However, this is not an ideal source either. Slaughterhouse data give an estimation only of "legal" slaughters--i.e., government supervised--these data do not capture clandestine slaughters, such as those for household consumption or for sale in small villages. An official of the Ministry of Agriculture in Piura estimates clandestine slaughters equal as much as 50% of legal ones.

How, then, can a confident estimate of the goat population in Piura be obtained? I have tried to answer this question using a different data source--the trade in goat hides. No matter where, when, and why a goat or a kid is slaughtered, there is a good chance that its hide will be sold. The trade in goat hides has always been vigorous in Piura because the skins have few domestic uses. (More than 90% of 160 ganaderos interviewed claimed they sell all the hides they have had.) These hides are partially processed within the department and then shipped to Lima for industrial use or export. Every shipment must be accompanied by a certificate issued by the Ministry of Agriculture's provincial agency. Monthly or yearly figures of hide shipments (obtained through the certificates) and the knowledge of average herds' production and dynamics enable calculation of total population size, independent of direct counting or observation.

The following data in Table 3.2 on hide shipments were gathered from monthly reports of the Ministry of Agriculture's agency in Sullana. The

data represent the total trade of hides in the provinces of Sullana and Ayabaca.

TABLE 3.2
HIDE TRADE IN SULLANA AND AYABACA PROVINCES (1977-1981)

1977 - 55,866 hides/year (based on data of 12 months)
1978 - 96,033 hides/year (based on data of 4 months)
1979 - 92,105 hides/year (based on data of 11 months)
1980 - 102,041 hides/year (based on data of 9 months)
1981 - 110,700 hides/year (based on data of 4 months)

90,000 hides per year is taken as the overall average. Interestingly, Zuniza reports the export of 300,000-450,000 hides per year from Piura in the 1940 and 1950's.) Average kid production in a regular year is assumed to be 100% (assuming two kiddings a year and a fair amount of twinning.) 15% is lost to predation, theft, natural mortality, etc., and 10% is consumed (mostly male kids). Of the 75%, 35% are males which are sold at a certain age (Ch. 4) and 40% are females which are kept to replace old, non-producing goats or to augment herd size. Interviews revealed that 15% of adult goats are sold every regular year, mostly because of their declining productivity. Based on these data, the total goat population can be calculated. It was found that 180,000 goats will produce 90,000 hides. The official figure for the goat population in the province of Sullana for the corresponding years is 72,500 (ORDENORTE 1980). Since goat production in Ayabaca is marginal, an estimate of 100,000 goats for both departments is almost an exaggeration. If this is the case, the difference between official estimates and calculations based on the trade in hides' is 80%!

In Morropon Province (upper Piura) most of the human population is concentrated in large agricultural villages far from the urban centers--Chulucanas and Morropon. Most of these villages have local systems of slaughtering and meat marketing. However, such systems are considered clandestine because they are conducted outside official slaughterhouses. Monthly reports of the Ministry of Agriculture's agency in Chulucanas from 1981 plus nine months of 1982 indicate that 121,891 hides were exported from the province. But officially only 2,368 goats were butchered during the same period. In other words, only 2% of all goat slaughters took place in an official abbatoir. Obviously, any estimates of goat populations based on "official" slaughter figures will be highly inaccurate.

Sociedad Mercantil Lima (formerly the Duncan & Fox import-export firm) has dominated the hide trade for many years. It controls 70%-80% of the Piuran market every year. According to their data, 136,085, 121,966, and 177,093 hides were purchased in Piura during 1975, 1976, and 1977, respectively. Given that approximately 20% of all hides offered for sale in the field do not satisfy the companys'[1] commercial standards, and based on the average figures presented above, it was calculated that this number of hides derives from 520,000 goats. The official figures in Piura for the corresponding period (1975-77) was 436,000-438,000 goats. In other words, figures based on annual hide yields indicate a population 20% larger than official estimates.

The method suggested above for calculating the goat population still is not perfectly accurate. Nevertheless, it does add a more objective

measure to the rather subjective and inaccurate official method currently in use. It is therefore suggested that a coefficient factor of 20% should be added to any official goat-census figures.

Population size is only one component in a demographic analysis. The spatial distribution of the population is equally important. Goats can be found almost anywhere in Piura. Nonetheless, the dry scrubland (despoblado) is their dominant habitat. Goats are also quite common in the agricultural valleys, but there they share the space with many other livestock--most notably cattle, pigs, and sheep. On the western slopes of the sierra only few goats are found; this is a stabled cattle zone. Most potential pasturage here has been cleared to make room for rainfed, seasonal maize cultivation. Taking care of grazing animals is an onerous task in this steep environment. Campesinos instead prefer to keep a few stabled cattle, fed with residues from the family plot. Milk cows dominate the livestock industry in the mountainous valleys (Ayabaca and Huancabamba), where cultivated pasture is available. In the high elevations sheep prevail. High demand for wool, especially for domestic needs, determines the herd composition in this region. In sum, goats are the most important livestock in the lowland of Piura (costa), primarily in the non-agricultural environments.

If it is difficult to determine the number of goats in Piura, it is even more difficult to estimate the number of goatkeepers in the department. The first question here is who exactly is a goatkeeper? I.e., is everyone who owns a couple of goats a herder (ganadero)? Or should maybe only those for whom goats are the main source of income be considered goatkeepers? Can all campesinos living in the despoblado be considered ganaderos? I do not have clear-cut answers for these questions; no solid data on the size and distribution of Piuran ganaderos exist. The only figure I could locate was 20,300-20,800 families of "active" ganaderos in Piura during 1972-1976 (Anuario Estadistico Agropecuario, 1963-1976).

Herd Size and Composition. There is extreme variation in herd size in Piura. The problem is rooted, first of all, in the question of which herds to include in a herd-size analysis--i.e., who is to be considered a goatkeeper?. Another factor contributing to the large variation in herd size is the environmental diversity of the Piuran lowland. The environment--particularly soil and rainfall conditions--determines pasture availability and consequently range carrying capacity. As already noted in Chapter 2, the lowland and agricultural valleys of Piura are divided into various ecological zones which differ in pasture potential and range conditions (cover, composition, duration). Each ecozone may support a distinct goat production system (Ch. 4). Different economic and socio-political spheres in which herders live, or with which they interact, further complicate any attempt to generalize about goat herds' size and composition.

The average herd size in 190 cases interviewed was 90. This included: 43.5 adult goats (standard deviation + 49.9), 15 young goats (just before first gestation) (S.D. ± 19.5), 1.6 bucks (S.D. ± 2.0), and 18.6 young kids (less than 12 months old) (S.D. ± 18.7). Nevertheless, average herd size in the despoblado is much higher because peasants living there have few other subsistence alternatives. According to Arauzo (1973) an average goat herd in Peru consists of 66% mature does,

15% young does, 12% young kids, 4% reproductive males, and 3% maturing males. Sibille (1972) recorded one reproductive buck per every 44 goats. Table 3.3 presents data on herd size in the Sullana region based on a survey conducted by Jack (1978). The average herd size according to Jack is 99.4 goats.

TABLE 3.3
HERD DIVISIONS IN PIURA ACCORDING TO SIZE

Number of Goats	Number of Owners	Total Number of Goats
10-50	605	20,320
51-100	352	28,400
101-250	319	66,360
over 250	32	14,920
Total	1308	130,000

Goats clearly dominate Piuran herds. The overall goat:sheep ratio is 1:6. In the despoblados the ratio is 1:12, and in the agricultural zones 1:4.5. In my survey, the reasons Piuran peasants cited for preferring goats over other livestock were as shown in Table 3.4.

TABLE 3.4
REASONS FOR PREFERRING GOATS

Reason Provided	% of Informants Responding
Produce more kids	30.9%
Produce more milk	23.5%
Better adapted	17.6%
Require less attention	16.2%
Smaller losses	5.9%
Herds increase more rapidly	2.9%
Total	97.0%

Responses 1, 2, 3 and 6 are directly correlated with higher kid production. Response 5 is related to herd size. On average, herders also own: 7 ± 11 sheep and 0.7 ± 9 heads of cattle. The typical livestock operation in the despoblado consists of 70 ± 60 goats, 6 ± 11 sheep, 3 ± 6 cattle, 6 ± 5 pigs, and 1 ± 4 burros. The latter are an essential part of the household, serving to transport people, water, and loads). In the agricultural zone the composition of a family herd is slightly different: 35 ± 38 goats, 8 ± 8 sheep, and 7 ± 8 cows.

Farmers explain the higher percentage of sheep in their herds by pointing to a behavioral difference between goats and sheep. The latter are more accustomed to being stabled and fed in the corral, while the former become nervous if not allowed to graze in the open. 46% of all herders interviewed do not own any cattle. 34% have 1-5 heads of cattle while 16.5% own 6-20 cattle. Cattle are expensive, they demand more attention, and natural pastures in Piura are not adequate everywhere for

cattle. Thus Piuran campesinos call the goat la vaca de los pobres 'the cow of the poor'.

Reproduction and Productivity

Oestrus and Gestation. Oestrus in goats occurs every 18-21 days and lasts 24-36 hours. In the tropics, goats enter oestrus all year round; in temperate climates heat is seasonal. It is not clear whether this difference is environmentally (temperature, length of day, etc.) or genetically (breed) determined (Devendra and Burns, 1970). It seems that in Piura, under favorable conditions where fodder is plentiful and nutritional requirements are met, goats can enter oestrus and become pregnant all year round. In many regions throughout the department, however, forage is seasonally scarce. Consequently, oestrus occurs only periodically, when the nutritional-physiological is adequately achieved (Ch. 4).

The service period--i.e., the interval between kidding and next oestrus--is two months in most tropical goat breeds (ibid). The gestation period in tropical goats is 145-148 days (ibid.) According to local herders, the pregnancy period for goats in Piura falls within or close to this figure.

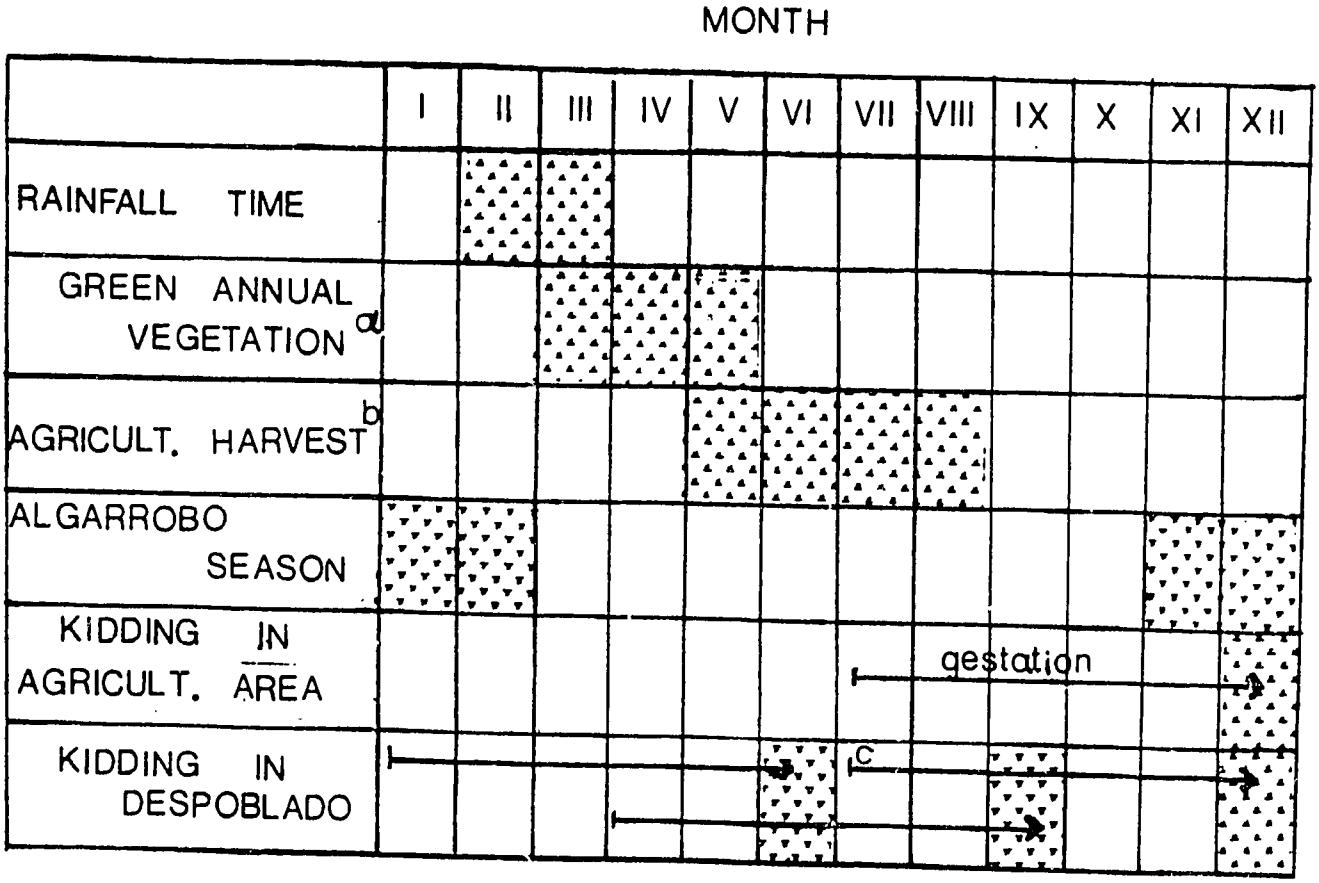
Breeding/Kidding Season. Various sources (Arauzo 1973, Calle 1968) indicate that June and December (pariciones de San Juan y de navidad) are the peak kidding periods in Piura. September is also said to be a productive month (Cordero et al. 1977). Breeding seasons occur five months prior to kidding, during January and July. This supports the assumption of a causal relationship between reproductive cycle and nutritional status. January is the peak ripening period for the algarrobo (mesquite, Prosopis juliflora) pods. This is a very nutritious and common fodder throughout Piura. Algarrobo trees are found both in agricultural areas and across the scrubland. Because of the pods, nutritional value and ready availability, they have an evident effect on most goats in the region. The pods' high carbohydrate and protein content elevates the animals' physiological state enabling many does to enter oestrus.

June-July, the second breeding period, corresponds the harvesttime availability of agricultural residues (e.g., from corn, rice, cotton, and sorghum) and by-products. Obviously, this post-harvest time is more important for goats reared in the agricultural area. However, some herders migrate with their herds from the despoblados to the agricultural fields to take advantage of these resources (System E, Ch. 4). In the despoblado September is a common breeding time. There, natural forage is the main fodder. Herbaceous vegetation sprouts and covers the scrubland during March-May, if enough rainfall occurs. This new pasturage considerably enhances does' nutritional status enabling them to become pregnant.

Figure 3.2 depicts the breeding/kidding cycle of goats in Piura. Sixty-six out of 150 herders surveyed (44%) claimed that June-July is the most productive kidding season. 23 (15%) said December is more, or at least as, productive as June in terms of kidding. And 20% cited September as the most productive time. Benzaquen and Callacna (1982)

Figure 3.2

KIDDING CYCLES IN PIURA



a - strongly depends on actual amount of rainfall.

b - varies according to geographical location and crop (Table 10, Ch. 4).

c - occurs only in herds which seasonally migrate to agricultural fields.

⟼ - gestation period.

report that most kidding in extensively managed herds in Jayanca (Lambayeque Department) occurs in June and September.

Sex Ratios. Devendra and Burns (1970) suggest that the normal caprine sex ratio is 52% male and 48% female kids. In Lambayeque the sex ratio in one criollo herd was 51% males and 49% females (Velez-Nauer and Callacna 1976). In another study in Lambayeque, a sex ratio of 50.5:49.5 was found (Benzaquen and Callacna 1982). Sibille (1972) found a sex ratio of 53.5:46.5 in 3,789 births in Piura. In other words, sex ratios of criollo goats in Piura are no different from other herds of goats in the world.

Productivity and Prolificacy. Goats have a notable prolific capacity. However, significant variations in actual productivity have been observed in different breeds, management systems, and geographical locations. Prolificacy is the average number of kids produced by a doe per birth or per year. Devendra and Burns (1970) present some comparative data on prolificacy in goats in the tropics, indicating a wide range in litter size: 1.27 to 2.45 kids/doe/birth. It should be noted that most of these data were gathered under completely or partially, controlled conditions. The prolificacy of two herds raised under partly extensive conditions in Lambayeque was reported in one study to be 1.95 kids/birth (Benzaquen and Callanca 1982), 1.74 in another (Velez-Naur and Callacna 1976), and 1.43 in yet another observation (Cordero et al. 1977). In Piura, Sibille (1972) recorded a kidding rate of 1.47 for 3789 births. 57% of these were single births (usually first kiddings are single); 39% were twins; and 4% were triple births. Sibille also found that the total kidding percentage in 102 herds in Piura was 72.3%

My survey of 131 herds yielded an average kidding rate of 1.31%. However, this survey was carried out in 1982, when acute drought and consequent forage shortages obviously lowered herd productivity. According to this survey, total kidding in 1982 was 68%.

Devendra and Burns (1970) report twinning rates of 10-70% in various tropical breeds, with an average of 40-50%. In Piura, herders claimed an average of 33% twinning in their herds. 42% of 63 herders interviewed even stated that twinning was the standard birth pattern in their herds. 39% said that single kiddings prevailed. In Piura, Jack (1978) observed 47% twins in 207 parturitions where 81.4% of the does gave birth during the year. Relative to goat production in other tropical habitats, it seems that the criollo goats of northern Peru are no less prolific than other breeds, especially if the very extensive management in which they are raised is taken into consideration.

Kidding Interval. Kidding interval is defined as the service period (the time between last kidding and next conception) together with the gestation period. According to Devendra and Burns (1970), this interval ranges between 240-480 days in various tropical breeds. However, most sources indicate a kidding interval of more than 300 days, implying one birth per year. In my survey in Piura, 59% of 136 herders reported two kiddings every year; 25% reported one; and 16% said that in a good year most of their goats gave birth twice, but in dry years only once. This

information is not very clear because some ganaderos cited the actual number of kiddings from the same goat, while others described the general kidding pattern in their herds.

Age at First Kidding. Goats are capable of reproducing at an early age, but the actual age of first kidding varies in different tropical breeds. According to Devendra and Burns (1970), this occurs at age 12-14 months. In Piura, 63% of 132 herders interviewed reported first kiddings at 12-16 months, and 31% answered with 16-20 months. Only a few ganaderos (5%) reported late births of 20-24 months. In a monitored herd of crossed goats (Anglo-Nubian and criollo) the age at first kidding was 20 months, but these goats' nutritional status was reportedly very poor (Cordero et al. 1977).

Kid Survival/Mortality. Survival rates among newborn kids are important for assessing reproductive success. Mortality rates of 20-50% are reported in the literature (Devendra and Burns 1970). In Piura, the mortality rate in young kids is about 9.6%, as indicated by the average of responses from 127 ganaderos. In Lambayeque a mortality rate of 12% was recorded in kids younger than 6 months reared under extensive management. The mortality rate dropped to 8.5% in kids 6-12 months old and to 8% in adult goats (Velez-Mauer and Callacna 1980).

Reproductive Control and Weaning. Pastoralists are renowned for their prudent livestock management. They usually control reproduction, timing it to coincide with high pasture availability or adequate climatic conditions. They also take full advantage of milk production by controlling weaning and suckling. However, my researches in Piura suggest a very different management approach. Out of 163 herders responding, 149 (91.1%) do not practice any control over reproduction. 68.1% do not control weaning, allowing kids to suckle as long as they wish.

At first sight, this seems very inefficient. One might even wonder if a lack of know-how prevents ganaderos from more closely controlling their herds' reproduction. However, observations on herders who do practice various forms of regulating reproduction and suckling suggest that technical solutions are available to most herders in Piura. The failure to use them is, then, a deliberate managerial decision rather than a technological deficiency. To understand this decision, goat herding must be examined in a broader context.

Ganaderos view goats primarily as meat (=kid) producers. (In contrast, many officials and local scientists see the goat mainly as a milk producer.) Management is therefore aimed at maximizing kid production. Since temperatures fluctuate little over the year and pasture sources are relatively diverse (herbaceous vegetation, shrubs and trees, algarrobo pods, stubble), there is no preferred season for kidding. I.e., in lowland Piura there is no particular time which presents serious problems for kidding. Under such conditions the decision "to let nature" regulate reproduction is apt. Leaving the buck (macho or padron) with the herd to service any doe entering heat will maximize kidding. The simplest way to control kidding is by stabling bucks when the herd is let out to graze. But this is not very effective in Piura because on grazing fields herds become mixed, so a buck from one herd is often "at service" in other herds. In many cases herders report that "foreign" goats are attracted to their herds by a vigorous buck or a

doe in heat. Sometimes herders put a piece of cloth (pachera) on the buck's genitals to control his sexual activity. In addition, day length and average temperature in Piura, as in other tropical habitats, allow does to enter heat all year round. Since oestrus is an individual phenomenon, it is advantageous to keep a buck available for mating. The fact that 52% of 155 herders state that their goats become pregnant twice a year supports this.

In general, my inquiries on kidding control were met with stupefaction. Chivateros believe that nature does its job perfectly--if a goat is physiologically ready, mating should take place. If the physiological or nutritional state of the doe is inadequate, the buck's presence does no harm. Actual kidding and mortality rates provide a good indication of whether this reproductive policy is sound. Kidding rates are relatively high, about 100% in normal years; and mortality is low, around 10% (77.1% of 127 herders responding). One can therefore safely conclude that the "natural reproduction" system practiced in Piura is quite efficient. The only possible problem with this management approach is the difficulty of introducing genetic improvements through selected bucks. However, whether such improvements are necessary is yet another question.

The fact that weaning is rarely controlled in Piura should be interpreted in like fashion. Herders are interested, first and foremost, in kid production, survival, and rapid development (high rate of weight gain). It is therefore logical to let kids suckle for as long as they wish. It is common to see kids 4-6 months old still suckling while they graze along with their mothers. Ganaderos even report that 12-month-old kids may still nurse. Interestingly, when a prospective padron is selected from among the young male goats, he is allowed to nurse for a year in order to assure his full development. Since most chivateros are less interested in fresh milk (see below) than in the rapid gains in kids' weight which determine their market price, the characteristic lack of weaning control in Piuran goat husbandry is quite understandable.

However, when the herder does want to save some milk for household use, he binds one teat of the mother with a piece of fabric (extremo); her kid uses the other teat. In the green season when many kids are born and the herder is very busy, kids are left in the chiquero (a small compartment of the corral) to control the milk consumption.

Meat Production

Average Weight at Birth and Growth Rate. A study on criollo goats in Lambayeque (Velez-Nauer and Callacna, 1980) found that the average birth weight of kids was 2.6 kg. (n=162). Male kids from single births gained 77.7 gr/day and twins gained 75.6 gr/day during 24 weeks. Female kids and twins gained 62.4 and 68.6 gr/day respectively. Benzaquen and Callacna (1982) recorded birth rates of 2.9 and 2.7 kg for male and female kids, respectively. The growth rate for these kids was 104 and 96.4 (male and female) gr/day for the first 56 days, and 52 and 50 gr/day for the next 42 days. Calle (1968) found that a single male kid at birth weighed 2.1 kg, a twin male 1.55 kg, a single female kid 1.79 kg. and female twin - 1.36 kg. Nolte and Arauzo (1973) state that most of a kid's growth takes place during the first 18-24 months.

Average Weight of Adult Goats and Carcass Weight. According to Calle (1968) the average weight of criollo adult females is 32 kg males average 65 kg. He also claims that the carcass constitutes 40.4% of the kid's weight and 38.9% of the adult weight. Benzaquen and Callacna (1982) found that the carcass of 5-month-old kids accounts for 52% of total weight. According to Velez-Nauer and Callacna (1980) carcass weight is 10.3 kg for a male kid (6-12 months), 11.2 kg for a female kid (6-12 months), 16.0 kg for an adult female, and 24.0 for an adult male. The dressing (carcass) percentage of other tropical goats is 35-55.4% with an average of 48% (Devendra and Burns 1970). Live weight among these breeds is 13.6-42.3 kg, with an average of 29 kg.

In meat production operations, males are typically castrated. This causes them to gain more weight--the most important factor in market price. But in Piura only two ganaderos out of 170 interviewed say they castrate their ram lambs. Yet the technique is well-known in the region; it was commonly used on hacienda herds. Why Piuran herders today fail to use it is an open question.

Milk and Cheese Production

In contrast with many other pastoral systems, milk and dairy products are not of prime importance in Piura. Selling meat is by and large the principal source of income for most of the herders. Milk contributes to the family economy or diet at least seasonally, however. 23% of 186 ganaderos surveyed claim they never milk their goats. The majority of those who do milk only during the green season (March-June). Most non-milking goatkeepers reside in the agricultural areas, where they probably enjoy an alternate source of milk (cows). They prefer to let the kids suckle the milk and gain weight more rapidly. Only 15% of 154 herders surveyed sell some of their goats' milk. Usually, goats are milked once a day, in the morning before the herd leaves to graze. Women almost always are in charge of this task, but older daughters may help them.

Lactation Length and Average Milk Yield. Callanca et al. (1982) report a lactation period of 175.2±4.7 days for criollo goats kept in semi-stabled conditions in Lambayeque. This figure seems a bit low in comparison with the 300-800 lactation days reported by Devendra and Burns (1970) for other tropical breeds. The study by Callacna and his colleagues also shows that criollo goats in Lambayeque produce on average 0.58 liters of milk per goat per day. The average daily yield of milk in Piura was 0.7 liter/goat/day according to my survey. Tropical goats produce 0.5-3.4 liters/day with an average of 1.0 liter/day (Devendra and Burns 1970). It seems that the Piuran criollo goat is not a very efficient milk producer, at least under existing management conditions.

Cheese Production. Besides fresh milk, two dairy products--fresh cheese and half-dry cheese--are commonly produced in Piura. The fresh cheese or quesillo (sometimes called also quajada) is made by adding a starter curd (cuajo) to a container of milk. The curd is taken from the stomach of a slaughtered kid and is stored dry. It is activated by soaking it in water and then warming it. After an hour or two the milk is converted to cheese which is then transferred to a special mold to shape it into its final form. The quesillo is always kept moist. No salt is used to prepare quesillo and the traditional way to eat it is with sugar, sweet syrup, or as an extraordinary treat, with honey.

Queso is a finer cheese. The raw cheese is processed in the same way as quesillo but with salt. Next, the cheese is ground and kneaded. Finally, it is pressed into a mold and left to dry. The dry queso develops a crust which keeps the inside moist. Queso can be kept at home for a couple of days. Its storability makes it more marketable than quesillo, so most of the cheese produced in the campo and sold in urban centers is queso.

Husbandry

Most goat production in Piura is extensively managed. Of the nine production systems defined in the next chapter, only one can be considered even semi-intensive. Three main factors distinguish extensive from intensive husbandry systems: the source of fodder--natural pasture vs. purchased feed; the amount of capital invested--minimal vs. considerable; and special care such as housing facilities, veterinary treatments, genetic selection--i.e., minimal vs. maximal.

In essence, the fundamental difference between these two management strategies is the availability of capital. Capital can free the production process from complete dependence on natural resources, whose availability tends to fluctuate significantly, especially in semi-arid environments. Capital also helps producers cope more effectively with factors limiting production, e.g., labor availability, health problems, or diet balancing. Table 3.5 presents the principal differences between these two husbandry systems.

Housing. Piuran goat operations require a stockyard (corral) for housing the herd at night. The stockyard is fenced with posts made from local trees (algarrobo or hualtaco) and bars made from overal. The structure is usually about 1.5 meters high and typically is composed of various sections (Figure 3.3). The central or largest section is the manga or corral grande, where adult goats spend the night. A gate leads from the manga to a smaller compartment, the manga chiquita or corral chiquito, which serves as a milking place. Milk goats are brought in one after the other, early in the morning, for more convenient milking. Suckling kids (less than three months old) are separated from their mothers in the chiquero, another small section adjacent to the manga. Twice a day the kids are released from the chiquero in order to nurse. Kids are left in the chiquero because they are too young to follow their mothers to the pasture and also because the herder can better control milk production. Usually the ganadero allows kids to suckle freely from one udder, while milk from the other one goes to household use.

Alongside the corral is a leveled arena, where the herd is gathered upon returning from the pasture. This arena is called majada or pampa de la llegada. If a herder also owns cattle, another large and solid corral may be attached to the stockyard complex--the corral de vacas or cattle yard. In the vicinity of the corrals are canovas or comederos, feed troughs made of tree trunks, usually hualtaco or zapote.

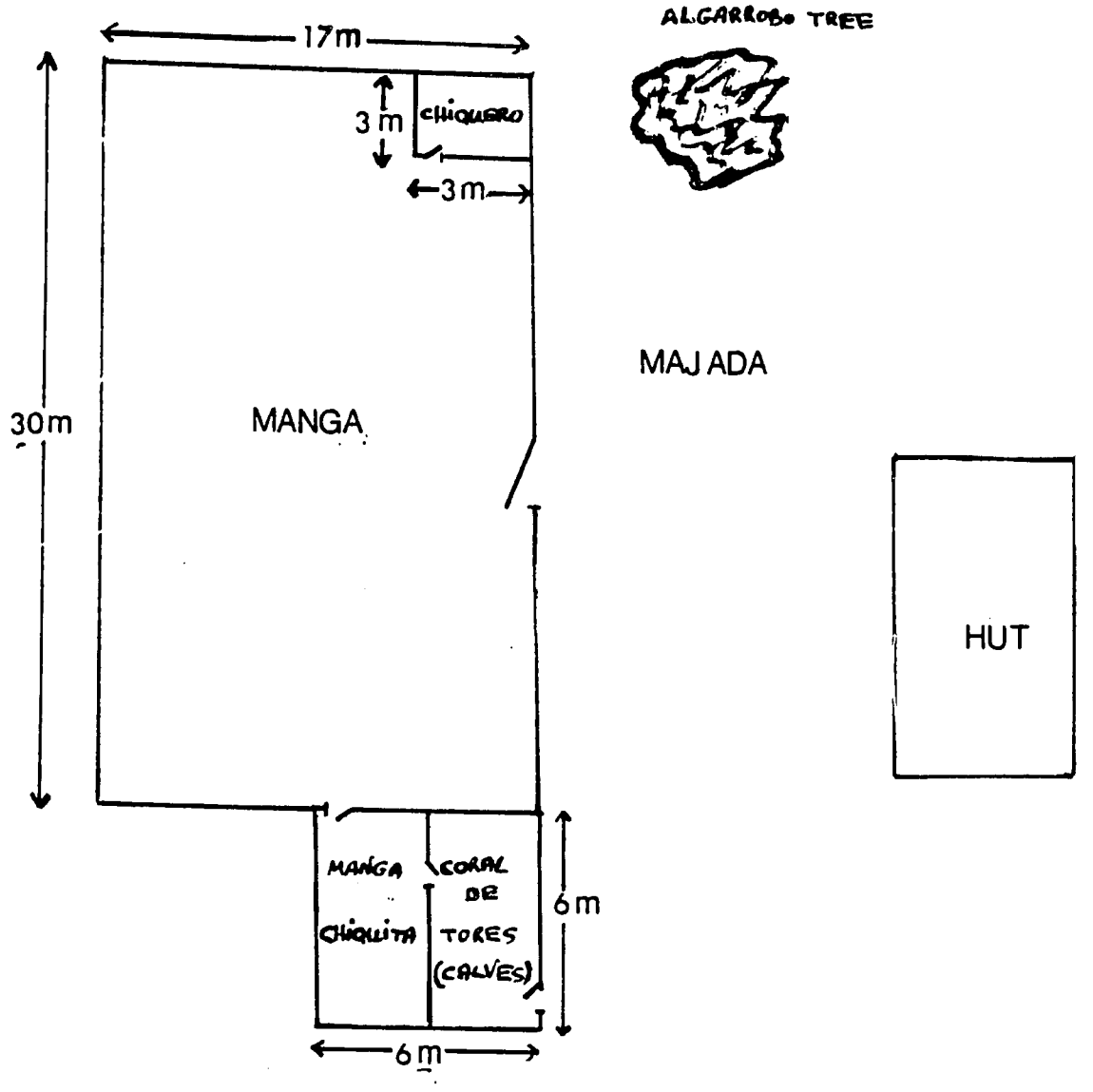
TABLE 3.5
EXTENSIVE AND INTENSIVE MANAGEMENT SYSTEMS

	Extensive	Intensive
Herd Composition	Diverse	Homogeneous
Final product(s)	A variety, both for market & home consumption	The most profitable product in market terms
Stocking rate	High, but varies according to environment and other limiting factors.	Optimal for maximizing production/profitability
Forage:		
source	Natural pasture	Various
supplementary feed	Given only in emergency	Given regularly
Health:		
medicine type	Traditional and/or modern	Modern
disease control	Minimal, only in emergency	Regular
Labor:		
principal source	Family	Hired workers
availability	Occasionally limited	Usually unlimited
Selection:		
technique	Traditional, less advanced	Advanced
goal	Survival and a variety of products	Maximal production of preferred product
Mating control	Application depends on environmental conditions	Application depends on productivity pattern and on market conditions
Marketing strategy	A function of household necessities	A function of market conditions
Capital:		
source	Family activity	Institutions
application	Minimal	Extensive

Not every herding operation necessarily includes all the housing facilities mentioned above. Small herds kept by peasants who rely little upon livestock for their livelihood may be housed together in one corral. However, pastoralists, for whom control over production is essential, must establish adequate facilities.

Shepherding. Shepherding skills are a fundamental feature of many pastoral groups. It is therefore surprising to discover that Piuran

Figure 3.3
A TYPICAL CORRAL COMPLEX IN PIURA



goats often are not actively herded, but are instead allowed to graze the scrubland alone. In the agricultural areas, however, herds are almost always accompanied by a shepherd, usually a young child or an elderly person. The principal task of the shepherd here is to deter rustling and to prevent the goats from damaging agricultural fields. In the despoblados the danger of rustling is smaller and there are no fields the livestock can damage; so supervision is less important. Thirty of 83 herders surveyed (34%) say their herds go unsupervised; 47 (56%) send a family member to supervise the livestock, and 6 (7%) hire a shepherd.

Herds are usually watered in late afternoon; thus thirst alone drives them back home from the pastures. In dry years, when forage can be found only far from home, some goats may stay overnight in the range. The ganadero is disturbed by such behavior only if losses due to predation occur. Many ganaderos claim that sheep weaken faster than goats while searching for pasture in dry years. Therefore sheep more often remain overnight on the range and are more frequently taken by predators. This is one of the reasons ganaderos prefer to raise goats over sheep in the scrubland of Piura.

Herders receive help in looking after their livestock from trained dogs (perro ganadero, ganacho). These dogs are raised in the corral alongside the goats. The dogs' only food is goat's milk, which they receive once a day when the herds return from the range. The milk is placed in a pit (huaco) dug in the corral floor. These feeding and housing practices likely form a strong attachment between dogs and their charges, probably strengthening the dog's devotion to their guard duties.

Watering. Herds are usually watered once a day, and sometimes twice in the hot season. In some cases, the herder's family owns a small well (noria), and father or son fills the drinking troughs (canovas) with water drawn by buckets from the well. In other cases, one deep well serves a small village. Then young children transport wooden barrels on the backs of donkeys from the well to the watering site near the corral. In agricultural areas herds drink freely from canals or ditches. The common water sources in the hilly region are jahuays--small, natural springs. It takes 0.5-1 hours to water a moderate-sized herd (about 50 goats). Drawing water from wells is considered hard work and is almost always a man's job.

Diet and Fodder

The caprine diet in Piura is derived from various sources: natural forage (herbaceous or shrubs), agricultural stubble (rastrojo), agricultural residues (e.g., rice straw), concentrated feed (e.g., cottonseed cakes), cultivated forage (e.g., sudan grass), and other supplements (e.g., algarrobo pods). Each herder structures the diet of his herd according to the availability of natural forage near his home at any given time, and his economic situation.

Out of 171 herders surveyed, 105 (60%) supplemented the diet of their goats on a permanent or temporary basis. However, recall that this survey was made during a severe drought; this definitely had an effect on the supplemental regime. In the despoblados goats' diet is normally supplemented only during the dry season, when little dry herbaceous biomass is available. The need to supplement grows if the herder does not migrate to the stubble fields in the river valleys. The favorite

feed in the despoblados is cottonseed cakes (pasta de algodon). It is considered high quality fodder rich in protein. However, it is quite expensive and its trade in the market is controlled by Ministry of Agriculture quotas. Substitutes for pasta de algodon are non-processed cottonseeds (semilla de algodon) or cotton shells (cascara).

In the agricultural region the critical feed period arises during the growing season, when goats are not permitted near the cultivated fields. At this time, goatkeepers may use weeds from the fields, algarrobo pods, or concentrated fodder to meet livestock nutritional requirements. Garcia (1983) presents a detailed study on the grazing behavior of goats in natural pasturelands in the Olmos region near Piura. According to his findings, the dominant fodders in the "average" caprine diet are: herbaceous species 40%, overal (Cordia rotundifolia) 22%, faique (Acacia marcocanta) 19%, and algarrobo (Prosopis juliflora) 5%. Garcia also provides information about the protein content and grazing periods for these plants as shown in Table 3.6.

TABLE 3.6
CHARACTERISTICS OF PRINCIPAL CAPRINE FORAGES

Month	Principal Fodder	Percentage in Diet	Protein Content (%)
Jan-Mar[a]	faique	35%	17.8%
Mar-Aug[b]	overal	30-35%	18.3%
Jan-Aug[c]	herbaceous plants	35-45%	18.1% (green) 7.2% (dry)
Nov-Jan[d]	algarrobo	?	11.2% (leaves)[e] 13.7% (pods)

a) Time of regrowth of faique.
b) Both green and dry leaves are intensively consumed by goats as green material during January to April and later as dry standing biomass.
c) According to the author's observations.
d) Algarrobo leaves are rarely consumed, probably because of high alkaloid content.

In samples of dry herbaceous material gathered in southern Piura and the Olmos region at the end of the dry season of 1981-82 a relatively high protein content of 5.22% to 13.8% was found[2].

In Piura, herders try to reserve herbaceous pasture by fencing a plot (potrero) with wooden bars. This pasture is used later in the year when the open range becomes barren, or it may serve as a recuperating place for sick or pregnant goats. The potrero usually includes algarrobo trees.

Offtakes, Losses, and Trade

A livestock operation is a dynamic system; at the same time that new animals enter the system, e.g. through purchases or births, others leave

it. Producers remove livestock from the herd for a variety of reasons, e.g., home consumption, marketing, selective breeding, and external factors like losses to predation, rustling, or disease. In Piura most offtakes are due to a need for cash to meet household expenses. The main cause of losses varies by the production system (Ch. 4).

Self-consumption. Since goat meat is the most popular and available meat in rural Piura, one expects high rates of self-consumption among goat herders. On average, a herders' family consumes 11±16 goats a year (the average from 128 families). Given that the average herd size is about 80 goats (of all ages), self-consumption accounts for 7-10% of the herd size. However, it seems that ganaderos eat meat more frequently than once a month. Table 3.7 describes the various sources from which a ganadero may acquire meat.

Table 3.7 demonstrates that herders are reluctant to consume livestock from their own herds. They are more likely to purchase meat from neighbors or from the village market, which also relies on livestock sold by neighboring villagers. Such behavior is another indication that herders tend to do everything possible to maximize the size of their own herds. Chapter 6 explains the logic of herd build-ups as an adaptation to climatic conditions in Piura. Self-consumption of goat meat may increase on the occasions of feasts, family celebrations like birthdays, weddings or mother's day, and religious gatherings.

TABLE 3.7
SOURCES OF MEAT IN RURAL PIURA (40 Informants)

Source	% Informants Deriving From This Source
Neighbors	35.0%
Own herd	25.0%
Urban market	20.0%
Local market	15.0%

Trade and Marketing. As noted earlier in Piura, goats are raised primarily for meeting family cash needs. The demand for meat in Piura can be considered limitless, mostly because markets in the principal cities (Piura, Sullana, Talara, and Paita, where 60% of the department's population resides) depend almost exclusively on regional sources of meat and milk. Yet regional production can rarely satisfy all the demand in the urban markets.

Goat meat is popular not only because it is 15-25% cheaper than beef, but also because of its role in certain traditional dishes. The meat of a young, milk-fed kid (cabrito de leche) is considered a delicacy. Seco de chavelo--goat meat with fried banana--is another typical Piuran dish. Sun dried goat meat and intestines cooked with blood and spices are common foods among poor people in Piura. As a famous novelist from Piura writes, "El Piurano del bajo pueblo es producto de chicha y carne, carne del ganado cabrio en multiples y varidades formas... es caprino ante todo y sobre todo..." The Piuran peasant is a man of chicha (a local alcoholic drink) and meat, goat meat. Goat meat is used in many and varied forms and it comes before and above all else (Lopez Albujar 1936). Goat meat is popular not only in urban

but also in rural areas. Tables 3.8 and 3.9 present data on meat preferences among Piuran campesinos. From these tables it is clear that goat is preferred over other types of meat, though the reasons for this preference are not entirely clear.

TABLE 3.8
MEAT PREFERENCES IN RURAL PIURA (58 Informants)

Meat	% Informants Preferring
Goat	34.4%
Mutton	27.6%
Beef	20.6%
Pork	3.4%
Chicken	1.7%
No preference	12.1%

TABLE 3.9
Reasons for Meat Preferences in Piura (47 Informants)

Reason Cited	% Informants Citing
Taste	29.8%
Availability	25.5%
Nutritional value (alimentoso)	21.3%
Health value (sana)	17.1%
Price	2.1%

In order to meet urban market demand, live goats or their meat must be transported from remote production sites. Almost every settlement in the despoblados is connected with the "outside world" by a dirt road. Equipped with big trucks, merchants from the cities (comerciantes or negociantes) cross the plains seeking buyers for the goods they bring from town (cloth, utensils, foodstuffs) and sellers of livestock or wood. In most cases goats are sold at the herders' house. Out of 38 herders, 28 (74%) said they sell most of their livestock at home; the remainder sell in a nearby market. After purchasing an animal, a merchant must obtain a certificate proving it is not stolen. The local authority (teniente gobernador) provides the document. Livestock are then transferred directly to an urban slaughterhouse and from there to the market, or they can be left in the centro de acopio, a stockyard on the outskirts of Sullana, while the merchant looks for a buyer. The time livestock spend in the stockyard is sometimes used to fatten them. Lack of refrigeration and the hot Piuran climate prevent any direct marketing of meat from the despoblados to the cities. In some cases, a neighbor may drive some goats to the city for a fee; in other cases a family member may carry a goat or two to market to sell, and use the money for purchasing fresh produce.

Goat-marketing strategies--what, when, and why to sell--are largely determined by household economic status and forage availability. In general, male kids are destined to be sold, but the age at which this

happens may differ. If the scrubland is bare, does have little milk and the kids have little chance to survive. In this case, newborn kids are marketed or consumed at home within a few weeks. When pasture is plentiful, male kids are allowed to gain weight; only a few are sold at a young age in order to meet immediate cash needs. Forty-six herders out of 107 (43%) report they sell most male kids at 0-6 months; 40% prefer to sell at 7-12 months. Only 6% sell mature kids (older than 12 months) and 11% have no preference at what age to cull their kids. Jack (1978) also notes that kids are sold at a young age (3 months old). The same observation was made in Parinas during a study on goat production in the vicinity of Talara (Convenio 1978). Female kids usually remain in the herd to replace old does or to build up herd size. Mature goats are culled when their productivity declines. After 6-12 months of barrenness the does are considered machoras (macho - male) and are sold. On average, in Piura does are culled at about 5-6 years. In time of drought or urgent need for money, even producing goats may be marketed. Table 3.10 summarizes data on marketing habits in Piura. These data strongly support the information reported above. Chapter 6 presents a comprehensive analysis of the marketing strategies with reference to production, environmental, and economic conditions.

TABLE 3.10
PREFERENCES IN MARKETING GOATS IN PIURA (103 Informants)

Category of Animal	% Informants Preferring to Sell Animals in this Category[1]
Old goats	52.4%
Maturing kids	24.0%
Milk-fed kids	20.4%
Poisoned goats[2]	1.9%
Young does (tiernas)	1.0%

[1] The survey asked about preference in marketing, but the response may also be interpreted as a reflection of actual practice.

[2] Goats which are intoxicated after eating leaves of borrachera (Ipomea carnea), a common shrub.

Trade in Milk. Milk is a secondary product in most goat-raising operations in Piura. Only 24 out of 155 (15.5%) herders say they sell milk. However, 51 (33%) sell cheese. But meat production is unquestionably the principal goal for Piuran herders. The mode of selection, the management scheme, and the marketing strategy are all oriented toward maximizing meat (i.e. kid) production. In many cases this is achieved at the expense of milk production. For example, by letting kids suckle freely or by selecting for high rates of twins, ganaderos deliberately lower the amount of milk available for marketing. However, in the green season, if pasture is abundant there is an excess of milk. The limiting factor on the milk trade then becomes the poor or nonexistent facilities of transporting milk from production sites on the despoblados to the cities. Ganaderos prefer to use the milk to make dry cheese (queso), which may be kept without refrigeration for a couple of days and can therefore be marketed in Piura.

It should be noted that near the main cities there are some specialized goat farms whose main product is fresh milk. These farms are managed in a semi-intensive manner and are quite successful. The following chapter describes these operations.

Trade in Hides. In the past, Piuran goats provided a variety of products, including soap, tallow, wax, and cordovanes or strips of leather (Lequanda 1793). But industrial development made these products obsolete, and it is doubtful whether present herders know much about this past commercial activity. However, hides have always been, and still are, much sought-after. Of 148 herders, 126 (85%) claimed to sell goat hides; only 15% did not do so (or didn't want to acknowledge it). When asked about domestic uses for the hides, 94 out of 119 (79%) responded negatively. Slaughtering is done carefully in order not to damage the skin. Perhaps this is the reason why the local term for slaughtering a goat is pelar una calra, 'to peel a goat'. Hides are covered with salt and left to dry. Merchants ship them to Lima where they are further processed and then sold to local industry or exported.

Losses

The extent and causes for losses among livestock raised under extensive management may vary drastically from year to year and place to place. There are strong correlations among climatic conditions, pasture availability, and livestock survival rates. The geographical location of the operation may also affect losses by introducing various factors (e.g., wild animals).

Mortality Rate. Based on the survey data, the average mortality rate is 10.1±8.3% (from 127 herds). This figure seems quite low, considering that the survey was done during a severe drought. Interestingly, the mortality rate of kids in hacienda milk herds raised semi-intensively was 15-20% (Derteano 1946). Of course, mortality figures given in an interview are not very accurate; also, the figures are inclusive, and it is hard to differentiate between mortality in kids and mature goats. Jack (1978) estimates mortality rates of kids in Piura to be 20-40% depending on production conditions, especially the feeding regime. In any case, a mortality rate of 10% is low.

Perhaps the dry climate and the spatial separation between herds in the despoblados contribute to a slow and limited spreading of diseases. The most common ailments among goats in Piura are the following.

- Septicemia--a disease caused by pathogenic organisms (Salmonella) or their toxins excreted into the blood system. Usually occurs among young animals and frequently causes death.
- Pneumonia--more widespread in time of forage scarcity.
- Mastitis--an inflammation of the udder.
- Parasites, both internal and external.
- Intoxication--mostly by poisonous plants. The most harmful shrub in Piura is the borrachera (Ipomea carnea) whose green foliage attracts goats in the dry season. After eating the borrachera's

leaves, goats behave as though they are drugged or drunk (borracho in Spanish means drunk). Many are killed by falling from cliffs or they faint in the tropical sun and become dehydrated.

- o Coquera--a disease affecting the muscles of the digestive system. According to local herders, coquera is related to a poor diet composed mainly of algarrobo pods. In the absence of any scientific study of this disease, little is known about it.

Veterinary medicines for and vaccinations against most of the diseases mentioned above are available in Piura. But in only a few cases are they fully and correctly applied. Only when a plague is already taking its toll will ganaderos use modern medicines or consult a veterinarian. It is hard to determine whether such behavior is a result of the high cost of medical treatment, of the "minimum capital investment" strategy practiced by most herders, or of the lack of proper education and training. I found no traces of a developed traditional veterinary medicine and only rarely are plant materials used to treat sick goats.

Abortions. Abortions are common in Piura, especially in dry periods. Twenty-one herders (42% of respondents) reported that 10-25% of their does aborted during the drought of 1982. Herders say that most abortions occurred either in the dry season (lack of forage) or the cold season (deficiency of energy or protein?). Spontaneous abortion was considered the principal reason for losses according to Capps (1983).

Predation. Losses of goats, sometimes in considerable quantity, due to predation are well known in certain regions of Piura. The principal predator is the mountain lion (puma or leon) which lives in the bushy slopes of the sierra or in the hilly area. Therefore, the most affected region is the strip along the sierra where dense savanna-type vegetation gives the lions a good refuge from hunters. Out of 81 herders throughout the department, 37 (46%) suffered no losses to predation during 1982. 28 (35%) lost 1-10 animals, 10 (12%) lost 11-30 goats, and 6 (7%) lost 31-60 animals.

The leon may enter the corral at night and kill a couple of kids, but it will eat or carry off only one. Many goats or kids are attacked while grazing in the despoblados. Some ganaderos try to hunt the puma or poison it. Others accept its attacks as an inevitable part of extensive management. In the region of Las Lomas the custom is that a herder who succeeds in killing a leon receives a cash present (gratificacion) from his neighbors; in upper Piura the present is a live goat. In the "leon-infected" regions herders pay more attention to careful shepherding, while in other habitats goats may be left to graze without supervision.

Rustling. Rustling is quite a common problem in Piura, as it is everywhere in Peru (Orlove 1973). It seems most prevalent in agricultural areas where population is denser; but rustlers, on foot or with a vehicle, also visit the despoblados. Thirty-one ganaderos (54% of the survey group) claimed to have lost 1-10 goats to rustlers during the survey. Eight (14%) lost 11-20 and 6 (11%) lost 21-40 head.

The local police are very inefficient in preventing rustling or locating the rustlers. The presence of a shepherd may deter thieves, although in some cases a band of rustlers with a pickup overcame young shepherds and stole their livestock. Ganaderos claim that some of the rustling is done by neighbors while the rest is carried out by city dwellers.

CHAPTER 4

GOAT PRODUCTION SYSTEMS IN PIURA

An essential first step in the analysis of agricultural systems is to establish a set of criteria for classifying and characterizing the systems in question. Most such endeavors have been confined to biological-managerial aspects. In his classic book, Spedding (1975) presents several examples of such classification schemes based on types of crop, nature of management/husbandry, or the principal products produced by the system along with their related management. The emphasis in Spedding's classification models is on the physical production process, although the relevance of some socioeconomic factors (e.g., labor availability and cost) and the physical enviroment is also recognized. When dealing with grazing systems, however, Spedding's "characters" and "values" come mainly from the realms of biology and livestock husbandry. Duckham and Masefield (1970), in generalizing about the farming systems of the world, consider ecological factors, infra-structure features (land tenure, water supply), external economic constraints (market, credit), internal operational factors (farm size, labor availability), and the personal attitude of the farmer as the most significant components of agricultural systems. A similar approach, although more location-specific, has been adopted by Norman et al. (1982) in describing agricultural systems in the African savanna.

Hart (1982) examines farming systems via a hierarchial model which integrates various crops and/or animal production systems into agroecosystems. The latter, along with their associated socioeconomic subsystems, form the "farm systems" which are themselves integrated regionally with financial and informational institutions as well as with non-agricultural systems.

McDowell and Hildebrand (1980) identify the prevailing mixed agricultural systems (where both cropping and livestock raising are pursued by the same household) involving small farmers in various regions of the world. Their analysis is based on enviromental characteristics (e.g., elevation and humidity), major crops and/or livestock types, and feed sources for the animals. In a more detailed analysis of some selected systems, McDowell and Hildebrand emphasize the interrelations between animals, crops, and farmers, including marketing and labor practices. Chudleigh (1976) presents a descriptive classification of animal production systems in Kenya based on type of livestock, degree of reliance on grazing, and source of feed. Norman et al. (1982) suggest a more complex model for agroecosystem classification but do not test it on actual systems.

Most of the references mentioned above are very general and lack any quantification of major parameters. In most cases, there is not even an attempt to group systems according to measurable variables, and the classification schemes that result are completely qualitative. The lack of quantitative analyses of agroeconomic systems can be explained by the considerable amounts of money and time required to gather adequate data. However, the reason that most of these studies tend to underestimate or entirely overlook the importance of cultural, social, and political factors is probably related to the professional background of most agroecosystems experts and researchers. The systems they are most familiar with are intensively managed, individually owned, heavily

capitalized, and oriented toward maximization of profit, usually through optimization of production. Traditional agroecosystems in the developing world differ, sometimes significantly, from the "modern-western" model. Social, cultural, and political factors may be responsible for much of this deviation. The fact that these non-biological, non-agronomic variables are less easily observed or quantified has not helped them to gain popularity among modelers of the agricultural process. Yet the causal effects of these variables on agricultural production seem beyond dispute.

Classifying Goat Production Systems in Piura: Environmental Factors

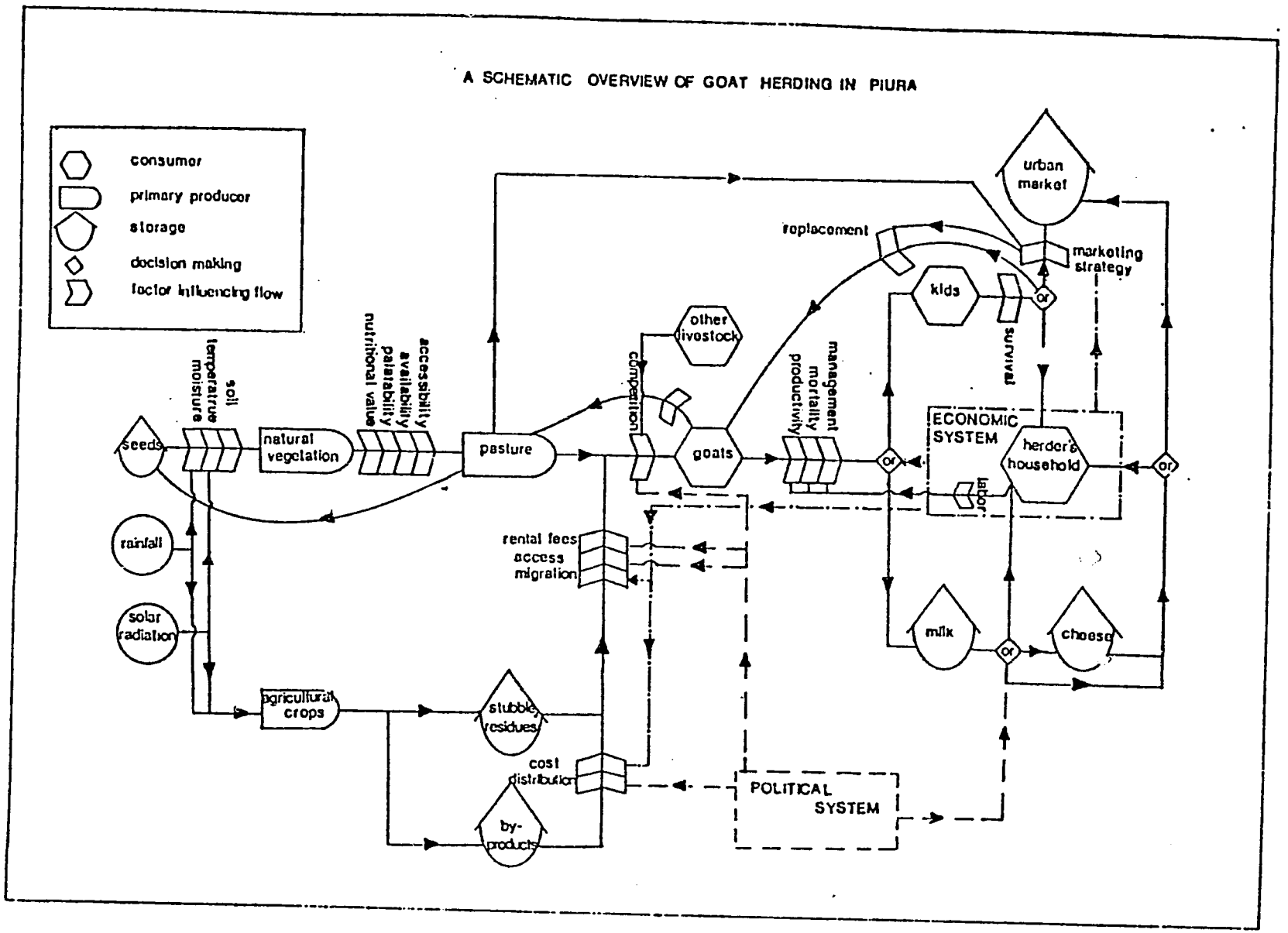
In analyzing data on Piuran goat raising, an attempt was made to identify causal relationships between components of the production process and the environment in which this production takes place. Production characteristics (kidding rate, timing of milk production, mortality rate) and husbandry practices (e.g., migration, supplementary feeding, weaning) are determined or constrained by a large array of factors, some of them exogenous to the production process (pasture quantity or market demand), and others endogenous (e.g., husbandry decisions by the herder). The problem, however, is to correctly identify the factors or causes most affecting production features. Naturally, the first correlation tested was between production characteristics, herd management, and the ecological setting--the climate-soil-vegetation complex--which was studied independently. Figure 2.5 shows the natural ecozones (A-D) identified in the lowlands of Piura. Also shown are the five distinctive ecological units most common to the agricultural valleys (1-5). Each unit represents a different combination of three variables: types of crops, agrarian organization, and availability of nearby natural pasture (All factors are instrumental elements in a mixed livestock-cropping enterprise.) A more detailed characterization of each ecozone or unit is given in Tables 2.1 and 2.3.

Only a partial correlation was found between goat production, livestock husbandry, and marketing behavior variables on the one hand, and ecological units on the other hand. Only by introducing economic factors (alternative income sources and the longterm reliability of these sources) and socio-political features (land tenure organization and degree of control over natural resources) was it possible to cluster the 200 herders surveyed into distinguishable systems. Figure 4.1 presents a schematic overview of goat herding in Piura, including factors discussed more broadly in the following pages.

The surveyed households were grouped according to similarities in their geographical-ecological location along with economic and sociopolitical characteristics (see next section). In order not to break down the sample into units too small to be analyzed, households fitting the overall production scheme shared by a group of herders but differing in one of the dimensions were nevertheless included in that group. Of course, even after the addition of economic and sociopolitical factors, the differences between systems are still not absolute and clear-cut. However, the proposed classification does however, minimize variations within each system while emphasizing the differences between systems.

Again, the dividing line between the groups is not absolute and the classification is somewhat flexible. E.g., certain households could be

Figure 4.1


A SCHEMATIC OVERVIEW OF GOAT HERDING IN PIURA
consumer
primary producer
storage
decision making
factor influencing flow
urban market
replacement
marketing strategy
kids
or
other livestock
survival
soil
temperature
moisture
nutritional value
palatability
availability
accessibility
competition
management
mortality
productivity
ECONOMIC SYSTEM
seeds
natural vegetation
pasture
goats
herders household
labor
rainfall
rental fees
access
migration
solar radiation
milk
cheese
agricultural crops
stubble, residues
cost distribution
by-products
POLITICAL SYSTEM

placed in more than one group, and others do not fit all the characteristics of the group in which they are included. One may question the utility of such a classification scheme. In fact, an analysis in which all surveyed operations were compared along one combined continuum could provide a more accurate account of the variability among Piuran goat herders. Nevertheless, it is assumed that grouping individual cases into spatially integrated units is much more applicable for further research or development initiatives than dealing separately with each operation.

One important conclusion of this analysis is that although ecological setting is instrumental in determining production and productivity of these livestock operations, the "human factor" is of no less importance. As a matter of fact, in many cases herders living in and utilizing the same physical enviroment have been grouped into different production systems due to their significantly different social, economic, or political status.

Economic and Sociopolitical Aspects of Goat Herding in Piura

As noted earlier, "human factors" have rarely played a major role in agroecosystems analysis. However, before attempting a multidimensional analysis of goat herding in Piura which includes such factors, some background information is required. This section presents a schematic overview of the principal economic categories and social or political structures prevailing in agrarian Piura. Only those factors closely related to or strongly affecting goat herding are discussed here.

In order to understand the socio-political forces that shape agricultural production and livestock husbandry practices in Piura, it is first necessary to become acquainted with the region's land tenure systems and their related social organization. There are four main systems:

Cooperatives. Agricultural cooperatives were founded in Piura and in other parts of Peru as a consequence of the agrarian reform in 1969. The cooperatives have replaced the large, individually-owned estates (haciendas) which previously controlled most of the cultivated land in Peru. Peasants who worked in the old estates on a permanent basis were given communal ownership of the tillable land. At present, agricultural cooperatives control about 60% of the cultivated land of Piura--around 60,000 hectares (Revesz 1980). Cotton, rice, and sorghum are the primary crops grown on cooperative land. Agricultural production is modern, intensive, capitalized, and mechanized. The cooperatives' fields provide excellent stubble after harvest.

The cooperatives are managed, at least in principle, by their members, who make decisions through established political institutions like general assemblies and elected managerial committees. Decisions regarding stubble utilization are also determined by the group as a whole. The general assembly decides which fields will be open to grazing, when to open them, who will benefit from the resources (cooperative members only or interested outsiders as well), and what the grazing terms will be (fees for rental and fines for damaging nearby crops). A very sensitive issue is whether socios (members of cooperatives) are asked to pay a rental fee for using the stubble fields

or are exempted from such payment, and whether this fee is the same as, or lower than, the fee "outsiders" pay. The cooperative's immediate economic needs as well as the relative importance of livestock raising for most of its members will eventually determine the cooperative's policy. If cash is badly needed, all users, including socios, are required to pay high rental fees. If the cooperative is economically successful, only non-members are charged. If the majority of members owns livestock, the expected decision is to open the stubble fields first to members' herds and only later to lease them to others. Socios' advantage over non-members who may live in the same village and have grazed their herds on the same stubble fields for years before the agrarian reform is obvious.

Peasant Communities (Comunidades Campesinas). These are the traditional agricultural production units in the Andean region, including the coast. They are characterized (or perhaps idealized) by soldarity, cooperation, and consensus. (See Orlove and Custred 1980 for critique and alternative models.) Peasant communities have traditionally controlled the means of production--land, water, pasture--communally. However, external pressure, penetration of market-oriented crops, and the division of communal lands imposed by early republic decrees have all contributed to the increasing "individualization" of community resources. For generations peasant communities lost land to the growing haciendas due to Indians' weaker economic and political status. But in the last decade the political atmosphere in Peru has changed, and the rights of peasant communities have been reaffirmed and reinforced; territorial boundaries and control over resources have been restored, legally defined, and widely recognized. However, internal conflicts and inequality in resource allocation are still common among these communities (Olasibal 1982, Orlove and Custred 1980).

Although peasant communities are not viewed at present as "integral entities" (Yambert 1980), they demonstrate quite a pluralistic process of managing their communal affairs. Administrative and vigilance committees are democratically elected by all community members. These committees are in charge of public affairs education, development, communal resource management--and of dealings with the authorities. Agricultural fields and livestock herds are owned and managed individually, although the land as a whole and the pastures are collective property.

Today, after centuries of encroachment by big, rich, and influential estates, the land controlled by peasant communities in the agricultural valleys is limited. Most Piuran peasant communities are located in the mountainous region or on the western slopes of the sierra. However, the commmunity of Catacaos, near the city of Piura, is politically influential (Yambert 1982). Catacaos community also controls much pasture land in the despoblados of Sechura, Nomala, and Pabur. Peasant communities control about 28,000 hectares of cultivated land in Piura, or about 27% of the total area (Revesz 1980).

Peasant Groups (Grupos Campesinos). These socio-political units are products of the agrarian reform. They were created to accomodate groups for whom it was not feasible to institute a cooperative, or for whom no communal organization existed and hence no justification for a peasant community. In Piura such groups are primarily found on land previously owned by lumber haciendas. The agricultural potential of these lands is limited, and the only profitable economic activities they afford are goat

raising and lumbering or firewood felling. Traditionally, hacendados leased the lumber resources to contractors from the cities, and charged local herders an annual fee for grazing on the land. After the agrarian reform, the herders were advised by state officials in charge of the reform's implementation to organize themselves as a group so that they could be recognized as the managing body--but not the owner--of the land on which they lived. They were told by the government officials that if their communal management proved successful, the group would be recognized as a livestock cooperative. With only one exception, this promise has never been fulfilled.

The peasant group is not a corporate social unit. Formation of such a unit has been prevented both by subsistence necessity--the need of these herders to spread out across available pasture land--and by tradition--a long-standing norm of very loose social ties among group members. Group members live in small hamlets (caserios) miles away from each other; aside from a school, a general store, and sometimes a communal well, they have nothing in common. Political institutions among these groups are similar to the administrative and vigilance committees of the more traditional peasant communities. However, lack of experience in managing communal affairs plus the historical and structural factors mentioned above make these political institutions rather ineffective. The actual impact of communal institutions on the economic and social life of the members largely depends on the personal capabilities of the elected leaders.

Despite their weak social structure, most grupos campesinos have adopted a series of measures designed to protect their natural resources. Commercial lumbering or woodcutting on group land has been prohibited; even members of the group are required to obtain permission for substantial woodcutting (e.g., for house construction or clearing a rain-fed cropping parcel). Because almost all group members rely on goat herding for their subsistence, there is little opposition to the adoption of strict conservation measures which only help to improve livestock production.

There seem to be fewer occupational and economic differences within grupos campesinos than within indigenous communities. This relative homogeneity has given rise to a more consolidated organization--at least in terms of resource management. Lack of experience and tradition in managing communal affairs, the obscure political future of these organizations, and the objective technical difficulties of organizing a community of herders who are spread out over a large area are obviously restrictive factors on grupos campesinos.

Public Land (Tierra Estatale). Many herders live on land owned and managed at present by the state. Prior to the agrarian reform (1969), almost all the land in the department of Piura, agricultural and non-agricultural alike, was under the ownership of either haciendas or peasant communities. Most haciendas had two distinct types of land: a large cultivated tract along one of the main rivers, and a vast portion of the despoblados (scrublands) adjacent to it. The latter would often be much bigger than the sown fields. Hacienda Mallares, for example, controlled 440 hectares of agricultural land and 4560 hectares in the despoblado. Cattle from the haciendas used to graze the natural forage in the despoblado if enough rain fell. Goat herders were allowed to live

in and use these scrublands in return for an annual fee, payable in cash or kind (goats or their products).

With the agrarian reform, arable land was transferred to the agricultural cooperatives; but most pasture land remained under state control. Local government agencies are supposed to manage this vast territory, but budgetary and organizational problems prevent them from doing a satisfactory job.

The changes in land tenureship and resource management as a consequence of the agrarian reform have had significant impacts on goat herding communities. On the positive side, goat herders were released from annual rent payments to the haciendas. On the other hand, herders are no longer shielded by hacienda authority from competition for forage on the despoblados. In good years, ranchers (engordaderos) drive their cattle to the despoblados in order to take advantage of the abundance of "free" green forage there. In dry years, when the despoblados are readily accessible, goat herders observe helplessly how lenaderos (firewood merchants) cross the plains in search of dry or "drying" wood to sell in the cities. Large groves of algarrobo (Prosopis julifroa) have been cut down by the lenaderos' axes.

The local herders, who have no legal claim to the land or its forage resources, even if they have been using them for generations, can do very little to prevent cattle competition or the destructive wood felling. Similar resource abuses never occurred in the pre-agrarian reform period simply because it was in the hacendado's interest to defend and prudently manage the resources of his land. He also had the means--mounted guardians and efficient foreman--to administer the despolados. Herders also had an authority to whom to refer complaints when they noticed rangeland abuses. The government and its agencies lack the ability, the means, and perhaps even the motivation, to carry out a similar policy. The urban interest groups--meat and firewood merchants--have far more political access to, and influence on, the policy makers (Ministry of Agriculture, forestry police) than the illiterate, desert-dwelling herders. Thus, these interest groups can easily gain official approval of their activity.

In terms of economic status, the goatkeepers of Piura can be divided into six groups.

Herders (Ganaderos, Cabreros, or Chivateros). These are peasants who live in the scrublands of the coastal plains of Piura between the agricultural valleys. Livestock, especially goats, is their principal, if not sole, source of income. The husbandry and production characteristics of their operations are largely determined by environmental factors (climate variations, pasture and water availability). Lack of ready capital (other than the herd itself) and credit prevents more intensive diet supplementation in very dry years, and seriously limits herd production in this system.

Members of Cooperatives (Socios). Typically, these are peasants residing in the agricultural zone who became members of the reform-era agricultural cooperatives founded in Piura. They earn a monthly salary and are entitled to a small, private cropping plot on the communal land. Members of some cooperatives also pay subsidized prices for foodstuffs produced by their cooperative. Most socios enjoy a much higher economic

status than other Piuran peasants. Of course, a member's actual situation is largely determined by the economic state of the whole cooperative to which he belongs. Many of these communal organizations are near bankruptcy. However, the government has a reform-policy commitment to support the cooperatives economically.

Some members of cooperatives keep a small herd of goats. This assures the family some cheap meat or milk as well as a ready source of cash from livestock sales. With this cash income, they can cope with needs like fiesta, illness, or educational expenses). In such circumstances, the herd may be rightly considered the "savings account" of the peasant-herders.

Agricultural Wage Laborers (Eventuales). These are usually the neighbors, and in many cases the relatives, of cooperative members. But there is one significant difference: they are not socios and enjoy none of the benefits of that rank. Even if these eventuales were employed by the hacienda in the past, they are not eligible to become cooperative members unless they were listed as permanent workers in the hacienda documents. It was not in the hacendado's (landlord) economic interest to employ many permanent laborers because agricultural activity required only seasonal effort. Therefore, most of the hacienda's working force was temporary. These poor workers found little relief in the agrarian reform, from which they were virtually excluded (e.g., McClintock 1979).

The economic status of the eventuales is far from homogeneous. Some depend completely on the cooperatives, which employ them seasonally. But most cooperatives are careful not to provide any single eventual with more than 90 consecutive days of work during the year; otherwise, according to Peruvian labor law, the temporary laborers can claim permanent employment in the cooperatives. Other eventuales are hired as laborers (peones) by members of cooperatives to take care of their individual parcels (chacras).

Many young eventuales or their children migrate from the agricultural communities because of the hopelessness of their economic situation. Many wage laborers who prefer to stay in the agricultural region become goatkeepers. For them, livestock raising is an important complementary activity which helps maintain the family in the face of economic difficulties. Selling goat kids and marketing milk and cheese are important economic resources for many eventuales even though they see themselves primarily as farmers.

Smallholder Farmers (Microfundistas). These are peasants who own a small agricultural parcel (0.5 to 5.0 hectares) which provides the household with basic foodstuffs (casava, maize, vegetables) and some income from cash crops (cotton, vegetables). Most of this group are members of indigenous communities (comunidades campesinas), which for generations lost land to the large, neighboring estates. Encroachment by these estates plus sharp population growth put enormous pressures on cultivable land; the final result was the division of community lands into small, family-owned farms. Since the returns from cropping these small parcels are poor, many household heads were forced to seek an additional source of income, mostly in wage labor. However, along with Peru's chronically high rate of unemployment, their lack of marketable skills reduces their chances of finding wage labor. Some of them migrate temporarily to centers of colonization in the Amazonian basin; others

leave the communities with their families in the hope of finding a better life in the city.

Many of the poor peasants who prefer not to leave their communities raise goats as an additional source of food or income, and especially as a "cash generator" for their agricultural operation (see system A following).

Medium-size Farmers (Mediofundistas). Also, called coloneros if they have a farm in a colonization area, these are farmers who own medium-size farms (5 to 20 hectares). They either survived the agrarian reform because their farms were too small to be confiscated, or because they were able to obtain a new farm on reclaimed land as part of a colonization effort (e.g., San Lorenzo). These farmers typically have a better educational and technological background than most Piuran peasants and are, therefore, able to manage their enterprises in a more modern and intensive way. They also enjoy access to credit and extension services. Most of the cultivated land on these farms is devoted to cash crops, in many cases fruit trees (lemon, papaya, avocado, mango). Because the agrarian reform essentially did away with the class of rich landlords in Piuran agriculture, the mediofundistas are now considered the most well-to-do farmers in Piura. Although many mediofundistas are of peasant origin, they are clearly not peasants, nor do they perceive themselves as such.

Mediofundistas usually keep no goats because of the damage they may do to fruit trees. Sheep or cattle are more popular among these farmers since they can easily be kept stabled. Cattle are often kept where pasture is available, far away from the farm, under the care of hired laborers. Some farmers raise milk cows, with much technical assistance and credit provided by the government.

Non-agricultural Peasants. These are campesinos (peasants) whose main source of subsistence is not agriculture or livestock, but commerce, lumbering, firewood gathering, or wage labor in the cities. Most peasants in this category dopossess goats, however and they consider them an economic asset. These non-agricultural peasants are therefore also included in this discussion.

Goat Production Systems In Piura: Survey Results.

Data gathered from interviews with more than 200 herder families, located in different sites in the lowlands of Piura, were grouped into nine production systems according to the economic status of the herder, the sociopolitical organization to which he belongs, and the enviromental setting of the herding operation (Table 4.1). As already mentioned, the division into systems is by no means absolute. Neither are the spatial boundaries of these systems always clearly defined, although Figure 4.2 depicts their rough geographical distribution. Nor is the characterization of each system very homogeneous--as the high standard deviations of variables and low percentages of consent in Tables 4.1-4.4 indicate. Nevertheless, the only feasible way to study a complex human system is by dividing it into groups, even if artificial criteria are sometimes employed. However, the key for grouping still remains open and is strongly dependent on the research goals, theoretical or applied, and on the methodology used. If individuals within each group share similar

Figure 4.2

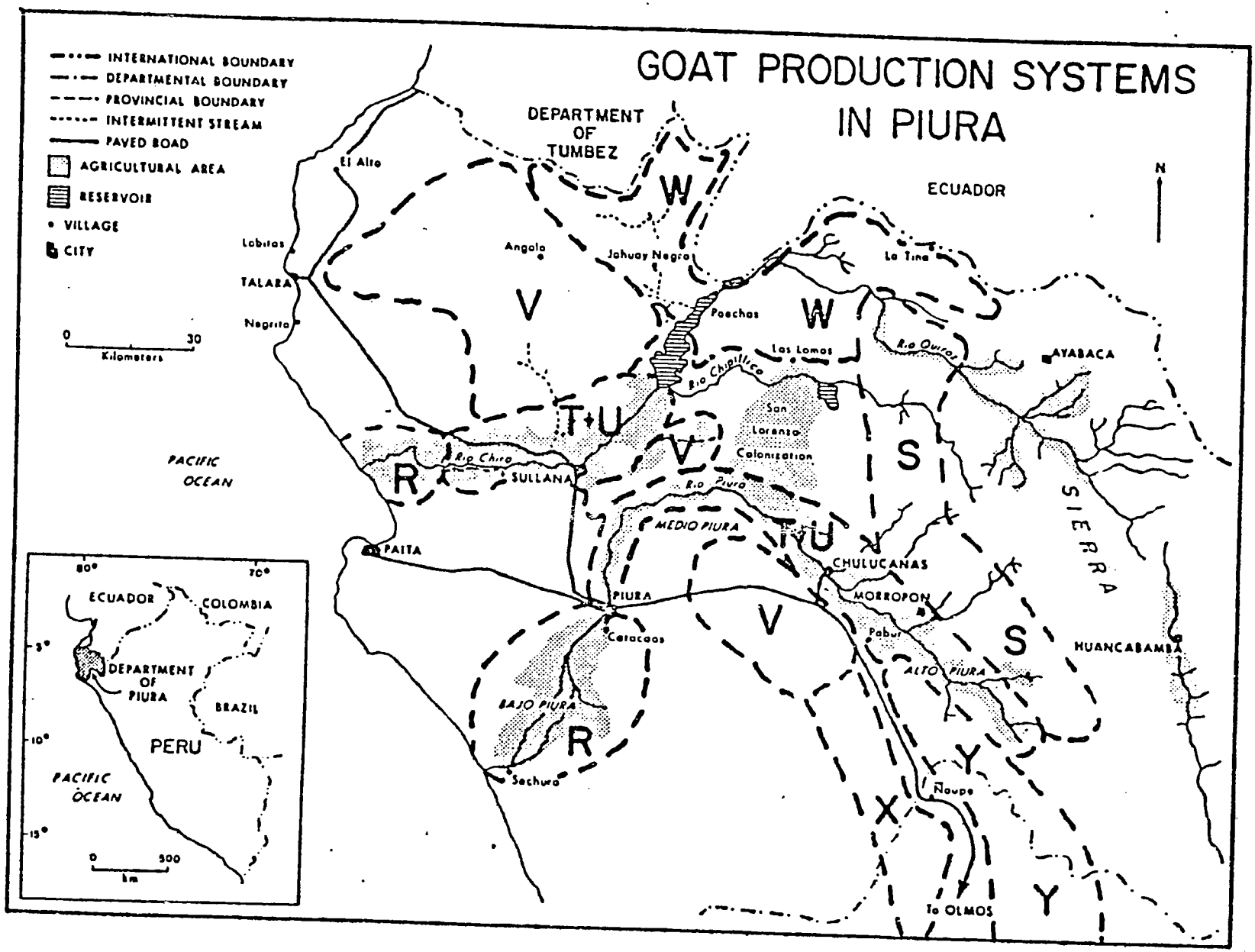

GOAT PRODUCTION SYSTEMS IN PIURA
INTERNATIONAL BOUNDARY
DEPARTMENTAL BOUNDARY
PROVINCIAL BOUNDARY
INTERMITTENT STREAM
PAVED ROAD
AGRICULTURAL AREA
RESERVOIR
VILLAGE
CITY
0 30 Kilometers
DEPARTMENT OF TUMBEZ
ECUADOR
N
El Alto
Lobitos
TALARA
Negrito
Angolo
Jahuay Negro
La Tina
Paechas
Las Lomas
Río Quiroz
AYABACA
Río Chipillico
San Lorenzo Colonization
Río Chira
SULLANA
Río Piura
PACIFIC OCEAN
MEDIO PIURA
PAITA
CHULUCANAS
MORROPON
PIURA
Catacaos
Pabur
ALTO PIURA
HUANCABAMBA
SIERRA
BAJO PIURA
Sechura
Naupa
To OLMOS
W
V
T+U
R
S
Y
X
80°
70°
ECUADOR
COLOMBIA
5°
DEPARTMENT OF PIURA
BRAZIL
10°
PERU
PACIFIC OCEAN
15°
0 500 km

Table 4.1

System Description

ZONE	SYSTEM CODE	SYSTEM CHARACTERIZATION	SYSTEM LOCATION	NUMBER OF SURVEYED HERDERS	PRINCIPAL[1] SUBSISTENCE SOURCE	AVERAGE HERD SIZE AND COMPOSITION (mean ± s.d.)			PRINCIPAL FORAGE SOURCE
						GOAT	SHEEP	CATTLE	
AGRICULTURAL	R	Small farmers, comuneros, very arid environment (ecozone A)	Lower Piura valley. Lower Chira valley.	6[1]	Mixed: cash crops/ foodstuffs and livestock (100%)[2]	8 ± 9	2 ± 2	4 ± 10	Jan.-June:roadside vegetation. July-December: stubble
	S	Moderate-size farms comuneros, favorable environment (ecozone C & mountain slopes)	Upper Piura valley. Western slopes of sierra. Quiroz valley.	24	Mixed (100%)	67 ± 88	11 ± 18	16 ± 6	Nov.-June:natural pasture. July-Oct.: agricultural residues and by products.
	T	Cooperatives' members	Mostly mid- and upper Piura and Chira Valleys.	18	Monthly salary private cropping plot (100%)	23 ± 14	6 ± 5	3 ± 5	Jan.-June: natural pasture near agricultural area July-Dec.: stubble
	U	Wage laborers (no land) from agricultural valleys. Mostly non-comuneros.	Everywhere in the agricultural valleys.	19	Wage labor or sharecropping (67%)	43 ± 39	11 ± 8	5 ± 10	Same as T
DESPOBLADO	V	Goat herders, no permanent cropping. Live on state land, unorganized politically.	Despoblados of Sullana, Angolo, Parinas	31	Goat raising (78%)	84 ± 57	5 ± 9	3 ± 7	Jan.-June:Natural pasture. July-Dec.: stubble (migration)
	W	Goat herders with occasional rain-fed agriculture. Mostly "peasant groups" in dense, dry savanna.	Las Lomas - Suyo-LaTina region	24	Goat raising (71%)	102 ± 92	3 ± 7	4 ± 5	Natural Pasture all year round.
	X	Goat herders, no cropping. Comuneros Semi-arid environment. (ecozone B-C)	Despoblados of Pabur, and western Olmos	19	Goat raising (78%)	55 ± 57	11 ± 15	3 ± 6	Same as W
	Y	Goat herders, occasional rain-fed cropping. Comuneros. Dry savanna (equivalent to ecozone C-D)	East Olmos, Salas (Dept. of Lambayeque.	29	Mixed: livestock and rain-fed agriculutre	40 ± 33	5 ± 11	3 ± 5	Same as W plus agricultural residues if enough rainfall occurred.
SEMI INTENSIVE	Z	Milk producing	Mostly located on the cities' outskirts	10	Goat raising, selling milk. (75%)	118 ±109	8 ± 15	5 ± 10	March-May:Natural pasture, July-Dec.: stubble & diet supplementation

[1] Only six herders were actually interviewed, however, additional information was gathered in the local slaughterhouse or taken from censuses of the ministry of agriculutre in lower Piura and lower Chira.

[2] Refers to the number of informants (of the number of surveyed herders)

Table 4.2

Production Features of the Various Goat Production Systems in Piura

SYSTEM CODE	PRINCIPAL PRODUCT	SECONDARY PRODUCT	AGE AT FIRST KIDDING (MONTHS)	PEAK PERIOD OF KIDDING	NUMBER OF KIDDINGS/YEAR	% OF KIDDING/HERD (mean + s.d.)	MILKING AND TIMING
R	kids - cash	manure	18 months	Dec. - March[1]	1	N.A.[2]	no milking
S	kid - cash & self consumption	manure	12 - 93%[3]	no regularity	*[4] - 47%	50 + 0	no milking - 93%
T	kids - cash & self consumption	N.A.	12 - 50%	May - July[1]	1 - 50%	84 + 30	June - Sept.- 50%
U	kids - cash & self consumption	milk/cheese	N.A.	July/Dec.[1]- 54%	2 - 71%	N.A.	June Sept. - 65%
V	kids - cash & self consumption	cheese	12-13 - 75%	May-June - 71% Dec. - 33%	* - 52%	52 + 24	April-June - 90%[5] Aug.-Oct. - 50%
W	kids - cash & self consumption	cheese	12-13 - 71%	May-June - 38% Jan.-March - 38%	* - 42% 2 - 38%	69 + 48	March-Aug. - 68%
X	kids - cash & self consumption	N.A.	16-18 - 59%	July - 57% Sept.-Oct.- 35%	* - 59%	61 + 35	April-July - 60%
Y	kids - cash & self consumption	cheese	no regularity[6]	May-July - 68%	2 - 75%	N.A.	April-July - 55%
Z	milk	kids	18 - 60%	June-July - 62% Dec.-Feb. - 54%	2 - 56%	105 + 43	all year

[1] May-July refers to kiddings occurring during the whole period between the two months. June/December refers to two distinguished kidding periods, one in each month.
[2] N.A. means that the data available are not sufficient for analysis.
[3] The percentage reflects the number of people giving the response.
[4] * means two kiddings per year in a good year (enough pasture), and only one kidding in a dry year.
[5] April-June is the milking time in good years with much green pasture. August-October is the milking time in dry years when herds migrate to cotton stubble fields.
[6] There was not any common response among the surveyed population.

Table 4.3

Management Characteristics of Goat Production Systems in Piura

SYSTEM	KIDDING CONTROL	WEANING	SUPPLEMENTING[1,2] WITH FORAGE AND CROP RESIDUES	SUPPLEMENTING[1,3] WITH CONCENTRATES	MIGRATION[4]	SHEPHERD (USED OR NOT)	CHANGE IN[5] HERD SIZE DURING 1982
R	no	no	yes	no	no	yes	no change
S	no - 100%	no - 93%	yes - 64%	no - 93%	no - 100%	no - 100%	increased - 100%
T	no - 100%	no - 94%	yes - 78%	no - 89%	no - 100%	yes - 83%	no change - 47%
U	no - 100%	no - 79%	yes - 68%	no - 79%	no - 100%	yes - 56%	no change - 40%
V	no - 100%	no - 52%	yes - 95%	yes - 73%	yes - 52%	no/yes[6] - 61%	decreased - 74%
W	no - 96%	no - 92%	yes - 100%	no - 83%	no - 100%	no - 100%	decreased - 79%
X	no - 89%	no - 53%	no - 63%	no - 84%	no - 84%	no - 69%	decreased - 42%
Y	no - 95%	no - 50%	yes - 73%	no - 95%	no - 77%	N.A.	decreased - 57%
Z	yes - 80%	yes - 100%	yes - 100%	yes - 100%	no - 69%	yes - 100%	decreased - 63%

1 These responses were recorded during a very dry year. Under regular conditions fewer herders supplement their livestock diet.
2 The most common fodder is algarrobo pods (algarroba) and rice straw.
3 The most common concentrates are cottonseed meal (pasta de algodon) and unprocessed cotton seeds.
4 Refers only to long distance movements (over tens of km.), usually from the despoblados to the stubble fields.
5 Refers to changes in herd size during the severe drought of 1982.
6 No shepherding is required while grazing the despoblados, but once migrating to the stubble fields a shepherd is a necessity.

Table 4.4

Marketing Aspects and Limiting Factors of the Goat Production Systems

SYSTEM	SELL MILK	SELL CHEESE	SELL KIDS	AGE OF KIDS SOLD	TIME OF SELLING MOST KIDS	LIMITING FACTORS
R	no	no	yes	no regularity	Jan.-March	pasture, capital
S	no(93%)[1]	no(93%)	yes/no[2]	no regularity	Nov.-Dec.(50%)	labor, predation, abortions
T	no(83%)	no(94%)	yes(100%)	11-15 months	March-May (58%)	labor/manpower, pasture
U	no(84%)	no(74%)	yes(100%)	no regularity	no regularity	pasture/stubble, diseases
V	no(100%)	yes(78%)	yes(92%)	2-5 months(43%) 6-10 months(33%)	no regularity	pasture & water during dry years, capital (concentrates), labor during migration.
W	no(100%)	yes(56%)	yes(92%)	8-12 months(50%)	March-May(34%)	pasture & water during dry years, diseases, predation.
X	no(100%)	no(74%)	yes(100%)	not available	all year	pasture & water during dry years, diseases, cheese marketing, poisonous shrubs (borrachora).
Y	no(100%)	no(77%)	yes(95%)	not available	no regularity	pasture during dry years, disease, predation, cheese marketing.
Z	yes(100%)	no(94%)	yes(94%)	0.5-2 months(73%)	all year	availability of natural forage and stubble, capital/credit.

1 The percentage refers to the number of people who gave this response.

2 Ordinarily do not sell kids, except in a very dry years or when necessities arise.

living conditions, pursue the same subsistence activities, and face similar problems, the likelihood is high that the group's members will react similarly to any change, whether natural or man-made (Norman, et al. 1982). In fact, for development and intervention purposes the expected response to change may be the most useful criterion.

It is also important to note that by defining and characterizing a "production group" little is said about the actual relations among group members. Some groups (e.g., some peasant communities in the highlands of Peru) are closely organized through elaborate sociocultural ties and cooperate extensively in agricultural production activities. Other groups communally control resources or share information while keeping household production separate and independent. Still other groups are composed of individuals who react in a similar way because of a common history, tradition, or environment but who are very loosely integrated. In some cases, there is no social group at all except in the minds of pragmatic, classification-oriented researchers. Group interrelationships are less relevant in diagnostic efforts, but they become key factors in policy or development programs. Some studies, for instance, have shown the effect of group socioeconomic stratification on attitudes toward change and development (Faye 1979) or on decisions made by individual peasant members of the group (Newman et al. 1979).

Table 4.1 presents some fundamental features of each goat production system identified in Piura. Tables 4.2, 4.3, and 4.4 give a diagnosis of the production features, management practices, and prevailing marketing strategy in each system. A brief description of each system follows.

System Description and Factors Limiting Production

The aim of this section is to tie together the background information and quantitative data presented in the previous sections and to portray the major features and dynamics of actual production systems. In order to make this description more relevant to development programs, factors which limit production and/or economic returns are also briefly discussed. The importance of identifying and defining the limiting factors in agroecosystems, especially as the producers perceive them, has already been recognized (Saint and Coward 1977; Shaner, Phillip, and Schmell 1982). However, in only a few cases has an actual study of such factors preceded the plan or even the execution of an intervention project. It is suggested that such an analytical approach--i.e., one which combines an objective examination of the production process by accepted scientific criteria (preferably quantitative ones) with an account of the limiting factors as expressed by local producers--is very helpful in proposing relevant, feasible, and adoptable aid programs.

System R. This system mainly includes poor community members (comuneros) who own a very small agricultural plot (0.5 to 5.0 hectares) in the lower part of the Piura and Chira Valleys. Most are members of the Catacaos, Sechura, Colan, Amotape, and Tamarindo communities. The majority grow cotton as a cash crop on their small fields (algodonales) and intercrop some foodstuffs (pan llevar). Low cotton prices on the international market coupled with the small size of fields make for a low income and a very poor economic status among most of these peasants. Obviously, many poor peasants raise livestock--pigs, sheep, goats--for additional food or cash. Nevertheless, their goat herds are typically

rather small. Three factors limit herd size and determine other of system R's features (see Table 4.1).

The first factor is unavailability of natural pasture in the nearby despoblados. System R herders reside in the lower part of the agricultural valleys, which are surrounded by bare plains. (See Figure 2.5 and Table 2.1--ecozone A, 30 mm rainfall/year.) Natural pasture, which is mostly important during the agricultural growing season, is practically non-exisent here. This drastically limits goat production.

A second limiting factor is the household's continuous need for cash. The family's main source of income--cotton--is seasonal, very limited, and requires a prior investment, e.g. in seeds, fertilizers, etc. These economic conditions impose a constant pressure on the campesino--especially given the almost absolute absence of credit sources for this socioeconomic class. Livestock serve, as a principal "cash-generator" for these peasants. I.e. livestock are a source of agricultural credit. These economic considerations strongly affect marketing strategy (in particular, offtake timing) and drastically restrict herd build-up.

The third factor greatly affecting this production system is the agricultural organization and the resulting limited access to stubble resources. Under the environmental conditions of this system, cotton stubble naturally comprises one of the most significant seasonal sources of forage for livestock. The fact that the agricultural land is divided into small, individually-owned fields prevents the efficient utilization of stubble.

These three factors are the main determinants of: the small size of herds; their low productivity, as evidenced in the late age of first kidding and the low number of kiddings per year; and the common marketing strategy of selling goats of varying ages, especially from January to March, when cash is required to start the cotton season. The principal kidding time in this system (December to March) is determined by the availability of nutritious cotton stubble five to six months earlier. Goats are the preferred livestock here because they service and produce relatively well under harsh conditions. Milking is not practiced because it interferes with the development and survival of young kids.

Supplementing the goats' poor diet with purchased fodder--concentrated feed or cultivated forage--is not feasible because of the campesinos' economic status. The only diet improvements are algarroba (pods of the algarrobo Prosopis juliflora), which are gathered around the fields and irrigation canals by children, and weeds carried from the fields. The algarrobo also provides a nutritious mast (puno) which, along with roadside plants, maintains the livestock during the growing season. System R goatkeepers do not migrate in search of better pasture, both because they must stay near their fields most of the year and because the family head is frequently absent for long periods of time, seeking wage labor in the cities. Apart from providing cash, goats make an additional contribution to agricultural productionin the form of manure. Goat manure is extensively used as a fertilizer, not for its quality so much as for its ready availability and cheapness.

System S. This system is also practiced by peasant members of communities (comuneros); however, its stucture and function are noticeably different from R's. System S is found where pasture is available all year 'round and adequate conditions for agriculture exist. Most of these comuneros own a small to medium-size farm. Their land is located near descending tributaries on mountain slopes. This land is not well suited for intensive agriculture. Therefore, it has never been the object of serious hacienda encroachment--as was the case in the lower parts of the valleys. And, comuneros still control enough of the means of production--water and land--to live decently off their fields. Larger farm size and yearround availability of water constitute the main agricultural differences in System S as compared to R. The high availabilty of natural pasture on nearby rangelands and a different household economic base also make for significant differences in livestock raising between the two systems. Livestock--cattle, sheep, goats--here serve as a secondary source of income, which is basically used to elevate the standard of living. For instance, this income may be used to finance higher education for children (in a nearby city), cover health care expenses, or help children who have migrated to the cities. Many System S campesinos also own a house in the city, purchased with revenues from livestock sales. Livestock, in particular goats, also function as a means of saving capital as well as the main source of meat for household consumption.

The principal limiting factors in this system are not forage and fodder; these are plentiful in the nearby dry forest and from agricultural residues. The moderate to large herd sizes and the good productivity (early kidding age, two kiddings/year under regular conditions, and the occurence of kidding all year round) are all tangible testimonies to the favorable enviroment. In fact, herd sizes actually increased during the severe drought of 1982. This indicates not only that natural pasture is quite plentiful, but also that the economic state of most of these peasants is good enough that they have not been forced "to cut into the live meat"--to sell producing goats--in order to maintain their household during the drought. This production process does not require much capital investment; and even if the producer has such capital, he definitely prefers to invest it in the cropping enterprise or in purchasing more valuable livestock (cattle). Migration in search of pasture is not necessary in this region.

Goats are not milked in this system, since almost every family has a milk cow to supply their needs. Absence of economic pressure releases the campesinos from marketing young kids or even having any regular marketing pattern (Table 4.4). Timing of sales is therefore irregular and is mainly determined by incidental cash needs. The fact that most goatkeepers in this region are not compelled to sell young kids explains the near-complete absence of goat kids' meat from the regional slaughterhouse (Morropon and Chulucanas) records (see Ch. 6).

More serious obstacles to improving goat production in this system are predation by mountain lions (puma or leon) and an insufficiency of time and labor, which are mostly expended on the agricultural enterprise. Interestingly, campesinos do little to prevent predation; e.g., they let herds graze without the supervision of a shepherd. It seems as though they take predation as an inevitable part of goat raising in this area. They are also limited in available personnel to tend the herd since most of the family is occupied in cropping tasks. Some livestock owners hand

over goats to the few "pure" pastoralists in their communities and share the annual kid production with the caretaker. This custom is known as al partir. Disease and abortion in the cold season also take their share of the herds, although their overall impact on productivity is not very high (Table 4.2).

System T. This system is exclusively practiced by members of agricultural cooperatives located in the main river valleys of Piura. For these peasants, their monthly salaries and yields from the private plot allocated to them by the cooperative are the major subsistence sources. Livestock, primarily goats, are here seen as savings or investments which carry "interest" (banco de corral--the corral bank). Small herds, relatively low productivity (a single kidding/year), and limited management are good indicators of the marginal importance of goats for these peasants.

Most goatkeepers in this group reside in large villages near the agricultural fields. This introduces an additional managerial problem--shepherding. Stockowners worry that goats will damage neighbors' fields. They also fear rustlers, whose activity is facilitated by the good roads connecting the agricultural villages with the main highways. These considerations compel peasants who want to invest in the banco de corral to find a permanent shepherd. A child, an elderly relative, or a hired worker (peon) can solve the problem. Many campesinos replace their goats with a few stabled cattle or altogether give up raising goats in a densely populated agricultural environment.

Certain features of goat husbandry are shared by most System T practitioners. Goats are milked here during the most productive months of the year (July through November, when cotton stubble is available), but only after the goat kids are weaned. Milk is primarily consumed at home since most families do not own a milk cow. Supplementing goats' diet with agricultural residues is quite common here since most peasants have access to many agricultural crops. In fact, some people even grow cultivated forage (elepnant grass, sudan grass) on their private plot. However, no concentrates are purchased, although production could be improved significantly. As agriculturalists, these goatkeepers do not migrate with their livestock, even in years of abundant pasture in the nearby despoblados. Nonetheless, mechanisms of livestock transactions and production sharing (al partir) have evovled between farmers and pastoralists in order to ensure mutual access to scarce or desired resources once enviromental conditions change.

Aside from occasional household needs, the major determinant of marketing strategy among these peasants, is children's return to school (March through April). At that time, considerable expenses are imposed on the household budget (uniforms, supplies), especially in large families.

The major limiting factors in this system are the shortage of labor--which is mainly invested in the cropping plot or in the cooperative's tasks--and the fluctuating climate in this region (mostly within ecozone B), which makes for uncertain forage availability. Access to stubble fields, although controlled by the group as a whole, may involve substantial costs as described earlier.

System U. This system is mostly practiced by agricultural wage laborers (eventuales) residing in the villages along the river valleys of Piura. Although System U goatkeepers may be neighbors or relatives of peasants in the previous group, there are some significant economic differences between them, which directly affect goat production and management.

Only a few of these campesinos have managed to acquire an agricultural plot or to enjoy a relatively permanent source of income (e.g., sharecropping). The majority are temporary wage laborers who are continually looking for complementary earnings. Their economic base is definitely weaker than that of cooperative members. It is not surprising, then, that eventuales pay more attention to their livestock operations in hopes of obtaining much-needed cash or food.

An eventual's herd averages about twice the size of a cooperative member's. Most probably, the difference has to do with the former's stronger economic need, as well as the greater availability of labor in his family members. E.g., unlikecooperative members, women and children are not occupied in working the private plot. Economic necessity also motivates System U campesinos system to market milk and cheese, which their socio neighbors usually do not.

In this system, goats kid an average of twice a year--as compared to single kiddings in the operations of most cooperative members. This may be due to the closer attention herds receive. The importance of milk and the availability of family members who can gather supplementary forage or herd the animals to farther pastures are, most certainly, the reason for goats' higher production and productivity in this system. However, these goatkeepers have no capital for purchasing concentrated feed or providing veterinary care. This restricts overall productivity and production.

No clear regularities in marketing characterize this system. The volatile economic status of most of these families accounts for this irregularity. Sudden requirements for cash--e.g., for regular household maintainence, health problems, celebrations--make any planned marketing strategy unrealistic. Kids or adult goats are usually sold when the need arises since these poor peasants usually have no other savings for emergencies.

Like some of the socios, these goatkeepers are affected by the rental fees on stubble grazing imposed by the agricultural cooperatives (the owners of most large agricultural fields) and by the drastic fluctuations in the availability of natural forage on nearby despoblados. Eventuales are likely to pay rental fees regardless of the cooperative's policy for socios. (See the previous discussion on land tenure systems.)

More complaints about disease and mortality were recorded from goatkeepers in this system than from their neighbors--the cooperative members. Their complaints were also stronger, owing to such factors as the greater economic significance goats have for them, the lack of funds to purchase medicine and vaccines, and the crowding in their corrals.

System V. This is one of four systems with a "purer" pastoral character. Almost all campesinos in this system maintain their household principally by selling goats and kids. They inhabit a large area, mostly in ecozone B (Figure 2.5), where rainfall induces sharp variations in

pasture, both within years (seasonality) and between years (drought vs. abundance). Only rarely does enough precipitation occur to allow planting of fast-growing crops in flood-fed plots.

Productivity is largely determined by pasture availability and may vary considerably from year to year because of the capricious weather of Piura. In good years, for example, goats give birth twice a year, but under dry conditions only one kidding occurs (Table 4.2). Because of lack of pasture in the depoblados during the dry season (July through November), many herders are forced temporarily to migrate to the agricultural region, where they take advantage of the cotton and rice stubble. Acquisition of grazing rights and livestock transactions based on social, political, and religious interactions are local adaptive mechanisms that herders and farmers have developed in response to the erratic climate. A severe drought may force herders to migrate to the cultivated valleys for longer periods, and some may decide to settle down there, although if they do so they most probably retain their herds.

Average production and productivity figures in this system may not drastically differ from those in the previously described, well-managed herds. However, the deviation from the mean, is much more noticeable here because of greater exposure to fluctuating weather. The data presented in Table 4.2 (e.g., kidding rates), Table 4.3 (supplementing with concentrates), or Table 4.4 (decrease in herd size) mainly reflect the drought conditions which prevailed during 1982, when most of the survey took place.

Selling goat kids provides these herders' main income. Also, when green pasture covers the despoblados and the herd produces much milk, partly dried cheese becomes another marketable commodity. The age of kids marketed or the marketing time is largely determined by annual climate. Drought forces the herder to sell as soon as possible before starvation increases mortality. In abundant years, kids are allowed to grow and gain weight in order to bring better prices in the marketplace. Only enough male kids to cover daily household needs are sold during this time. Herd size in this system fluctuates considerably between years, and reflects the herders' "survival strategy." In dry years, herd size decreases due to lower productivity, higher mortality, and economic pressures; during the drought of 1982, herders in Piura lost an average of 40 to 50 percent of their livestock. In abundant years, when kid production is high, herds are builtup again while sales are kept minimal in order to enter the next drought with a large herd and to finish it with enough animals to "stay in business." (Ch. 6).

As already mentioned, access to agricultural stubble and residues is crucial for herders in this system. The agrarian reform had a significant impact on their operations. The imposition of rental fees on stubble grazing by the new landlords--the agricultural cooperatives, the exposure to competition with ranchers (engordaderos) over green forage and the destruction of woody vegetation by firewood merchants (lenaderos)--are all post-reform conditions with which the herders must cope.

There are a few factors which limit production and productivity in this system. First, the fluctuating weather, and especially the impact of very dry years on pasture and water availability, is obviously a limiting factor on production and a determinant of management practices

or marketing strategy in this region. Capital availability--or more appropriately in this context--unavailability capital is another significant limiting factor. Capital may help in coping with drought since it allows (or prevents) supplementing the herd's diet with costly concentrates like cottonseed meal or corn. Labor could also be a problem once the herd is transferred to the agricultural area, where careful shepherding, as well as dairy processing, demand workers hands. In the despoblados, on the other hand, goats are usually left to graze alone, and the women can milk and prepare cheese while performing household chores. Older ganaderos or young families are obviously more susceptible to labor problems.

System W. This production process is carried out under more favorable conditions--ecozone D, Figure 2.5--than any of the other pastoral systems. Higher and more reliable precipitation support dense vegetation in this region and the yearround availability of forage mean that herders need not migrate in search of pasture. Nevertheless, very dry years may occur, and these leave their mark on herd size. Average herd size is significantly greater than in the other systems--an indicator of the favorable enviromental conditions, as well as of the prudent management of natural resources exercised by the grupos campesinos who control most of this region. Livestock density is such that overutilization of rangelands has not yet occurred, mainly because of the emigration of both wealthy and poor herders to the cities. Severe droughts, which occur once every five to ten years, serve as a catalyst for such migration. Very successful herders may move to the cultivated area and convert their capital livestock to agricultural land; people whose herd size has fallen below the subsistence level also move to the same agricultural area in order to work as wage laborers. A similar pattern of migration has also been observed in Iran (Barth 1964).

Productivity is relatively high here, and cheese is marketed almost every year during the milking season if green herbaceous grass is available. Fresh milk is not usually sold because of the distance to markets and lack of transportation. Dietary supplements are given only during severe droughts. Even then, the common fodder is rice straw (paja de arroz), a cheap and nutritionally poor feed purchased in the agricultural area. The exchange of rice straw for goat manure was observed in some cases. Male goat kids are marketed when they reach an adequate weight, at about 12 months. School expenses in March trigger additional livestock sales. Shepherding is usually not practiced here.

Several factors may limit herd performance and size in this system. Production is partly constrained by dry conditions; however, droughts are infrequent in this ecozone. Predation by mountain lions is a serious problem here since in the dry season goats graze on the slopes of the hills, where the predators are very common. Diseases and abortion also take their toll especially in the cold season. Intoxication by poisonous plants--in particular the borrachera (Ipomoea carnea), a drought-resistant shrub which keeps green leaves even when all other plants are dormant--is also a limiting factor in this system. Its green foliage attracts livestock, in particular young ones, and the toxic substance causes them to fall and hurt themselves or to lie in the sun and become dehydrated. By and large, production and productivity in this system are high, and the combined effect of all these limiting factors is relatively small except in a very dry year.

System X. This system includes peasants living in the despoblados of Pabur and of western Olmos in the department of Lambayeque. Ecologically, the region belongs to the dry, highly variable climatic belt (ecozone B and the western part of ecozone C) of Piura. Politically, pasture land in Olmos belongs to the peasant community Santo Domingo de Olmos, so most ganaderos are community members. In the region of Pabur, the range is owned by cooperatives from the upper Piura Valley and by private ranches (Ganaderia Amazonas) which use it for raising cattle but let the goat herders live on and utilize it. Almost none of the ganaderos in the Pabur region is a cooperative member, but many work as cowboys for the cooperatives as they did for the pre-reform haciendas). It is interesting to note that when the Ganaderia Amazonas was founded in 1972, an effort was made to forbid goat raising in the region. The pasture was fenced, and ganaderos were asked to move out of the fenced area, even if traditionally they had lived on and used these sites. Only a local court decision plus political support from strong campesinos' organizations allowed the herders to remain (Ch. 7).

Production and productivity in this area are quite similar to system V and are highly dependent on weather fluctuations. The main difference between these systems is in herd migration to stubble fields. The proximity of the large cotton fields of Rio Chira to the despoblados of Sullana makes it easy to migrate when necessary. However, the agricultural land in the upper Piura Valley is less suitable for grazing. Some of it is medium-size fruit orchards, some is owned by peasant communities and is not available for leasing, and the large fields of the cooperatives are first used by the herds of their own members and wage laborers. There is less cotton--an excellent source of nutritious stubble--grown in this area because of water shortages. Agricultural residues or byproducts are also scarce (Table 4.3).

In the Olmos region there are no large agricultural fields to support seasonal migration. The fact that many people, especially in the Pabur area, have permanent jobs as ranchers also discourages long-distance movement. In Olmos many ganaderos complement their income by cutting and selling firewood from communal lands.

Marketing is another problem for the many herders who reside in remote hamlets in this sandy region. Transportation is very poor and only producers near the Pan-American Highway can market cheese in the cities of Olmos, Lambayeque, or Chicalyo; they use drivers employed in public transport as middlemen. In many cases, goats and kids have to be brought to the main road in order to ship them to urban markets. The timing of marketing and the age at which livestock are marketed is greatly determined by pasture availability and household needs.

Indiscriminate tree felling, whether carried out by local campesinos or by outsiders with strong political influence on the community (Soplopuco 1982), considerably hurts livestock production. Not only is important fodder like dry foliage and algarrobo pods removed from the system, but also the only source of shade, an essential in dry-tropical livestock production, disappears.

System Y. This production process sociopolitically is quite similar to the previous one, but its proximity to the mountains generates more rainfall, which occurs in a more reliable pattern. As a result, pasture

availability here is higher, and many peasants succeed in growing maize and beans on rain-fed plots every other year.

Productivity is slightly higher in this region due to greater pasturage a function of the better precipitation regime) and the availability of cropping residues (Table 4.3, supplementation). Still, local herders do face some bothersome problems. Marketing, for instance, faces the same obstacles as in the neighboring system: distance from the marketplace or from the main roads and lack of transportation. Another problem these peasants face is competition for natural forage by non-community members, especially in years of abundant pasture. The competitors are usually wealthy ranchers who acquire grazing access by paying rental fees to the community authorities. Their cattle are then driven to the open range where they rapidly consume the forage which otherwise could serve the local herds for a longer time. Needless to say, in most cases the fees paid to the community are not invested in improving services in the villages most affected. Before any attempt to improve pasture is made in this system, one must ask who will be the ultimate beneficiaries--peasants with small goat herds or wealthy ranchers? The grazing areas' proximity to the mountains again exposes goats to predation.

System Z. This production process is completely different from any of those previously described. This is a semi-intensive process, characterized by much capital investment, intensive labor input, and utilization of resources other than natural--as opposed to the previously-described systems, which are very extensive, use little capital, and rely on natural forage as the principal, if not sole, source of fodder. The main product of this process is fresh milk, whereas the other systems are focused on kid production, with some seasonal cheese production as well. System Z is usually found on the outskirts of cities, close to the potential market, rather than in remote areas. It is usually practiced by private entrepreneurs, mostly middle-class, educated, and socially and politically well-connected individuals--although there are some peasants who successfully pursue a similar enterprise.

There are some unique features to this production process. First, the herd is stabled part-time and fed with cultivated forage (elephant grass, sudan grass, etc.) and/or concentrates (cottonseed meal, corn). Herds are large and well attended. Capital is invested not only in feeding but also in housing and feeding facilities, veterinary care, and experienced labor. If nutritious stubble or natural pasture is available, the herds will spend a couple of hours grazing. (Piurans commonly believed that even if grazing does not add to the goats' diet, the activity on the open range nonetheless improves milk production.) After the rainy season, herds are brought to the nearby despoblado to take advantage of the green forage. Productivity and production are high in comparison to all other systems, and are also much more controlled (kidding control, weaning).

This system is labeled semi-intensive, not intensive, because a large part of the livestock diet still comes from natural or agricultural resources and therefore depends to some extent on weather conditions. The significance of this fact is evident in the decline in herd size during the drought of 1982 (Table 4.3). The reasons why more capital is not used to cope with natural difficulties are the low profitability of

these enterprises and the scarcity of credit. Since the price of milk is controlled by the Peruvian government and since production costs are high (especially veterinary care and feed enriched in protein), producers cannot invest more in feeding; instead, they must rely, at least partly, on natural resources. In other areas of Peru like Cajamarca or Arequipa, the dairy industry is quite successful due primarily to milder climate, improved pasture (grassland), and intensive pasture cultivation (mostly alfalfa).

Goat kids are sold at a young age (cabrito de leche) in order to save as much milk as possible. However, they are allowed to suckle for a month or two to gain some weight. Then, they are either consumed by the producer's family or sold in the urban market, where such meat is highly prized.

The chief limiting factor in this production system is the high cost of supplemental food. Since most of the concentrates (cottonseed meal, corn) are quite expensive and sometimes only irregularly availabile, the producer usually finds himself in a conflict between better management and actual profitability. The fact that the price of milk is controlled by the Peruvian government while the costs of production continue to soar does not help stockmen to optimize their milk goats' production. The high cost of medicines, scarcity of credit, and low availability of experienced workers are also significant constraints. Nevertheless, producers in this system are by and large very successful, in spite of the labor burden and the economic risk.

Local officials and scientists (e.g., Mendoza 1978, Piqueras 1981) have suggested that this semi-intensive, goat-milk producing system could serve as a model for developing the other goat production systems in Piura. For various reasons this is not the case, however. A peasant household, which is the core of production in extensive systems, lacks the surplus labor to practice an intensive system, particularly if the same family is also engaged in cropping. It also lacks any access to credit sources--both because the illiterate campesinos are generally, reluctant to deal with banks and documents, and because Peruvian credit institutions use land titles as a security guarantee, yet most goatkeepers do not have any such title and would refuse to put their herds in the bank's hands.

Markets and marketing are another problem. There is only a limited urban market for fresh milk because of the poor economic status of most people and also because of the availability of cheap canned milk. Transportation of milk from the despoblados is another obstacle. But on top of all the other difficulties is convincing peasants to cease raising goat kids under conditions which are very convenient and profitable and suit the erratic environment, and to start relying instead on the more vulnerable and labor/capital intensive process of milk production.

CONCLUSIONS

Two principal conclusions can be drawn from the study of goat production systems in Piura, Peru. The first is that human factors--economic status or alternative sources of income and sociopolitical considerations such as land tenure and control over resources--not only significantly affect the structure of the

agricultural production process, but also help determine some of the quantitative characteristics of this process. The second conclusion refers to the real complexity of classifying indigenous agroecosystems. Even taking a regional standpoint and concentrating on one production line--goat raising--does not simplify the task. Only a "complete analysis," including environmental, biological, and socio-political aspects, can generate a more realistic account of the spatial distribution of different production systems. An analysis of survey data from some 200 goat herders in the dry, tropical lowlands of northern Peru helps to establish these claims and to demonstrate an application of the multi-dimensional approach.

I suggest that the study of traditional agricultural systems, and particularly development-oriented research, should not exclude either human factors or regional complexity. A classification and diagnostic study, possibly following the general lines of the one presented here, is an essential prerequisite for further scientific analysis or for successful application of any aid program, even to a seemingly "simple" or unilineal production process or an apparently homogeneous environment. The ultimate test of whether a proposed diagnostic method is helpful in "visualizing" the structure, dynamics, and boundaries of an agricultural system, is its ability to provide an unambiguous basis for improvement (Spedding 1975:29). Only by correctly defining production processes and their related constraints --internal or external, biological or human, permanent or temporary, deterministic or probablistic--may a partial answer be provided to the fundamental question: "Why do peasants do what they do?"

CHAPTER 5

FARMER/HERDER INTERRELATIONSHIPS

This chapter explores relationships between farmers and herders in Piura. The ethnographic literature identifies two very distinct forms of integration between animal husbandry and cropping. The first is found in "mixed subsistence systems" where each household practices both modes of subsistence independently of other households, although pasture land may be communally held. In most of these cases the livestock operation is limited by labor and capital shortages (Vincze 1980), and household resources are consciously and preferably invested in the agricultural enterprise. (Indian communities in the Peruvian highland are a good example of this type of integration; McCorkle 1983.) In the second model, each economic activity constitutes a distinct "subsistence type" which is usually characterized by distinctive social and cultural traits. Farmers and herders are seen as competitors for limited resouces or as rivals with contrasting needs. Conflict rather than integration is assumed to take place regularly. Interactions are limited to the exchange of products produced in one system which are required by people following the other system, e.g., grain and meat.

Although many Piuran agriculturalists do raise some livestock (Ch. 4, Systems A-D), a clear geographical and occupational division can be drawn between the cropping and herding sectors. However, the relationship between these two sectors is not so much one of competition and antagonism as one of sharing and cooperation. This chapter describes these interactions and provides an ecological explanation of their evolution.

In particular, two common assumptions about farmer/herder relationships are examined. The first is that the two subsistence strategies are independent production systems, i.e. that one contributes little to production processes in the other, although goods may be exchanged between members of the two systems. The second assumption is that the populations of each system are disengaged demographically. Agriculturalists and pastoralists, it is claimed, rarely share the same ethnic origin; or if they do, a long process of spatial and cultural separation has divided them demographically. Farmers are supposed to be sedentary, living near their field, while herders roam after their livestock in deserts or other marginal areas. Migration from one system to another, inter-marriage, or other strong social ties across system boundaries are rare.

Two principal points are established in this chapter: intensive demographic exchange does take place between farmers and herders in Piura; and extensive production-related interactions do occur across the two sectors. There is a net of social, cultural, and economic interactions, which facilitates demographic and resource flows between the systems. These findings are examined in light of certain characteristic environmental features of Piura which directly affect economic and subsistence activities in the region.

Demographic Exchange

Analysis of life histories of farmers and herders in various regions of Piura reveals extensive demographic exchange between agricultural and pastoral sectors. Many present-day goatkeepers were once farmers; others are descendents of agricultural forebears. Similarly for farmers; many farmers or their ancestors migrated from the *despobladoes* and substituted cropping for animal husbandry. Some typical life histories exemplify this demographic pattern.

Don JCP was born in the agricultural zone of Bajo Chira near the farmer hacienda of Santa Sofia. His father was a wage laborer (*yanacona*) on the estate and JCP joined him for some years. During the winter of 1953, JCP lost his job when the Rio Chira overflowed and flooded the hacienda's fields. The landlord lacked the capital to restore his operation, so JCP, like many of his friends, had to find another way to make a living. He left his family in the village of Alto Grande near Santa Sofia and went to the *despoblado* of Mallares to cut lumber. He settled in a small village (*caserio*) where his brother and some relatives lived. Like all people in this region, his relatives were goat herders but JCP owned no goats at that time. After a number of years, he decided to marry the widow of one of his cousins (although he did not divorce his first wife). By virtue of this marriage, JCP became co-owner of a large herd, a well, and a temporary agricultural plot (*roso*). Today JCP is still living in the old house of his late cousin and making his livelihood by herding goats. His married son and daughter live in separate houses nearby.

Don FZS is 54 years old. He was born in Tomapampa on the fertile banks of Rio Quiroz near the road to Ayabaca. He inherited an agricultural plot from his father and grew fruit trees, mainly lemon and cacaco. He also owned a few head of livestock; but because his primary occupation was agriculture and because of predation by mountain lions his herd was small. In 1965 severe floods washed away part of his plot, but he managed to resume cultivation on the remainder of the land. Nevertheless, he was forced to rely more heavily on livestock in order to meet his family's needs. 1972 brought FZS's agricultural operations to an end when a second flood carried away the rest of his plot, leaving him with no cultivable land at all.

After working for a few years as a share-cropper, FZS took his family and his still modest goat herd and settled in Palo Blanco, 30 km west of the Quiroz river in the *campos* (rangeland) of Las Lomas. Water resources in this area are insufficient to support intensive agriculture, so most *campesinos* subsist on goat herding. FZS arrived in the *despoblado* with 60 goats. Abundant pasturage during 1976 helped him double the herd after only one year; a year later, the herd had grown to 200. But in the relatively dry years of 1981 and 1982, FZS started to lose goats. He decided to sell some of his producing does and purchase milk goats of Anglo-Nubian origin and some sheep. This new herd, however, is kept penned at the house of relatives of FZS in the agricultural zone. FZS also

opened a small grocery store in the hamlet (caserio) where he still lives.

Don SPS is an old ganadero who has lived for many years in the despoblado of Sullana. His grandfather, however, was born and raised in the agricultural community of Tamarindo in Bajo Chira. But several lean agricultural years, lack of water, and a shortage of wage labor drove the grandfather to try his luck on the other side of the department, in the campos of Hacienda Jahuay Negro. There he met the daughter of a well-to-do ganadero, married, and received a herd of goats as dowry. With this herd, the couple started their new life. SPS's father was born in the campos of Jahuay Negro; he maintained his family by goat raising and rainfed cultivation. SPS left Jahuay Negro with his family when his older brother was caught by the police and was accused of being a bandit. The frightened family left Peru and settled in southern Ecuador. But in 1936 they returned to Peru because the old mother wished to die in her homeland. SPS worked for a couple of years on the agricultural estates of Bajo Chira. In 1945, torrential rains in the despoblados of Sullana produced an exceptionally abundant cover of vegetation. In this area, the lower (western) despoblado of the ex-hacienda Mallares was sparsely populated, so SPS moved his home and his herds there. Although he married the daughter of a farmer from the community of Colan in Bajo Chira, he has remained a goatkeeper ever since. He is still living in the same place but his wife and children have left the campo. He himself dislikes life in the city, preferring his modest hut and precious livestock.

The counter demographic trend--movement from the despoblados to the agricultural area--is also significant. Although it largely lies beyond the scope of this study, some intriguing information does surface in the life histories of ganaderos. The pastoralists of the despoblado seems to contribute consistently to the agricultural population. The average size of a pastoral family is seven (the mean of 205 families surveyed). Of these seven, only one or two children remain in the despoblado and carry on their father's tradition of goat raising. The others migrate to the cities or the agricultural areas. Those who go to the agricultural areas sharecrop or work as wage laborers. They own only a few head of livestock and soon become absorbed into the cropping culture. Occasionally a former ganadero succeeds in acquiring a piece of land and becomes an independent farmer. Many of the immigrants who moved to the agricultural zone before the agrarian reform later became members of the new agricultural cooperatives.

Don PRQ was born of a family of ganaderos more than 50 years ago and has been a goat herder all his life. In 1941 he left the small caserio where he lived with his parents and built a house for his family in a more remote part of the despoblado. In 1951 a drought struck the region, leaving it so barren that Don PRQ had to take his family to Mallaritos, an agricultural village in Bajo Chira. 1953 was a very rainy year and PRQ returned, with his family and herd, to the old hut in the despoblado. 1964 was again a very dry year and PRQ was forced to move--this time to the village of La Noria. But in 1965 he went back to the campo to take advantage of

the exceptional forage which sprouted there following a stormy winter.

To summarize, these life histories imply an on-going demographic exchange between the pastoralists of the despoblados and the sedentary population of the agricultural area. Lean years in agriculture (drought, floods, lack of wage labor) force some farmers to seek their fortune in the despoblado. On the other hand, dry years, lack of pasture, or population pressure drive ganaderos out of the despoblado to the agricultural valleys.

Production-Related Interactions

"Relations of production" here refers to any contribution by one subsistence system to production processes in the other system. Agriculture can contribute much to livestock production. Agricultural stubble, residues, or by-products are used as fodder in many livestock systems. In developed countries this transfer of agricultural materials to livestock operations takes place through elaborate industrial and marketing channels. In less developed countries however, even when such an industry exists, the products are too expensive for most small livestock producers.

Goat keepers in Piura--especially those in the more drought-prone areas closer to the coasts--have traditionally migrated to agricultural fields during the dry season. In dry seasons or years, stubble fields are the only refuge for despoblado herds. As Chapter 7 will show, the agrarian reform led to drastic changes in land tenure in Piura, and these in turn affected ganaderos' access to stubble fields. Nevertheless, the importance of stubble fields for goat production in the despoblado has not diminished. These fields are especially critical in dry years. The agricultural area is also a source of cultivated forage residues such as rice straw and corn stalks, and by-products from cotton like cottonseed meal and seeds.

Migrating from the despoblado to the agricultural region is logistically complicated. Aside from the problem of acquiring access to pasture (see Chapter 7), the ganadero must also find living space for himself and, in many cases, for most of his family, since his stay may last several months to a year or more. A corral is also required for any livestock operation, especially when there is danger of rustling. In many cases the ganadero needs some assistance in herding, in processing or marketing dairy products, or in guarding his animals. Personal contacts and acquaintanceships with farmers can greatly facilitate migration and help solve many of the logistic problems. Figure 5.1 displays the general pattern of such migration. The accompanying Table 5.1 details specifics of individual herders' migration to agricultural areas and their personal contacts there.

While the ways in which agriculturalists can assist migrating herders are obvious, what do pastoralists provide in return? The answer is that they oversee farmers' goats in the despoblados in abundant years, thus allowing agriculturalists access to a resource they could

Figure 5.1

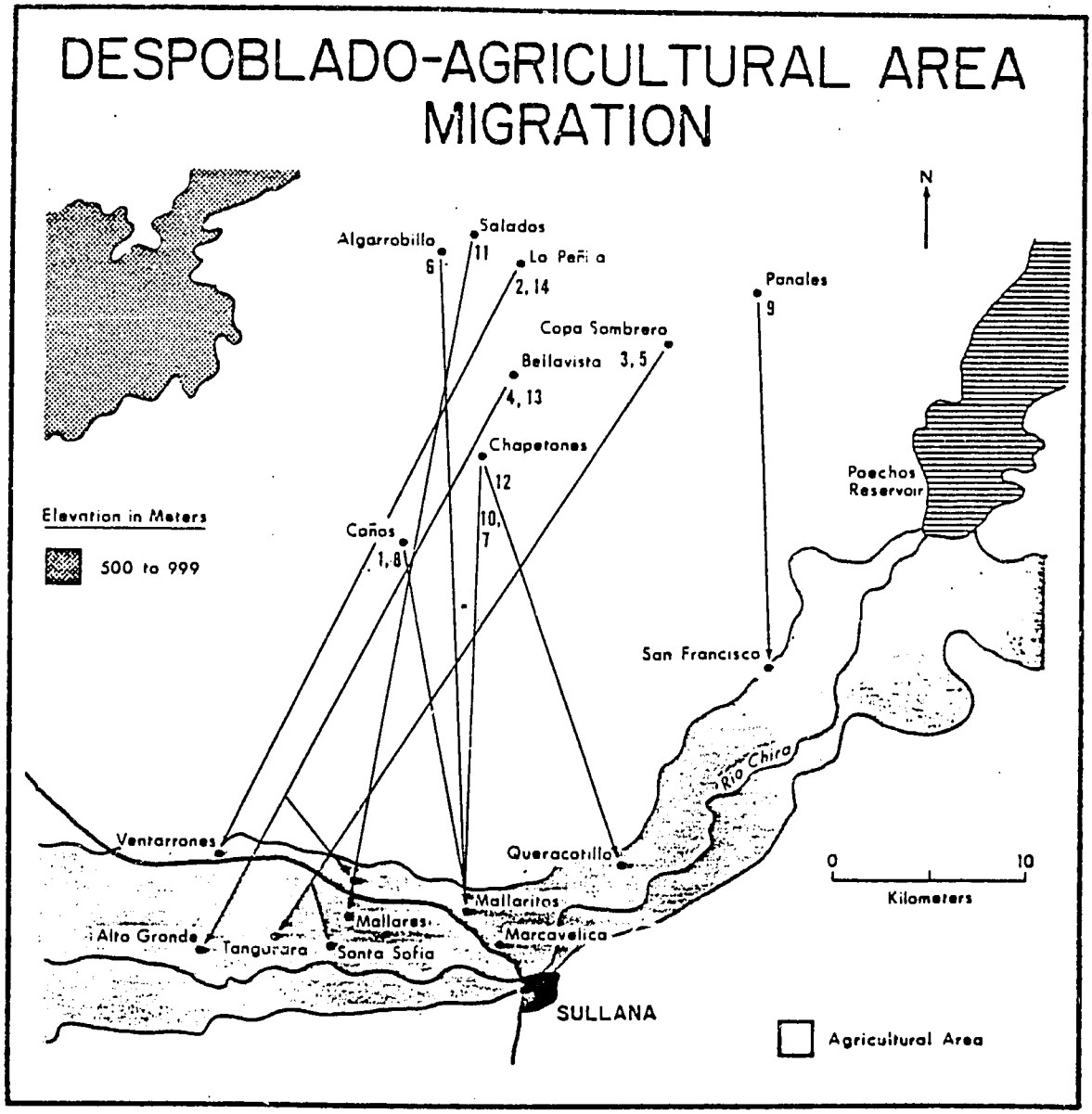

DESPOBLADO-AGRICULTURAL AREA MIGRATION
N
Algarrobillo
6
Salados
11
Lo Peñi a
2, 14
Copa Sombrero
Bellavista
3, 5
4, 13
Chapetones
12
10, 7
Caños
1, 8
Panales
9
Poechos Reservoir
Elevation in Meters
500 to 999
San Francisco
Río Chira
Ventarrones
Queracotillo
Mallaritos
Mallares
Alto Grande
Tangurara
Santa Sofia
Marcavelica
SULLANA
0
10
Kilometers
Agricultural Area

TABLE 5.1
HERDERS' MIGRATION TO AGRICULTURAL AREAS

Number on Figure	Migrating From	Migrating To	Date of Migration	Temporary(T) or Permanent(P)	Relations in the Agricultural Area
1	Canas	Mallaritos	August 1980	T	cousin
2	La Penita	Ventarrones	Sept 1979	T	relatives/compadre
3	Copa Sombrero	Tangarara	June 1980	T	uncle
4	Bellavista	Alto Grande	August 1981	T	relatives of wife
5	Copa Sombrero	Snata Sofia	August 1982	T	brother/cousin
6	Algarrobillo	Mallaritos	July 1979	?	brother
7	Chapetones	Mallaritos	August 1982	P	son
8	Canas	Mallaritos	August 1982	T	compadre
9	Panales	San Francisco	August 1980	P	own house
10	Chapetones	Malleritos	August 1982	T	relatives of wife
11	Salados	Mallares	July 1982	T	son's godfather
12	Chapetones	Querocotillo	August 1981	T	friends/compadre
13	Bellavista	La Nonia	July 1981	T	wife's parents
14	La Penita	Ventarones	Sept 1981	T	compadres

not otherwise exploit. The importance of goat raising for peasant farmers has already been discussed in Chapter 4. The limiting factors on goat production in the agricultural zone are seasonal lacks of forage and family labor shortages. In good years the despoblado turns green and produces a surplus of pasturage. In rare cases the agriculturalist or part of his family migrates to the despoblado to take advantage of this natural bounty. Then, they need the same logistic assistance as the ganadero who migrates to the agricultural zone. In most cases, however, farmers lack the time or personnel to move to the despoblado, so they instead leave their small herds with familiar and trustworthy ganaderos.

The notion of cooperation and mutual assistance in production has already been introduced in some of the preceding life histories; additional histories are instructive.

FZS is a ganadero who struggles to maintain his livestock on very dry pasturage with an inadequate water supply. To solve part of this problem, he replaced his meat-producing goats with a milk-producing breed, which he keeps at a relative's farm in the cultivated area near Rio Quiroz.

SPS is a ganadero who cannot migrate to the stubble fields because of labor problems--he is too old and all his children have left home. In consequence, he has divided up his goat herd to be cared for by various relatives and compadres[1]. With his daughter, who lives in an agricultural village in Bajo Chira, he left ten goats and two sheep; eight goats and a few more sheep were entrusted to a nephew in Alto Chira; and another share was given to a nephew in the San Lorenzo area. Dividing up one's herd in this fashion due to hard times is called tener las semillas 'haying the seeds'. The expression refers to maintaining a reproductive group for future herd buildup.

PVR is a ganadero who has lived for many years in the despoblado of Sullana. In dry years he is forced to migrate to the agricultural area. In fact, since 1979 he has kept his herd in the village of Mallaritos because the despoblado has been barren. Fortunately, he found living space with a brother-in-law and a corral for his goats with another relative.

JAA is an old farmer who lives in Mallaritos in Bajo Chira. His agricultural plot has long served as the main subsistence source for the family; but goats also constitute a significant share of the family's livelihood. In very good years when pasture is abundant, he always sent part of his family with the herds to the despoblado, where they lived near relatives or good friends of JAA. Between 1935 and 1937 he kept a temporary camp beside his cousin's house in Algarrobillo. In 1945 a compadre invited JAA to live in his house and to use his corrals and well. In 1952 JAA settled near his uncle in Saucillo. Later, his herd decreased, so he decided to leave his goats with a friend with whom he shareherded al partir. The interactions in this case are not one-sided. In dry years, relatives and friends of JAA who migrate from the

despoblado to the agricultural zone receive logistic help from him and access to his fields.

Many settlers in the new colony of San Lorenzo are descendants of pastoral families from the adjacent Las Lomas area. The settlers are very successful agriculturalists, but they maintain close relationships with their relatives in the campo. Here, too, a bilateral livestock transfer takes place. In good years during the green season, herders take care of cattle and milk cows owned by their relatives from the colony. In the dry season and in bad years, goat herds move to the cotton and rice fields in San Lorenzo. An additional interaction observed in this area is the exchange of goat manure for crop residues. Goat dung is a very potent fertilizer not commonly used in agriculture. However, it is very useful in the fruit-tree horticulture which dominates San Lorenzo. In return for the dung from his corrals, a goatkeeper receives rice straw from the farmer. The straw is of no use to the farmers, and therefore normally is just left on the fields. Each side provides transportation for the material he collects; usually they make a mutual deal with a truck owner to take the straw to the herder's house and bring back the manure to the farmer.

Mechanisms Enhancing Farmer/Herder Relationships

A web of economic interrelations between two geographically separated populations requires some effective mechanisms to keep contacts alive. The mechanisms by which farmer/herder interactions in Piura are maintained and implemented are briefly outlined here.

Kinship Ties. As noted, there is a good deal of migration between the despoblados and the agricultural areas in Piura. As a result of these inter-sectorial movements and of the large size of most rural families, many campesinos have relatives in various locations throughout Piura. The social organization of Piuran peasants is based on cognatic kin ties; strong relations are maintained through both male and female relatives. Decisions concerning the nature of relations with individual family members are partly determined by the potential economic assistance those relatives are capable of giving. Temporary migration from one sector to another, logistic help, or livestock transactions are often kin-based.

- For example, Senora Gregoria moved from the barren despoblados of Sullana to the agricultural area of Bajo Chira in August 1981. She oversaw a large herd of about 180 goats, partly owned by her two married children who live in the town. She is separated from her husband and has only one young child to help her. Labor, then, is her main problem in the agricultural zone, where herd supervision is a requirement because of frequent rustling and conflicts with crop-owners. Fortunately, her brother--who is a member of the agricultural cooperative Bentarrones in Bajo Chira--helped her gain access to the cooperative's cotton stubble fields; he also sent his son to help her herd. She preferred to stay with the goats in a temporary camp in the fields in order to avoid the

crowded village. So her brother also helps her sell goats and cheese in his village, and he purchases food for her in the local store. The problem, though, is that cotton stubble is available only from August through November. For the rest of the year (which was so dry that no green forage germinated in the despoblado) Sra. Gregoria must migrate to other agricultural areas where rice or sorghum stubble is available. On this occasion, she applied to a cousin, a member of another cooperative, for help. He provided her access to stubble, plus a large corral where her herd could spend the night.

Compadrazgo/Padrinazgo (Co-godparenthood). Throughout Latin America, this is a very important social mechanism which establishes new ties between non-relatives or enhances existing social or kin relations. In Piura, as in most of Latin America, godparenthood is not practiced only at baptism. Godparents are also named for birth, first nail and hair cutting, sprinkling holy water, confirmation, engagement, and marriage celebrations. Godparents have varying degrees of responsibility for the well-being of their godchildren throughout the godchildren's lives. These relations, which have mainly to do with children, also constitute an opportunity for the parents to establish new social ties or to strengthen existing ones. In many cases, the choice of a godparent is determined by the candidate's economic or socio-political status. Wealthy members of the community, political authorities, and other prominent figures are the most common choices. Before the agrarian reform, the landlord and his foremen were favorite choices. Godparents are not necessarily members of one's own residential area or occupational sector; many goat keepers in the despoblado choose godparents from agricultural areas, while many farmers look to the pastoral communities for potential godparents.

- For example, Don Guillermo sent his goat herd to the agricultural zone of Mallares in August 1982. He himself preferred to stay in the despoblado and earn money felling trees. His young son, Jorge, was given charge of the goats. Jorge's logistic base in Mallares was his godfather's house. The godfather is a member of the administrative committee of an agricultural cooperative. His socio-political status helped the young herder obtain access to stubble fields and cope with difficulties while in the agricultural areas. Doubtless, the godfather's social and political position was a factor in his appointment as Jorge's godfather 16 years earlier.

Private Fiestas. By and large, the most important individual celebration in Piura is a parent's birthday. The nature of the fiesta and the composition of the guest list vary from year to year and from household to household. Most of the guests are kin, but many birthday invitations are also determined by economic interest. Potential partners or people who can lend financial help are among the most important guests. Birthday parties can turn out to be major events.

- This was the case when Senora CST, a resident of Naupe, celebrated her last birthday. Among the guests were many relatives, neighbors, friends, and even some family members who came from as far as Chiclayo. The local policemen were of course also invited, but even they could not prevent the drunken quarrels that broke out. One goat, two ducks, a young hog, a big turkey, and 40 cases of beer (480 bottles) were among the offerings to the guests.

- Other sorts of individual fiestas, too, enter into the picture. Don SFC owns a large milk-goat herd in Marcavelica. Adequate diet is a primary requirement in milk production. Thus, access to cotton stubble is very important. Competition for such access--especially early on in the season--is very keen; bargains, special arrangements, and various types of manipulation are common. In this regard, every year Don SFC holds a big fiesta for the watchmen and administrators of a nearby government experiment station so that later they will allow his herd to graze the station's cotton fields before any other herds.

Although I collected no quantitative data on the flow of fiesta guests between pastoral and agricultural sectors, I suspect that this is an important mechanism in maintaining inter-sectorial relations, too.

Communal Fiestas. Almost every small village in Piura has its own fiesta, usually to celebrate its patron saint. These celebrations may be dedicated to a recognized Peruvian saint (e.g., Santa Rosa or San Martin de los Porros) or to a local shrine famed for miraculous events (e.g., Santa Teresa de Naupe). The fiesta provides an opportunity for local people to get together and enjoy food, beer, dancing, cock fighting, and sports. Although mass is almost always held, the fiesta is a social rather than a religious event. As with other celebrations, the guests are not only local peasants; communal celebrations are well attended by people from far away, including former members of the community. Some examples follow.

- In 1979 Don Primitivo migrated to Bajo Chira from Angolo, a hamlet located in the despoblado of Mallares. However, he devoutly continues to donate money to the organizing committee of the Santisima Cruz 'The Holiest Cross' fiesta in Angolo and to attend the annual celebration. Don Primitivo's continuing interest in his former community may stem in part from the fact that when lush pasture covers the despoblado, he grazes his livestock there.

- When the Corazon de Jesus 'Jesus's Heart' was celebrated in La Penita, many farmers from Marcavelica attended. Some were relatives of local herders, and some had longstanding relations with the pastoralists. In dry periods, goatkeepers from La Penita tend to migrate to the Marcavelica region, while cattle owners from Marcavelica

drive their livestock to the despoblados when pasturage is abundant there.

Al Partir. The sociocultural mechanisms described above affect goat husbandry and production in various ways, but perhaps their most important role is in facilitating al partir, or shareherding. This is a contractual arrangement in which a livestock owner leaves some or all of his herd with other herders for several months or years. Once a year, the new kids are divided equally between the owner and the caretaker. The latter also keeps the milk produced by the goats in his charge. Any losses of goats must be fully explained to the owner. In cases of predation or natural death, the hide of the dead goat must be shown to the owner in order to prove the animal was not slaughtered. Otherwise, the herder will have to compensate the owner with one of his own goats.

Because of the risks associated with al partir, livestock owners tend to practice it only with close relatives or trustworthy friends like compadres. Al partir occurs across sectors: pastoralists leave some livestock with agriculturalists when pasture is scarce in the campos, and farmers leave their goats with ganaderos when forage is abundant in the despoblados.

- For example, after the torrential rains of 1965, Don Primitivo's brother-in-law from the agricultural village of La Noria gave him ten goats al partir. After two years he received 35 goats in return. When the herd of Don Santiago from the despoblado of Sullana drastically decreased, he placed many of his goats in al partir with various of his relatives in the agricultural zone. Finally, Don SFC, who owns a large milk-goat herd in Marcavelica, agreed to keep al partir six sheep owned by a bulldozer driver from Sullana. In return, SFC will receive some free service of the machine.

About 25 percent of 50 ganaderos and farmers surveyed in the Mallares region practice or have practiced al partir. It should be noted that generally only older ganaderos possess enough goats, pastoral experience and skills, and social connections to engage in al partir.

A related custom is practiced in the campos of Las Lomas, where pasturage is usually abundant. Owners of very large herds (more than 150 goats) who experience labor shortages often give a portion of their herd al partir to a young married couple or to needy neighbors. In payment for their herding services, the caretakers receive half the kids produced. This arrangement solves the original owner's labor problems, and at the same time provides poorer members of the community the chance to establish their own herds.

Environmental Factors in Farmer/Herder Interrelationships

The cyclical pattern of dry and rainy years in Piura seems to be the primary factor behind the social and economic relations described above. These dramatic fluctuations in precipitation in Piura have been recognized for many years. As early as 1895, Eguiguren conducted a

study of the frequency of floods and droughts in Piura based on local verbal testimonies. He classified rainfall events between 1791-1890 into five categories: dry years, light rains, and regular, good, and extraordinary years. Figure 5.2 presents his findings graphically.

Occasional torrential rain storms in Piura and further south on the arid coast have been reported ever since the Spanish conquest. The priest-historian Cobo (1653) notes that such storms occurred in 1541, 1578, 1614, 1624, and 1652. Feijoo de Sosa (1763) described strong rains in Trujillo, a coastal town south of Piura, in 1701, 1720, and 1728. In the storms of 1728 the town of Zana in Lambayeque Department was destroyed when a nearby river flooded. In a study cited by Eguiguren, Santiago Tavera reported storms in 1728, 1749, 1814, and 1821. The latter two storms were accompanied by earthquakes. According to Eguiguren, in 1795 Tadeo Haenke was the first to suggest that torrential rains occur in cycles of six to ten years. However, statistically there is little evidence for the cyclicity hypothesis. Still, almost every decade there has been one very wet year.

Renan Iglesia (1975) studied the flooding in Piura which resulted from the storms of March 1972. He presents a climatic profile for Piura from 1926 through 1972 which incorporates five categories: very dry, dry, normal, humid, and very humid. His findings are depicted in Figure 5.3. Because they are based on human recollections, and because they cover a 100-year period, Eguiguren's data are not definitive. Renan, who relied on measures of the Piura river flow, produced a much more reliable analysis. Still, both sources clearly document the quasi-periodicity of Piuran rainfall and the dramatic fluctuations in total annual precipitation. Eguiguren describes the rainfall pattern in western Piura, the driest region of the department. The picture he presents is one of a normally dry area (71 dry years out of 100) which occasionally experiences good to extraordinary years one to three times a decade. According to Renan, the pattern of water flow in the Piura river reflects climatic conditions in the whole basin. On this basis, he sees the overall climatic picture of Piura as fluctuating between very dry years (16% of 44 years surveyed), dry years (20%), normal years (25%), humid years (20%), and very humid years (18%).

Severe droughts also strike the lowlands of Piura with about the same frequency as strong rains i.e., one per decade. The climate in the eastern area and closer to the mountains is more humid and more stable (see again Figure 5.3). Nevertheless, very good and very dry years also occur there.

The torrential rain storms which occasionally buffet Piura are related to the oceanographic-climatological phenomenon known as El Nino--literally, 'The Christ Child'. This epithet embodies the common belief that El Nino occurs around Christmas time. The El Nino results from complex interactions between atmospheric conditions and the Pacific Ocean. It starts with a period of about a year, during which strong trade winds drive water from the eastern Pacific via the South Equatorial Current to the western side of the ocean. While the water off the Peruvian coast remains cold due to intense upwellings of polar

Figure 5.2

CLIMATIC CONDITIONS 1791 - 1890 (following Eguigum).

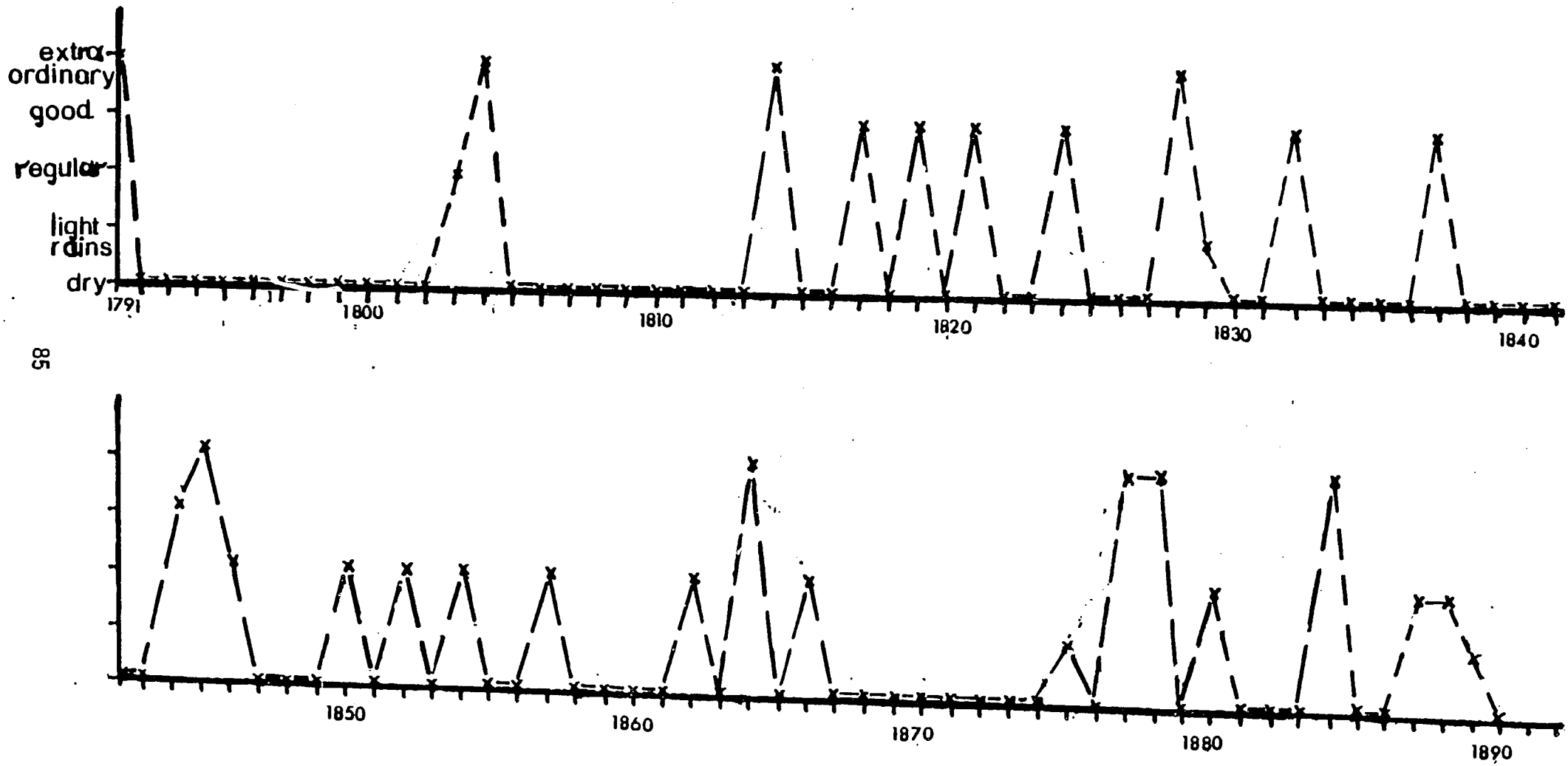
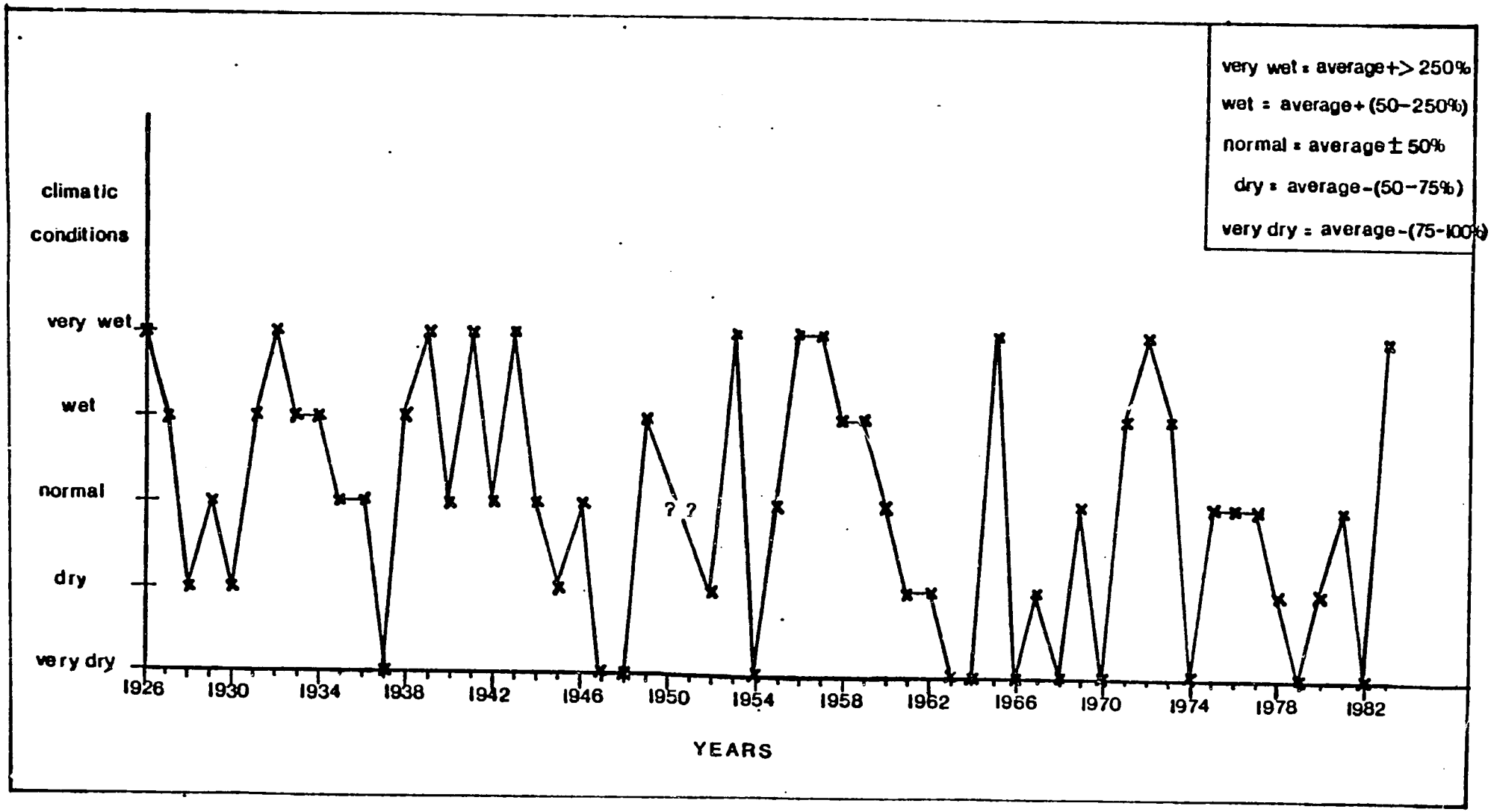


Figure 5.3

CLIMATIC CONDITIONS IN PIURA DURING 1926 - 1983



water, the water driven westward is heated by the high solar radiation of the equatorial latitudes.

During an El Nino year the trade winds abate and the excess of warm water which has accumulated in the western Pacific flushes back eastward. The water off the Peruvian coast becomes 3-7° C warmer than normal. This warm sea water has some detrimental effects on the marine ecosystem, and it also changes the weather of the adjacent coast. El Nino years are characterized by abnormal quantities of rains, sometimes occurring in just a few days or hours. These tempests cause the rivers to flood extensive areas both within and without the agricultural valleys.

The exact conditions preceding or accompanying El Nino are also not yet clear. For instance, the 1983 El Nino was much longer (six months of rains) than any other El Nino recorded in this century. The trade winds in the preceding year were not so strong as expected, and the difference in SST (sea surface temperature) between the eastern and western Pacific was relatively low. However, during the 1983 El Nino, Piura City received forty times the longterm average rainfall (Perevolotsky 1983).[2]

In my opinion, the cyclical, fluctuating climate of Piura is the most important factor behind the strong interrelationships between herders and farmers in the region. The knowledge that both very dry and very wet years are inevitable impels peasants to develop strategies to cope with these extremes.

Unquestionably, a very dry year has serious consequences in the despoblado; pasture and water grow scarce, and finding an alternative source of fodder becomes ganaderos' main concern. Agricultural stubble, residues, or by-products offer potential solutions. Access to agricultural fields and logistic assistance, though, has to be arranged prior to any migration. Social relations with agriculturalists are therefore an important part of Piuran ganaderos' adaptive strategy. In this context, it is important to note that dry years are usually not very problematic in the agricultural zone. Irrigation systems, reliable wells, pumps, or reservoirs all work to mitigate the effects of drought on Piuran agriculture.

Very wet years usually result in a dramatic increase of forage in the despoblado. Aside from temporary transportation problems, the effect of torrential rains on the pasture land is, on the whole, positive. After two weeks of rains, a green carpet of grass covers the plains, and shrub and tree growth is also stimulated. Green herbaceous vegetation lasts for three to five months; thereafter, dry but nutritious forage will be available for two to three years unless a new wet season arrives to destroy it. In the agricultural zone, however, extraordinary storms usually mean floods, damage, and losses. According to Renan Iglesia, the El Nino of 1972-7 destroyed 20% of Piura's crops, and livestock losses were estimated at 7,148,288 animals or $184,710. The destructive effect on agriculture of rainy years in Piura explains peasants' shift from cropping to herding. The life histories presented

earlier reveal that most migrations of agriculturalists to the despoblado occured right after an El Nino.

Green pasture in the despoblado is highly desired by farmers for improving their livestock's diet and, with it, herd size; but labor and logistics are problematic. Good relations with ganaderos living in the scrub lands can lead to productive, mutually satisfying al partir agreements. In years of "anti El Nino," characterized by severe drought, the despoblados become barren rangelands, and goat herders are forced to seek alternative pasture in the agricultural region. In such years, migration is extensive and the herders look to kin and acquaintances living in the agricultural area for help.

To summarize, dramatic fluctuations in climate and their consequent impact on pasture lead Piuran farmers and herders to develop and maintain strong relationships with one another. These relationships enable them to cope with, and even take advantage of, extreme years. Rather than conflict, mutual assistance and even dependency is the norm in farmer/herder interactions in Piura.

CHAPTER 6

MARKETING STRATEGIES AMONG GOAT HERDERS IN PIURA

Marketing is a key issue in any study of pastoralism. An understanding of livestock marketing strategies and decisions reveals much about household and regional economies (Primov 1981), livestock production and management, market features, and even environmental impacts. However, gathering reliable data on actual marketing behavior is almost always difficult. Herdsmen are usually reluctant or unable to provide quantitative information on livestock sales. It is also hard to persuade them to spell out the rationale behind their marketing behavior. Marketing studies which include longterm, household-level monitoring of livestock trade--i.e., objective measure of sales dynamics--are almost non-existent.

The conventional economic wisdom largely derives from micro-economic notions of profit-maximizing behavior. It predicts high sales in productive years; surpluses of new-born animals are converted into cash or goods, and animals which reach a certain age/weight are sold. According to this model, the overall trend would be to maintain an optimal herd size (known as the maximal sustained yield), thus allowing maximal production offtakes, and profit. However, there is a great deal of evidence that marketing decisions made by pastoralists, and especially peasants, are not motivated solely by strictly economic, profit-oriented rationales.

The principal subject of this chapter is the prevailing marketing strategy among Piuran herders and its rationale. To address this subject, two complementary methods were used. First, information on marketing behavior was obtained through questions included in the general survey. These questions dealt with: type, age (young vs. adult), and sex (male vs. female) of livestock sold; consistency of marketing behavior over time; timing of most sales; reasons for selling livestock; and average price received at the market. Second, slaughterhouse data provided more objective and reliable information while also increasing the time interval covered by this study. Fortunately, official data are available on turnover in number and weight of animals from a number of slaughterhouses across the last ten years.[1] Moreover, in two cases (Piura and Chulucanas), more specific data--number and weight of different sex and age groups--could be obtained. Finally, the spatial distribution of slaughterhouses within the region also makes possible a cross-regional and cross-ecozone analysis.

Marketing Strategies in Traditional Pastoral Societies

Studies of herd dynamics and typical marketing strategies for cattle in traditional pastoral societies (especially in East Africa) have revealed behaviors different from those predicted by the profit-maximizing model. The strategy commonly observed among these herdsmen is to maximize herd size by minimizing the number of livestock sold or consumed. An early explanation of this strategy was the "cattle complex" model. It suggests that cattle are rarely sold because of

their important cultural or social functions (Herskovits 1926). According to this explanation, herders give high value, personal attachment, and much affection, to their livestock. Slaughtering or selling an animal is a desperate measure taken only when no other alternative is available. Development workers have tended to view this attitude as irrational, and to label it the principal cause of economic backwardness and overexploitation of natural resources in East Africa.

Livestock also play a social role in many African and other societies; they may serve as bride-price, as prestige indicies, as friendship-acquisition vehicles, and so forth. Again, the marketing strategy is to keep as many animals as possible, minimize sales, and attempt to maximize herd size.

Maximizing herd size has also been seen as a rational adaptation to unpredictable environments in which crop failures are frequent; i.e., when crops fail, livestock are left as the sole subsistence source (Dyson-Hudson 1966). Low livestock productivity resulting from malnutrition and high mortality may also encourage herders to augment their herds.

Storing livestock "on the hoof" or using animals as means of capital accumulation is a common phenomenon in many pastoral societies througout the world. Barth (1973) highlights the investment and savings value of animals and the risks inherent in a pastoral economy. High rates of growth or decline in productive means or capital--i.e., livestock--are possible, regardless of market conditions or technological level. According to his model, capital (the herd) will increase in prosperous times and decline ("savings withdrawal") when times are hard. Though economically logical in the short run, increasing herd size may be very destructive to the environment in the long run because it leads to overgrazing and range deterioration.

This living "savings account" can be easily converted into a "credit line," especially in mixed subsistence systems where each household is engaged in both agriculture and animal husbandry. Sobro (1977) shows how the income a household earns from crops is invested in purchasing livestock, and how livestock later serve as a credit source or "cash generator" when money is required for the agricultural enterprise. The use of goats as a credit source in small-farm agriculture in Piura was discussed earlier (Ch. 4, System A). Viewing livestock as a dynamic savings and credit mechanism implies oscillations in marketing patterns and therefore also in herd size, according both to cash requirements and livestock productivity.

In yet another model, livestock are seen as "insurance policies." In Marx's (1980) discussion of goat herding among the Sinai Bedouin, he suggests that even though the Bedouin can realize no economic return from their goats, the animals can be viewed as an adaptation to unstable political conditions. Keeping goats while practicing a sedentary lifestyle, enjoying a prosperous economy, and utilizing heavily grazed rangelands is interpreted by Marx as a mechanism allowing the Bedouin to return easily to pastoral life if economic-political conditions change.

This explanation implies small herds of more or less constant size due to limited pasturage and management.

Slaughtering Patterns and Marketing Strategies in Piura

Figures 6.1 through 6.4 present slaughtering patterns in four representative slaughterhouses in Piura over six to ten years. Each Figure shows the number of goats butchered and the average carcass weight per month. Goats of all sexes and ages are slaughtered. Most of the data available for Piura are aggregated over sex and age. The average weight is also aggregated across all animals slaughtered during the month, regardless of sex, age, or size. A low average weight (less than 10 kg) means that most of the butchered animals were very young; conversely, a high monthly average (greater than 20 kg) indicates a predominantly adult population; and an average weight of 10-20 kg represents a heterogeneous mix of young and adult goats. Only in two slaughterhouses--Piura and Chulucanas--are the data adequate for analyzing the composition of the slaughtered population. For the slaughterhouse in Piura City, even more detailed data exist; they include separate figures for kids, male adults, and female adults, as well as the total monthly weight for each age group.

Figure 6.1 exhibits the slaughtering trends in Morropon, a small urban center in the upper Piura valley close to the slopes of the sierra. Most of the goats slaughtered there come from the immediate vicinity--an area which is agriculturally very productive, enjoys a relatively stable climate, and is surrounded by good rangeland (Ch. 4, System B). As Figure 6.1 indicates, goat marketing seems to remain fairly steady over the years. Goat meat constitutes about 12% of all meat consumed in Morropon (Table 6.1a). The data presented in Table 6.1 are calculated from the total number of animals annually slaughtered in the various abbatoirs. However, there is some bias in this presentation.

First, the slaughtering data emphasize the demand for meat among the population in the urban center where the slaughterhouse is located rather than among neighboring peasants or herders. Interviews with campesinos in Piura indicated that goats and pigs are the most common sources of meat in household consumption. Second, cattle are over-represented in the slaughterhouse data. A peasant family usually butchers small livestock for domestic consumption, but cattle are slaughtered at the urban slaughterhouse and the beef is distributed to markets in the town.

Interviews with local butchers (matarifa) in the rural area confirmed that goat is the most popular meat, mainly because of its availability and cheapness. Slaughtering by matarifas is illegal yet by official estimates it accounts for roughly 50% of all goats slaughtered in the department.

Figure 6.1

GOAT SLAUGHTERING IN MORROPÓN 1974-1981

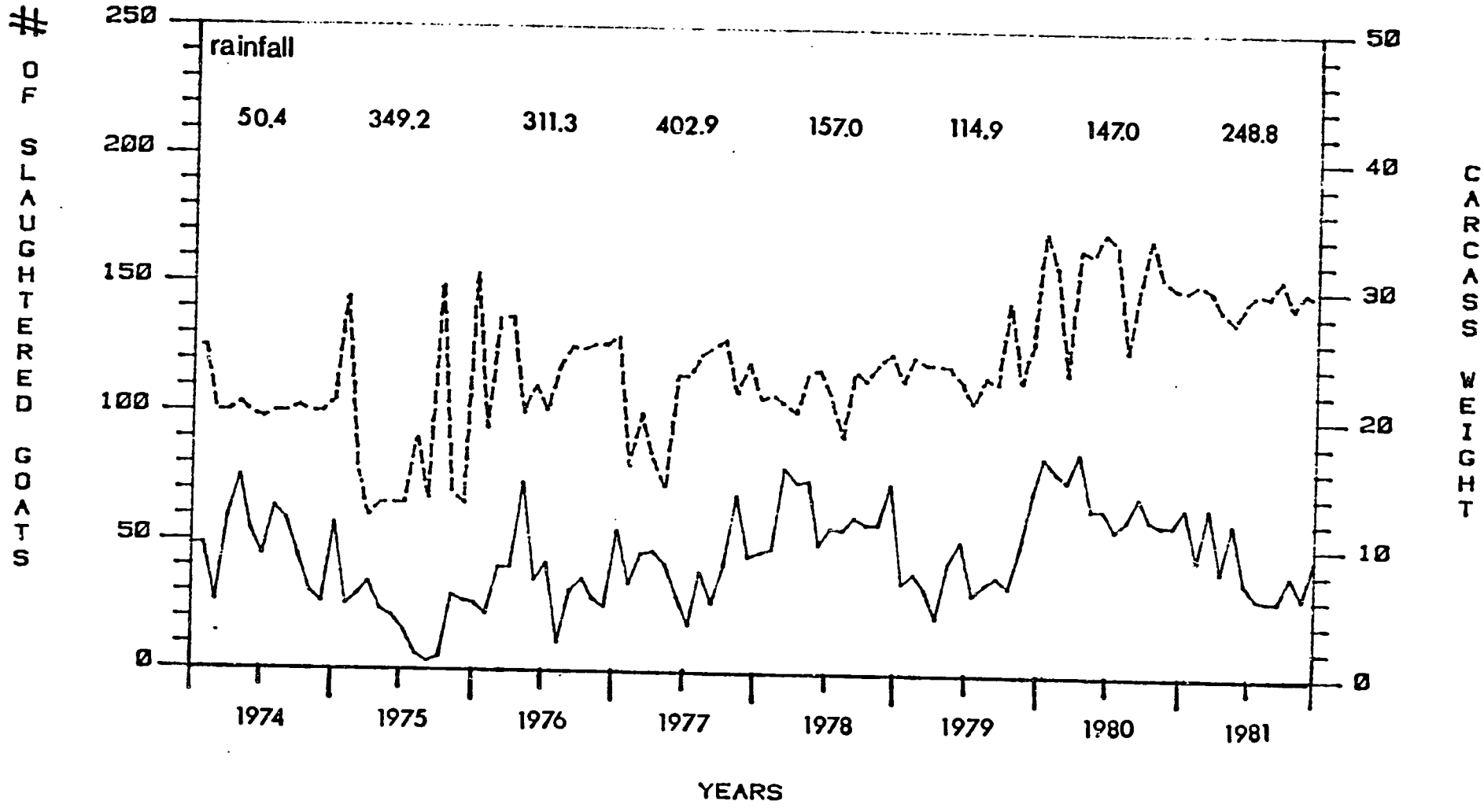


Figure 6.2

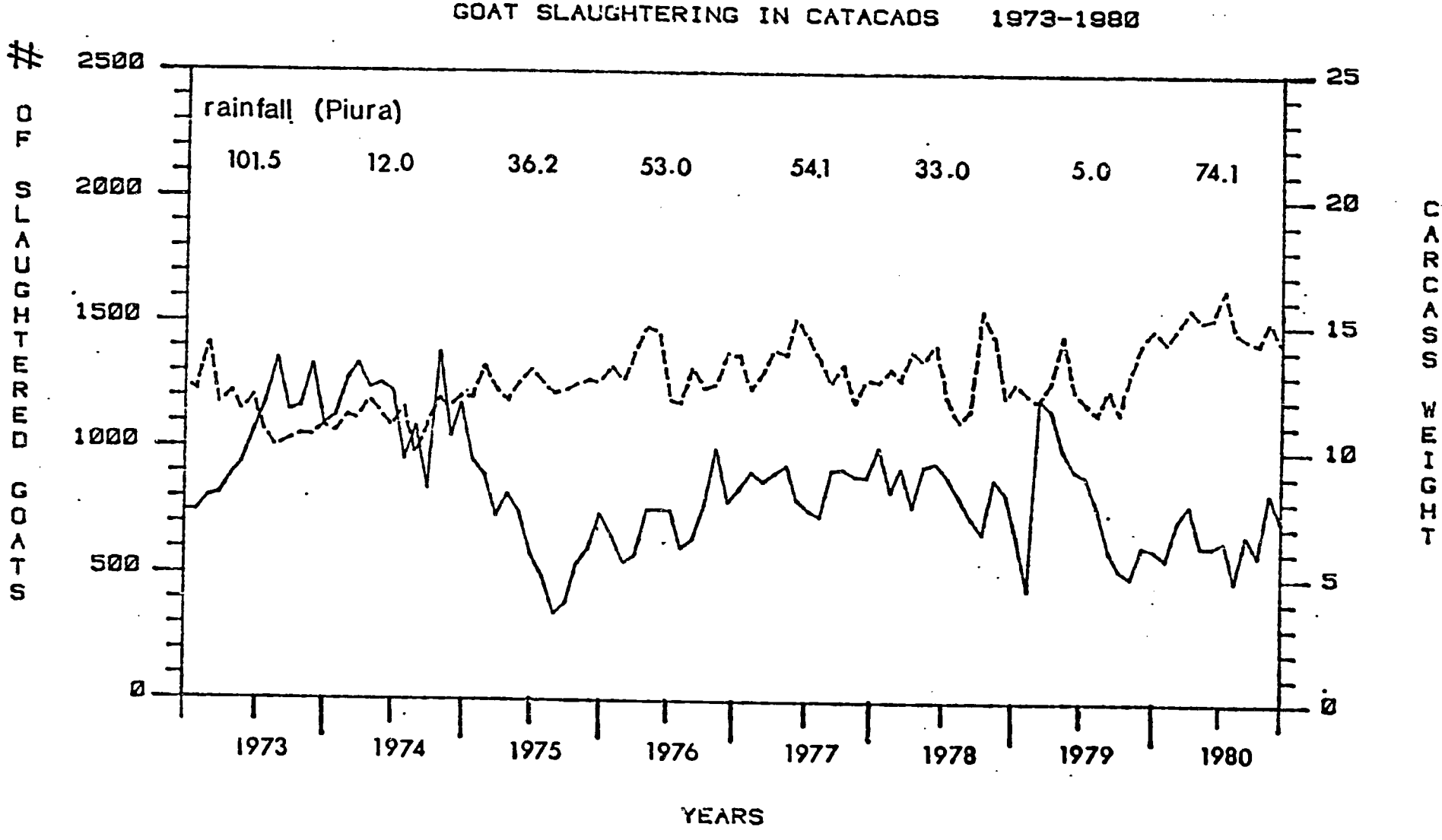

GOAT SLAUGHTERING IN CATACAOS 1973-1980
OF SLAUGHTERED GOATS
CARCASS WEIGHT
rainfall (Piura)
101.5
12.0
36.2
53.0
54.1
33.0
5.0
74.1
2500
2000
1500
1000
500
0
25
20
15
10
5
0
1973
1974
1975
1976
1977
1978
1979
1980
YEARS

Figure 6.3

GOAT SLAUGHTERING IN CHULUCANAS 1973-1981

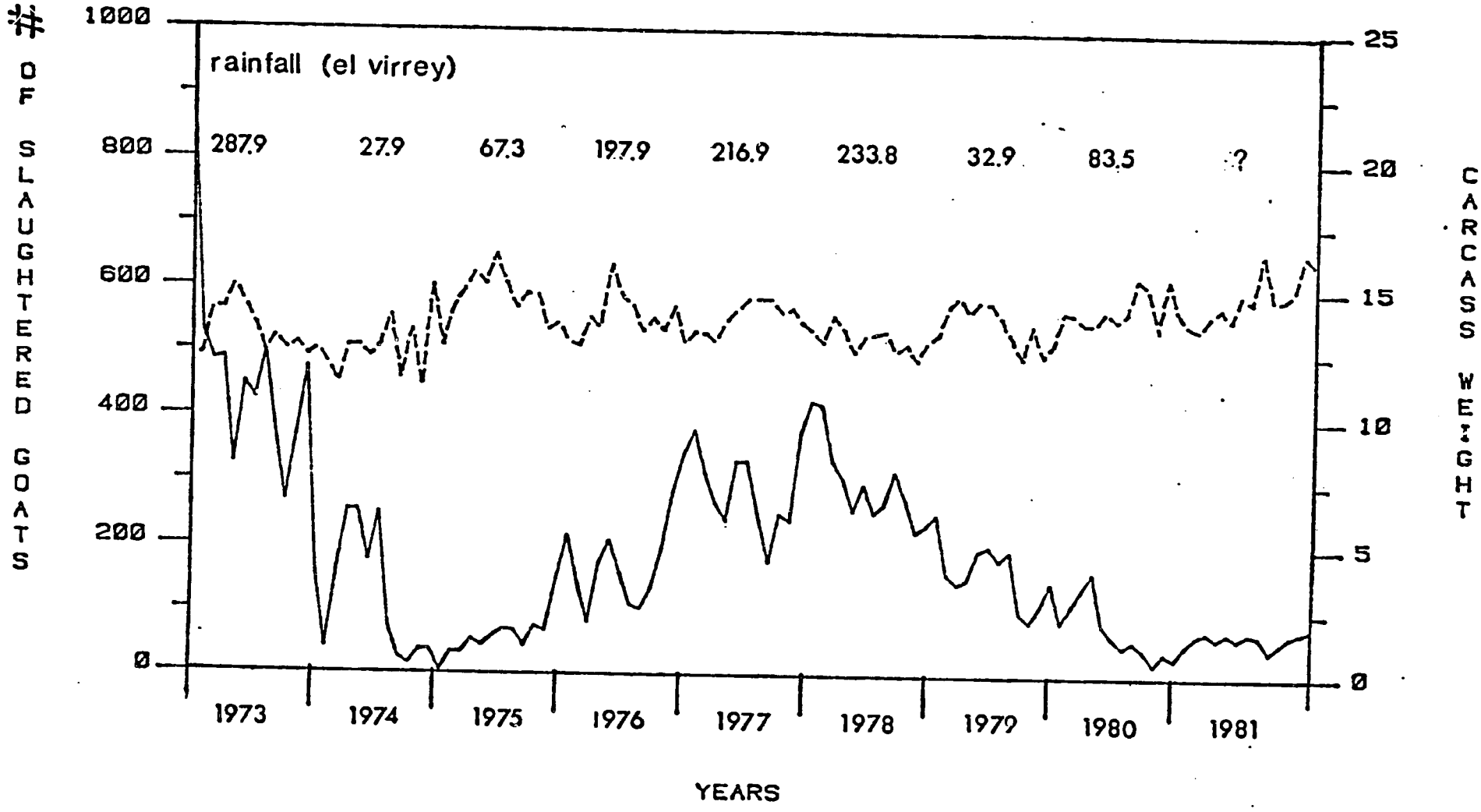


Figure 6.4

GOAT SLAUGHTERING IN PIURA 1973-1981

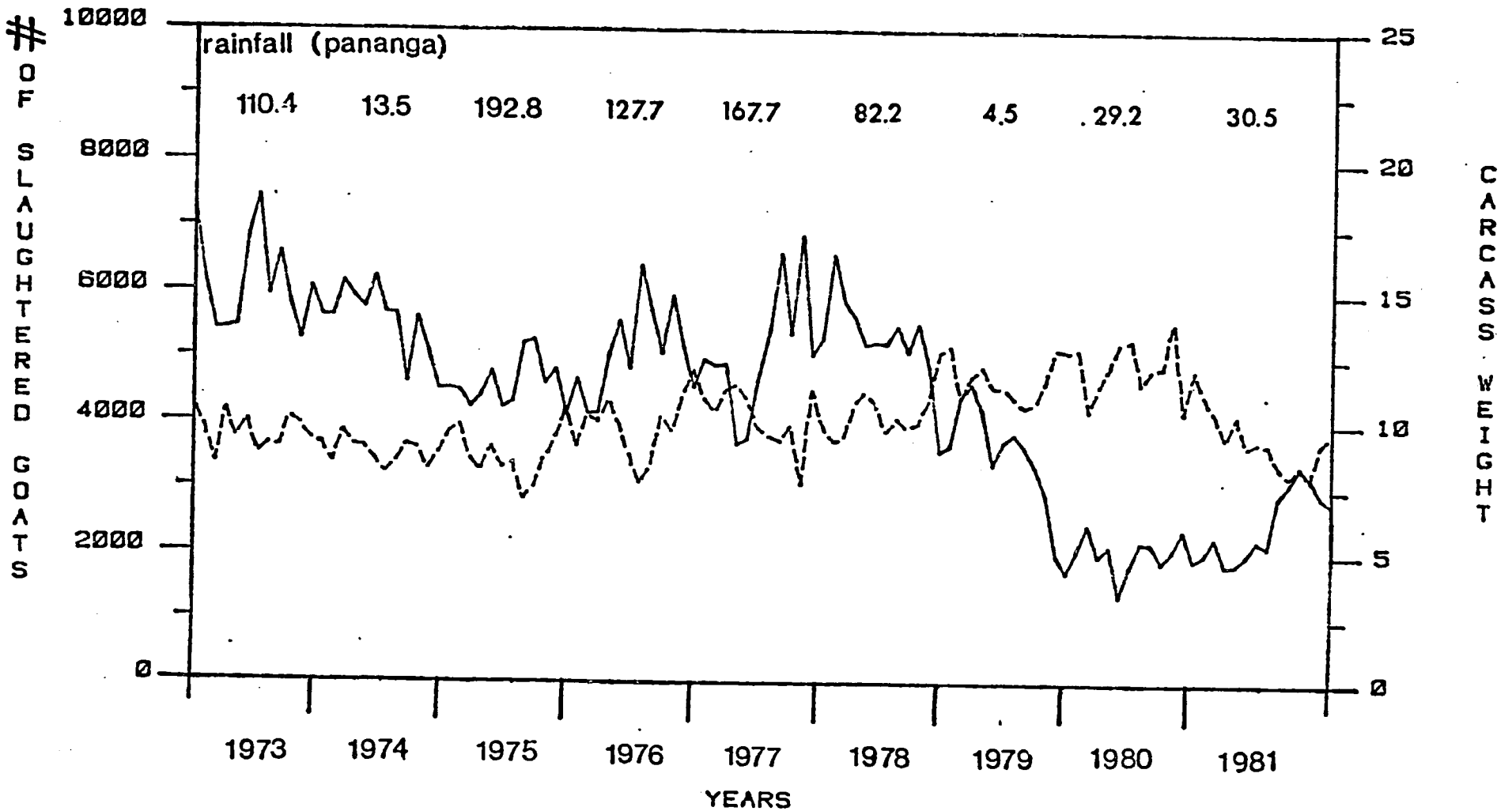


Table 6.1: Distribution of Meat Consumption According to Livestock Type in Four Urban Centers in Piura*

a. Morropon

Year	Cattle (%)	Sheep (%)	Goat (%)	Pig (%)	Poultry (%)
1981	67.3	1.1	10.9	11.1	9.6
1980	57.2	1.7	19.3	13.3	8.5
1979	71.0	1.6	10.2	8.3	8.9
1978	59.6	2.8	10.2	12.1	11.8
1977	64.4	1.0	8.7	11.4	14.5
1976	64.6	0.8	7.2	16.7	10.7
Average	64.0±5.0	1.5±0.7	11.7±4.3	12.2±2.8	10.7±2.2

b. Catacaos

Year	Cattle (%)	Sheep (%)	Goat (%)	Pig (%)	Poultry (%)
1981	66.3	2.7	12.2	17.4	1.4
1980	53.0	4.4	20.4	18.8	3.4
1979	47.2	4.7	21.7	21.4	5.0
1978	40.3	5.7	22.7	26.5	4.7
1977	44.8	4.5	21.1	24.8	4.9
1976	48.8	3.2	18.4	23.9	5.7
1975	65.9	3.2	13.9	17.0	---
1974	----	---	----	----	---
1973	47.6	3.5	27.8	21.1	---
Average	51.7±9.6	4.0±1.0	19.8±5.0	21.4±3.5	4.2±1.6

c. Chulucanas

Year	Cattle (%)	Sheep (%)	Goat (%)	Pig (%)	Poultry (%)
1981	62.5	2.0	3.0	12.5	20.0
1980	55.8	1.9	3.5	13.2	25.6
1979	60.8	2.4	8.7	12.4	15.7
1978	49.2	3.3	14.3	18.8	14.4
1977	42.1	3.7	14.6	21.5	18.1
1975	38.5	1.2	7.1	53.1	----
1976	37.9	1.8	8.8	23.6	27.9
1974	----	---	----	----	----
1973	49.3	4.3	19.1	27.3	----
Average	49.5±9.6	2.6±1	9.9±5.7	22.8±13.4	20.3±5.4

d. Piura

Year	Cattle (%)	Sheep (%)	Goat (%)	Pig (%)	Poultry (%)
1981	55.1	1.0	6.1	7.3	30.5
1980	60.5	1.4	8.0	9.0	21.1
1979	56.7	1.7	14.6	11.1	15.9
1978	51.2	2.4	21.5	15.1	9.8
1977	49.5	2.9	19.6	13.6	14.4
1976	56.4	2.4	15.7	11.5	14.0
1975	71.5	1.8	13.8	12.9	----
1974	----	---	----	----	----
1973	58.9	2.6	23.6	14.9	----
Average	57.5±7	2±0.7	15.4±6	11.9±3	17.6±7

*Calculated as the relative percentage that each animal comprises in the overall amount (kg) of animals slaughtered in each year.

The monthly average carcass weight of goats slaughtered in Morropon exceeds 20 kg in most cases; this implies that most goats slaughtered here are adults. The favorable environment and the yearround availability of forage make kid production in this area rather high. Nevertheless, few young kids reach the slaughterhouse. Almost all herders interviewed in this region indicated that a some of the male kids are consumed at home and the rest are marketed when they reach a high liveweight, usually after one year. Most peasants in the Morropon region have an income which covers the bulk of their economic needs, so goat owners are not forced to sell young kids. As young goats gain weight, their market value rises. The peasants therefore tend to wait until their animals are older before marketing them. Household economic needs or lack of pasture can, however, change this tendency. A significant number of aging goats, whose productivity has declined, are also marketed every year. Peasants in this region are primarily occupied with their agriculture, so labor and time are the main constraints on goat herding. As a result, herds are small, and adults as well as kids are sold or consumed in order to keep the herd at a manageable size. The tendency to sell many adult goats and to sell older kids together account for the high average weight of goats slaughtered in Morropon.

Theoretically, the urban center of Catacaos in the agricultural region of the lower Piura Valley (Bajo Piura) should resemble Morropon in slaughtering patterns. As Figure 6.2 reveals, the picture is actually quite different. The only feature these two regions share is their primarily agricultural subsistence base; but cropping conditions in Catacaos are significantly poorer than in Alto Piura. Consequently agricultural income is much lower (Ch. 4, Systems A and B). In Bajo Piura, livestock serve as a complementary source of cash for the household, as well as a source of credit for the farming operation (Ch. 4, System A). Herd size and productivity are rather low here because of limited fodder. Agricultural forage is available only seasonally, and natural pasture is almost non-existent in the nearby <u>despoblados</u>.

Interviews with local peasants and slaughterhouse administrators revealed that December-April is the "goat marketing season." At this time, peasants need cash to purchase seed and fertilizer for their cotton fields, and goats are the main source of this cash. During the rest of the year, goat sales in Catacaos are so few that the slaughterhouse must ship animals from Sullana in order to meet local demand. These shifts in local supply and preferred marketing times are not noticeable in Figure 6.2 because it essentially presents only the urban demand pattern, and not the marketing behavior of most herds.

The average carcass weight of goats slaughtered in Catacaos was 12-15 kg, representing a very heterogeneous population of both young and adult animals. It seems that constant economic pressures--due either to insufficient agricultural income or to high agricultural investment demands--often impel peasants to sell whatever goats are available regardless of age, productivity, or potential future profits.

The slaughtering pattern in Chulucanas (Figure 6.3) discloses yet another set of marketing conditions and behaviors. Goats marketed in

Chulucanas come mainly from the despoblados of Pabur along the Pan American Highway. In this region, herds rely on natural pasturage, but the forage supply fluctuates drastically because of highly variable precipitation rates. Annual rainfall in Chulucanas averages 226 mm; but the standard deviation is 192, and the high coefficient of variation--85%--indicates the dramatic changes this region undergoes. Even greater extremes are revealed in the meteorological data of El Virrey, the only station located in the despoblados of Pabur. Annual average rainfall here is 142.5±160.8 and the coefficient of variance is therefore 113%. In other words, annual precipitation in El Virrey varies from year to year by more than 100%. Taking 100 mm as the limit for grass germination and establishment, it is evident that herbaceous pasture does not develop in this region every year; there are years when the despoblados remain completely barren (e.g., 1982) and others when they are densely covered by a "green carpet" (e.g., 1983).

The livestock marketing pattern in this region is closely tied to these environmental changes. Figure 6.3 shows that the number of goats slaughtered fluctuates according to the weather. In good years (1973, 1977, 1978) many goats are marketed (250-500 per month) and their average weight is about 12 kg. In dry years (1974, 1975, 1979, 1980) fewer goats (70-200 per month) are sold and slaughtered, but the average weight seems a bit higher--13.8 kg. These trends reflect fluctuations in kid production. In good years production is high and many kids are sold. These are mostly males, because their reproductive value is low. Herders in this region cannot afford to delay marketing the kids until they reach optimal weight because goat sales are families' main economic basis. The high proportion of young kids in the slaughtered population explains the relative low weight of the average carcass. In dry years, when production is low, there are not enough male kids to sell, so ganaderos are forced to sell off a portion of the reproductive core of their herds, i.e., the producing does. A higher carcass weight in dry years then results. Data from interviews with ganaderos in this region support this interpretation of the slaughterhouse data (Ch. 4).

Data from the slaughterhouse in Piura City are presented in Figures 6.5 through 6.8. These enable more thorough analysis. Most goats slaughtered in Piura City come from the commercial center (centro de acopio) in Sullana, where many commercial routes in the province meet. Most goats brought to this center are raised in the despoblados and graze natural forage. They are exposed to the same extreme climate fluctuations as are Chulucanas livestock.

The slaughtering data for 1973-74 aggregate age and size classes. The only generalization that can be made with respect to these data is that the total number of goats slaughtered in these years is very high. Both 1972 and 1973 were very good years (1972 was an El Nino year) with abundant pasture, so many male kids were sold. This conclusion is supported by the relatively low average carcass weight (less than 11 kg). 1975-77 were also good years; as expected, both kids (less than 12 months) and adults (perhaps mature male kids) were marketed in relatively large numbers (Figures 6.5 and 6.7). Figure 6.6 convincingly illustrates the effect of dry years on kid production. In the 1980-81 dry period, sales of kids were more than 100% below 1975-1977 levels.

Figure 6.5

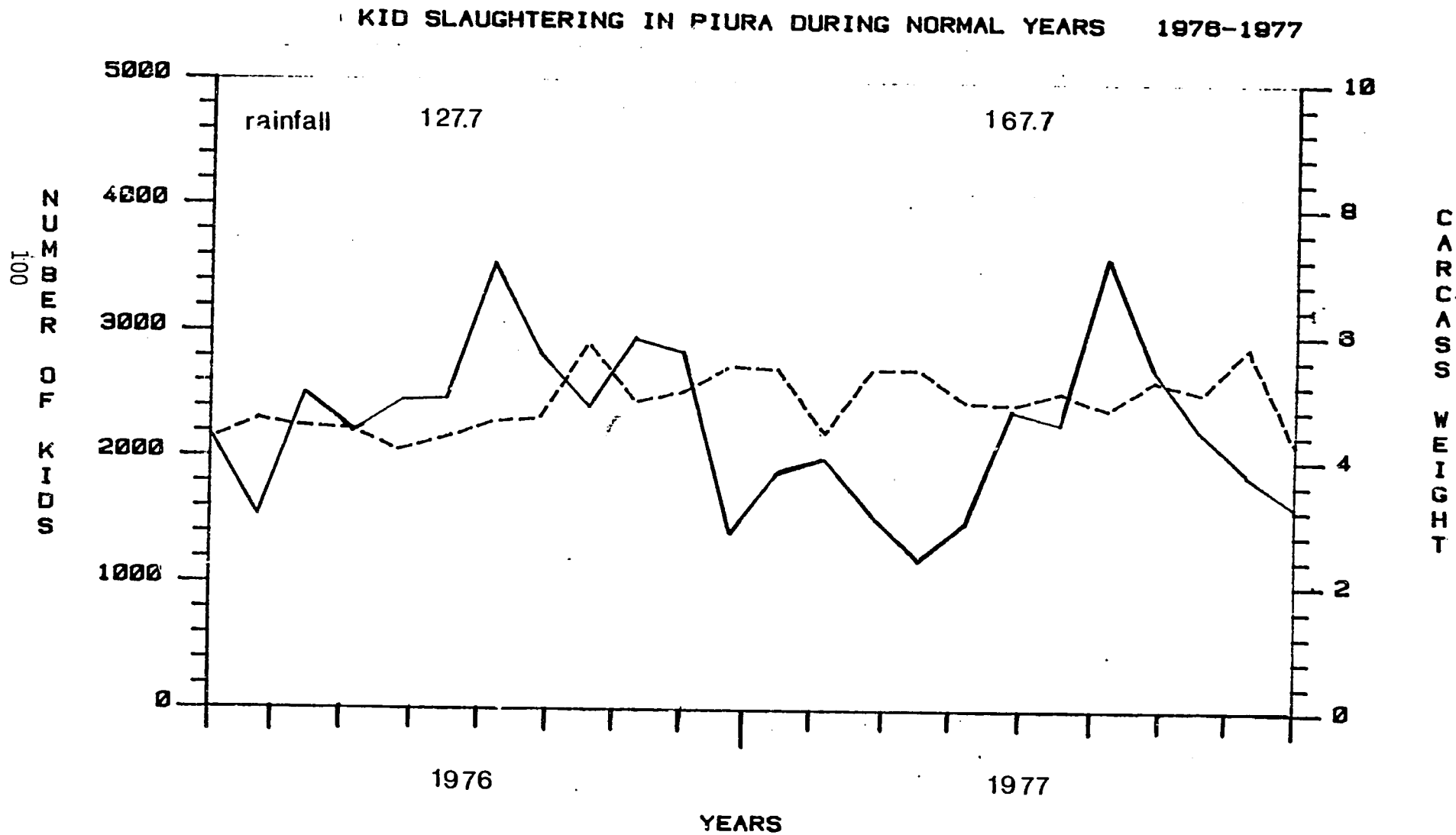

KID SLAUGHTERING IN PIURA DURING NORMAL YEARS 1976-1977
rainfall
127.7
167.7
5000
4000
3000
2000
1000
0
10
8
6
4
2
0
NUMBER OF KIDS
100
CARCASS WEIGHT
1976
1977
YEARS

Figure 6.6

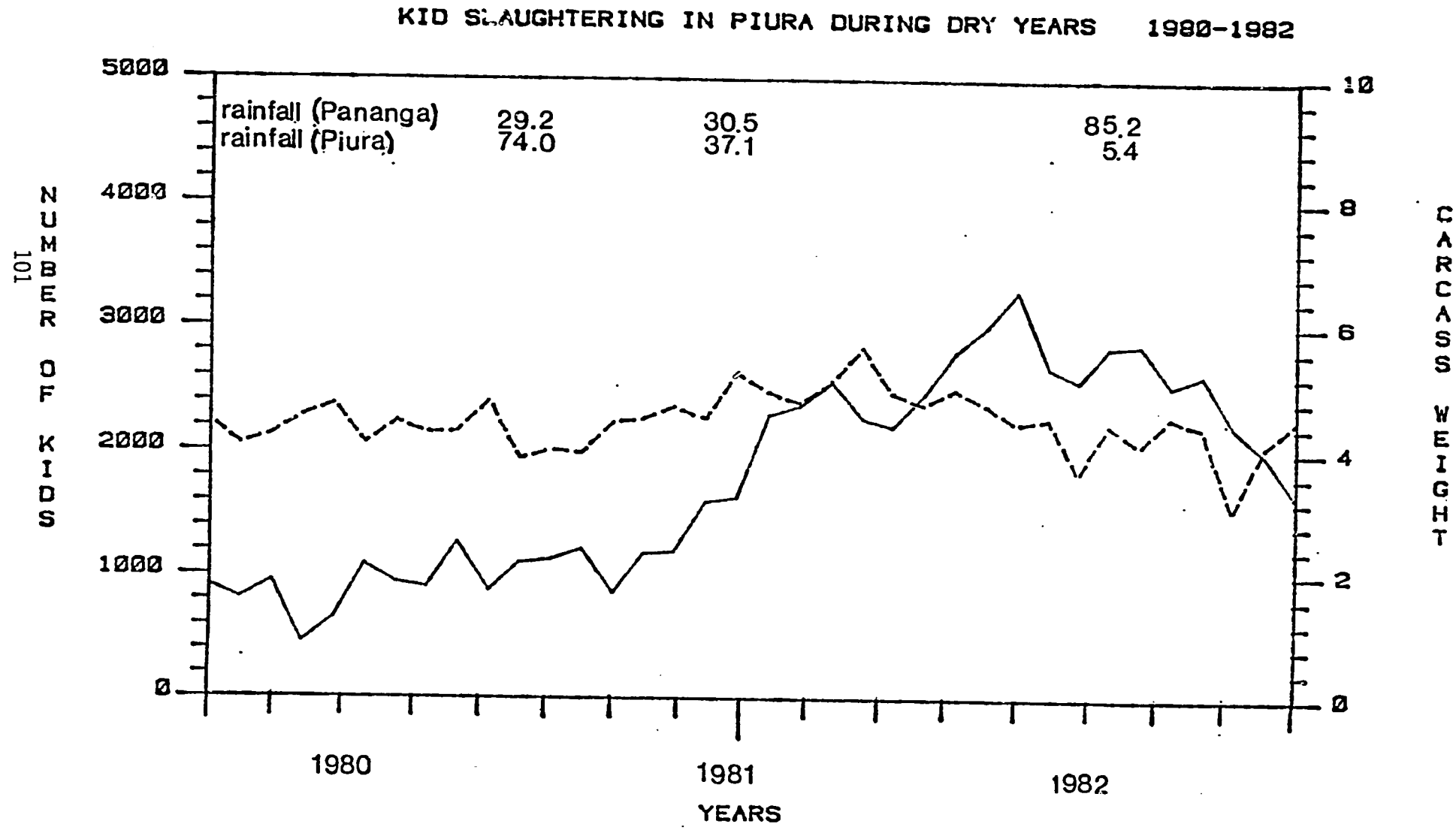

KID SLAUGHTERING IN PIURA DURING DRY YEARS 1980-1982
rainfall (Pananga) 29.2 30.5 85.2
rainfall (Piura) 74.0 37.1 5.4
NUMBER OF KIDS
101
5000
4000
3000
2000
1000
0
CARCASS WEIGHT
10
8
6
4
2
0
1980
1981
1982
YEARS

Figure 6.7

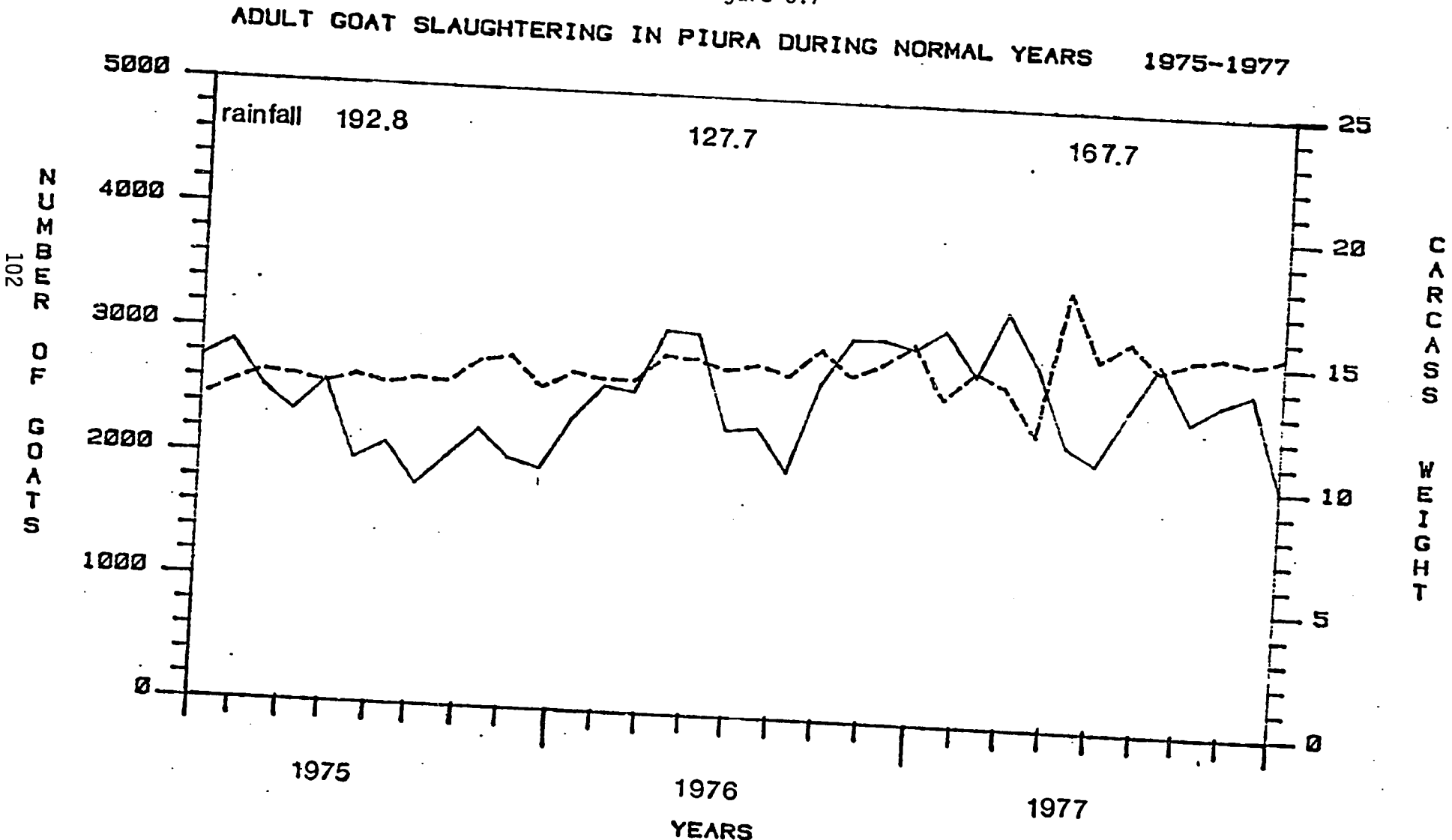
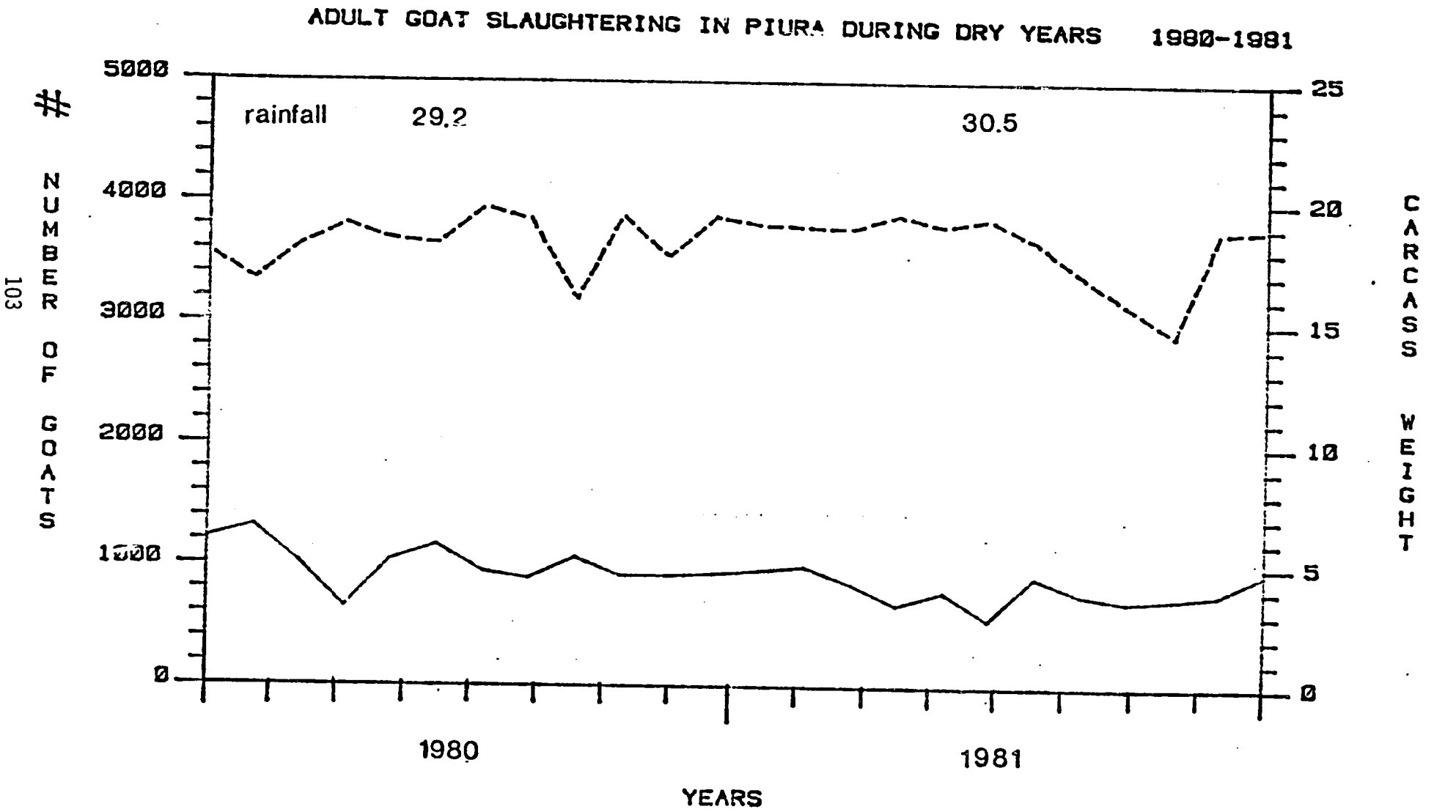

ADULT GOAT SLAUGHTERING IN PIURA DURING NORMAL YEARS 1975-1977
5000
4000
3000
2000
1000
0
rainfall 192.8
127.7
167.7
25
20
15
10
5
0
NUMBER OF GOATS
CARCASS WEIGHT
1975
1976
1977
YEARS

Figure 6.8


ADULT GOAT SLAUGHTERING IN PIURA DURING DRY YEARS 1980-1981
NUMBER OF GOATS
CARCASS WEIGHT
rainfall
29.2
30.5
5000
4000
3000
2000
1000
0
25
20
15
10
5
0
1980
1981
YEARS

Such a decline can be attributed only to a drastic decrease in kid production, since price and demand for meat (Table 6.1d) remained stable.

The same trend was also observed for adult goats. A drop of 150% in the total number of adults slaughtered took place between the 1975-77 good years and 1980-81's dry years. The average carcass weight during the productive years was 14 kg; during the dry years it rose to 19 kg. In order to understand this change, we have to remember that the population of slaughtered "adult goats" actually includes every goat which is not a kid--that is, every goat having a live weight of more than 20 kg or a carcass weight of more than 10 kg. Thus, mature kids 10 months old or older are included, together with all fully adult males and females. In abundant years many kids are sold at 10-20 months because there is enough pasture to let them grow and less economic pressure to sell all the young kids. The result for slaughterhouse data is clear. In good years the average weight of slaughtered adult goats is driven downward (e.g., 1975-77's 14 kg) because many maturing kids are included in this category. In dry years, however, the average weight increases (1980-81's 19 kg) because fewer kids are available for sale and economic pressures to sell productive does increase.

Non-producing old does (machorras) and old studs together comprise the slaughtered 'adult' population. During 1976-77 mature male kids and old breeding males comprised 43.6% of the slaughtered population; adult females constituted the remaining 56.4%. In dry years, kid production declines and the relative proportion of kids in the marketed population drops. Ganaderos have no choice but to sell off a portion of the reproductive core of the herd. The inevitable consequence is reduced herd size during dry years. 63.8% of 149 ganaderos surveyed claimed that the size of their herd decreased during the very dry year of 1982; 15.4% stated that the herd maintained its size; 20.8% reported that it actually increased. Most of the latter interviewees lived in agricultural areas, where stubble and crop residues are available, or they ran semi-intensive operations relying on purchased feed.

On average, herd size in the despoblados of Piura declined by 48.8% during the drought of 1982. Two or more consecutive dry years can cause a detrimental reduction in herd size--as was the case in the despoblados of Mallares 1979-1982. Good years and high production lead to the opposite result: sales of young male kids meet the economic needs of the household, so female kids can remain in the herd to increase its reproductivity. In very good years, the herd can actually double, even after male kids and non-producing adults are sold. This is most certainly the current (1983) case in Piura, since El Nino brought ten times the annual average of rain and, with it, plenty of good pasturage (Perevolotsky 1985).

Conclusions

Slaughterhouse data are a good source of information on marketing strategies. The quantity, weight, and age of marketed goats differ significantly in wet and dry years. Male kids comprise most of the animals sold in good years, while productive adult does make up the majority in dry years. Variability in rainfall and consequently in pasture produces continual oscillations in herd size. Reductions are caused both directly and indirectly by dry years: directly, in that herd productivity is naturally low during dry periods; and indirectly because the drought forces ganaderos to sell the only marketable commodity available to them at the time--mature, productive does.

In preparation for dry years, ganaderos naturally attempt to maximize herd size during good years. Increasing the herd when production is high means entering the next dry period with more goats and, more importantly, enough goats to continue providing for family needs when the drought is over. (A family which subsists on goats requires at least 50 animals to produce enough cash to cover regular expenses.)

In sum, in an extensive livestock system, maximizing herd size is clearly a rational response to drastic, periodic fluctuations in annual precipitation. There is some evidence in the literature that pastoralists in other parts of the world also practice the same "survival strategy" (e.g., Aronson 1980, Dahl and Hjort 1976, Widstrand 1975). It can still be argued, though, that such a strategy is environmentally destructive, and that maximizing herd size will eventually lead to severe overgrazing. This question is taken up in Chapter 8.

CHAPTER 7

LAND TENURE, LAND USE, AND GOAT HERDING IN PIURA: AN HISTORICAL OVERVIEW

Previous chapters have examined environmental, economic, and social aspects of Piuran goat herding. This chapter is devoted to its political context. The evolution of land use and land tenure systems is discussed with an emphasis on historical developments. However, attention is also given to interactions between ganaderos of the despoblados and large agricultural estates, both before and after the agrarian reform.

Given the limits of a technical report, the intention here is to investigate neither pastoralists' political institutions nor regional and national political structures in which goat herders are embedded. Rather, discussion is confined to political interactions directly related to goat production. These are important considerations in proposing any technical or organizational improvements in animal husbandry. Such interactions sometimes take place between certain members or sections of the pastoral society; but perhaps more importantly, they occur between ganaderos (individuals or groups) and political entities outside the pastoral system (state agencies, haciendas, agricultural cooperatives). These interactions are dynamic and are subject to socioeconomic or political factors external to the production process. In order to understand contemporary animal management fully, an historical perspective emphasizing land tenure and resource control is imperative.

Land tenure systems define property title and consequently land use rights. Such systems are the outcome of a political process which in turn implies the existence of a social order or of laws and the ability to enforce them. Land tenure is one of the most important non-biological factors involved in livestock production.

Access to various forage resources, and the costs of utilizing them, are largely determined by land tenure arrangements. Exclusive control over forage resources all year long grants livestock owners a certain security and thus makes alternative modes of management possible. Lack of control over fodder resources leaves the herder at the mercy of others, and therefore limits or even dictates his management options (e.g., migration).

The controversial "tragedy of the commons" (Hardin 1968) -- the overexploitation of rangeland under communal ownership -- is essentially a problem of land tenure. Some scholars believe the only solution to this problem is to privatize the land tenure system. Dependence on resources--e.g., pasture, water, migration routes--owned by others almost always imposes an extra cost on pastoralists' money, time, or energy, and/or restricts the production process in certain ways. The following pages provide an historical overview of land tenure arrangements and related political issues affecting goat husbandry in Piura.

Pre-Columbian Times

The focus of traditional agriculture and livestock production in Peru during Inca times was the *ayllu*[1]: a co-residential, social-ethnic kin group which communally controlled the means of production, engaged in an elaborate network of social, economic, and political interactions, and practiced cooperation and reciprocity. The *ayllu* is described -- or perhaps more accurately, idealized -- as an egalitarian unit enjoying much intra-group cooperation and solidarity. Recently, however, evidence that traditional groups, at least in the coastal valleys, were organized in a stratified social structure has surfaced (Rostworowski 1961, 1977).

The Indian population was organized in regional groups (*caciazgos*) governed by headmen (*curacas* or *caciques*) who controlled the land and distributed it to their subordinates (Jimenez de la Espada 1881). The *cauraca* also served as social, political, and religious leader of these ancient communities. Many toponyms in Piura are actually derivatives of old *cacique* names (e.g., Pabur-Pabor, Chira-LaChira, Amotape-Amotaje). The *curacas* of the Peruvian coast not only allocated cultivable land to their people in return for personal services and a certain percentage of the crop; they also owned large herds of domestic livestock (llama and alpaca) which were attended by the Indians (Rostworowski 1981).

There are many historical references to the pre-Columbian division of Piura into *cacicazgos*, territories controlled by a *cacique*. Most inhabitants of the region were engaged in agriculture, growing mainly maize, squash, and native cotton (Lequanda 1965); others were fishers. Some archeological findings and historical observations indicate that cameloids, mostly llama, were raised in the Piura region long before the Spanish arrived. However there is no archeological or historical evidence to suggest that livestock were produced in the *despoblados* of Piura independently of the river-valley agricultural settlements prior to the conquest. Pre-Columbian settlements were clearly confined to two primary regions: the cultivated valleys of Rio Piura and Rio Chira, where land is abundant and easy to irrigate (Vicus, Sechura, Catacaos, Amotape, Colan, etc.); and the inter-montane valleys (Aypate, Casa, Huancapampa). There is no historical or archeological hint of permanent or even temporary settlements in the *despoblados* other than a few roadside inns on old Inca routes.[2] The productive rangelands of the eastern Piuran lowlands were probably not fully utilized for livestock production. However, it is possible that herds were driven to the *despoblados* from the agricultural area, and that hunting, gathering, or timbering, took place in these vast plains.

Early Colonial Times

The land tenure system in Peru was radically altered by the Spanish conquest. The Spanish Crown granted *encomienda*--the right to collect taxes in kind, money, or personal service from Indians living in a certain region--to the conquerers and the first Spanish settlers. In return, *encomenderos* were to protect and Catholicize the Indians. The *encomienda* granted no ownership of land. But the *encomenderos* took

advantage of their political influence, the drastic depopulation of the natives, and the cheap labor to establish private estates within the encomienda territory (Burga 1976).[3]

Table 7.1 lists the encomiendas of Piura and north Lambayeque in 1561 according to Hampe (1977). The Table shows that a vast area which today lies within three different departments was divided among no more than 22 encomenderos.

In 1569 the Crown decided to resettle the natives who lived in small, dispersed villages into larger, more centralized, and more accessible communities (reducciones) modeled after European towns. This resettling was principally aimed at assuring the encomendero and the Crown more economic, political, and religious control over the Indians. Wolf (1957) claims that expelling the natives from their land and resettling them in "corporate communities" was ultimately intended to facilitate their exploitation.

It is noteworthy that the reducciones were in fact the precursor of today's Indian communities (comunidades indigenas or comunidades campesinas), which combine pre-Columbian and Spanish features (Yambert 1980:63). The land granted to each Indian community legitimatized much of peasants' political struggle against encroaching forces ever since.

The process by which the few huge encomiendas were transformed into many smaller and individually owned haciendas (agricultural estates) is not completely understood (Lockhart 1969, Morner 1974). Keith (1976:54) suggests that some haciendas -- particularly livestock ranches -- had preceded the encomiendas in areas where the native population was very scattered. Keith also mentions that non-encomenderos and artisans kept livestock (especially goats) as a secondary source of income as early as the 1550s. He points out that animal husbandry requires less capital and labor and therefore could more easily and rapidly yield profit.

I suggest this might also have been the case in the despoblados of Piura. The Spaniards quickly realized the great potential for livestock raising in the algarrobo groves and in the vast natural pasturage of the savannas on the eastern plains of Piura. Antonio de la Calancha (1639) wrote: "...no cuesto al pastor, o al ganadero mas que sacudir los arboles, porque las florecillas que los capados y crecidos algarrobos arrojan, llamadas puna, cubre el compas de sus sombras y deja dulce y provechoso pasto al ganado." ("It takes the shepherd or herder no more than shaking the tree and plenty of leaves, flowers and pods fall down. They cover the soil beneath the tree and serve as a tasty and nutritious fodder for the livestock.") The high demand for familiar livestock products (meat, dairy, wool, draft animals, hides, tallow) and the relative underutilization of the despoblados of Piura motivated some Spanish entrepreneurs to establish ranches of Old World livestock (ganado de castilla) soon after the conquest. Unfortunately, no documents to support this hypothesis have yet been located. Really, little is known about the earliest stages of the goat industry in Piura.

The market for livestock and their products was only one factor in the industry's rapid growth in Peru. The availability of more pasture

TABLE 7.1
THE ENCOMIENDAS OF PIURA AND NORTHERN LAMBAYEQUE (OLMOS)

Encomendero	Name of Encomienda
Piura	
o Highlands	
Capitan Diego Palomino	Guancabanba [sin]
Juan de Saabedra	Caxas Cajas
Gonsalo de Grijera	Caxas, Serran
Diego Nunez Vaca	Ayabaca
Lambayeque	
o Northern Region	
Juan Cortez	Olmos, Penacho, Pochos
Diego de Bustamante	Copiz
Suero de Cangas	Motupe
Alonso Carrasco	Xayanca (Jayanca)
Luys del Canto	Xayanca (Jayanca)
o Middle Piura Valley	
Gonsalo Alonso Camacho	Piura, Malingas
o Lower Piura Valley	
Diego Lopez Sauzedo	Colan, Catacaos
Miguel Rruyz	Sechura, Catacaos, Colan
Gonsalo del Corro	1/2 Catacaos, Sonto
Hernando de Orbaneja	1/2 Catacaos
o Upper Piura Valley	
Cristobal Franco	Pabur
o Lower Chira Valley	
Francisco de Lucena	Tangarara, Payta, Sechura
Pero Gonsalez	Motape, Salana, Bitonera, Guarua Payta, Silla
Juan Mendz	Maricabelica, Colan
Wife of Gonsalo Farfan	Chira
o Talara region	
Alonso Rangel	Parina (Parinas), Mancora, Catacaos
Rio Tumbez Valley	
Antonio de San Martin	Tumbez
Diego de Saucella	Chumalaque

land as a result of native depopulation and resettlement also stimulated expansion of the industry. Another important factor was economic changes on the encomiendas. The decline in the tax-paying population[4] by some 80% between 1530 and 1570 (Dobyns 1966) and the shrinking area under cultivation due to labor lacks together caused significant losses of income among encomienderos. In the Jequetepeque valley, encomenderos suffered losses of 45% in tax revenues between 1580 and 1609 (Burga 1976). As a result of this economic crisis, many encomenderos established livestock operations (estancias); these required less labor than cropping and their profitability seemed to be assured. Burga (1976) suggests that in this transformation, the Spaniards' role began to change from senor de los indios 'lord of the Indians' to proprietario de ganado 'livestock owner'.

There were various ways in which hacendados gained control over more land or pasture: merced, land granted by the Crown; composicion, legalization of land title in return for payment to a representative of the crown; and remate, auction (Ramirez-Horton 1977). Burga (1976) describes how hacendados in Lambayeque took advantage of official visits (visitas) by colonial administrators to acquire title to more land through political manipulation of the composiciones.

Theoretically, Indians could also obtain land titles, and occasionally they succeeded in doing so. The problems they faced were the price of land and the Crown's resolve to extract as much revenue as possible from land grants in order to fill its empty treasury. The Crown also preferred to keep a mass of landless Indians as cheap labor for the mines. Indians' political power was also limited and therefore, too, their ability to compete with Spanish landlords for available land. Yambert (1982) provides an interesting historical account of the difficulties faced by the peasants of Catacaos in the lower Piura valley when they attempted to purchase their own land.

Gaining control over pasture land was easier than acquiring agricultural land. In 1541 all pasture land in Peru was legally declared a communal resource (Keith 1976:61). This decree effectively stripped the Indians of any rights they previously held to pasture, and allowed Spaniards to gain exclusive rights to the very same resources.

Land and market demand are two essential variables in the production process, but labor is no less important. Spanish settlers had no intention of doing agricultural labor themselves. They viewed agriculture in the colonies merely as a means for acquiring the wealth with which to buy a higher socio-political position back home or within the local colonial elite (Keith 1976, Lockhart 1969). They were fortunate to inherit the Inca system of corvee -- the mita or 'turn' in Quechua, the Inca language. The mita originally was the quota of workers and days each Indian community had to contribute to public works like building roads, maintaining irrigation canals, or cultivating government-owned land.

The Spaniards simply replaced the Inca and carried on the mita. However, Ramirez-Horton (1977) claims that the Spanish mita was more systematic, more constant, and more coercive than the Incaic one. It

seems, though, that demographic declines and the consequent depletion of the potential pool of mitayos (Indians performing mita) plus the growing need for workers on the haciendas were the main reasons for increasing labor demands on the Indian population. Conflicts between encomenderos who controlled the Indian labor force and non-encomendero agriculturalists induced a decree in 1550 regulating labor allocation through the mita system (Keith 1970). Stern (1981) has recently suggested that mita relations were not a "habit of obedience on the part of the Indians" but an action calculated to ally political groups of Indians with the Spaniards against rival Indian groups.

Any transfer of a ranch from one owner to another through composicion, inheritance, or purchase was accompanied by a notarized inventory of the estate's properties as required by Spanish law, and by the quota of laborers (mitayos) legally granted to the estate by the Crown. For example, Don Francisco Herrera y Andres described in his will his various possessions: "Heredo de su esposa Juana de Albojer las haciendas de Parales (en el citio de Terela), Turicamaran, Seran, Pullicala, Totoral, Paccha y La Pana (Campana), la mitad de Santa Ana y San Martin y mitad de las tierras y pastos de Chapica y el de Curban con sus indios mitayos para la cuida y custodia. Cuatro mitayos para guardar 2700 ganado cabrio y obejuno." "He inherited from his wife...the following haciendas...including their Indian mitayos who watch and guard the livestock. Four mitayos take care of 2700 head of goats and sheep" (A.D.P. 1695). Don Francisco also purchased the estancia of Nomala in auction, including "...7000 goats young and adult and access [accion] to four mitayos from Catacaos (an indigenous community near Piura)" (A.D.P. 1695).

Capitan Andres de Urbina the owner of "una hacienda de ganado cabrio y obejuno nombrada Malingas" "an hacienda of livestock--goats and sheep--called Malingas" wrote in his will of 1679 that his mother bought this estate with "7700 goats of all ages and eight mitayos and one more de quiebra for eight months from the village of Catacaos together with eight mitayos more from the village of Olmos" (A.D.P. 1679).

Another document (A.D.P. 1681) gives a more complete description of Indian labor conscription which seems to follow, step by step, the pre-Columbian procedure: "Derecho que dejo por mas bienes mios una estancia de ganado cabrio y obejuno nombrada Somate con dos mitayos de sexta parte de Catacaos el uno de la parcialidad de Mecache y el otro de Nariguala con 3330 y tantas cabesas de ganado cabrio y obejuno." "I leave, as part of my property, one ranch of goats and sheep named Somate with two mitayos of sixth part (it is not clear whether the quota refers to the duration of service or the proportion to be rendered by the community population) of Catacaos, one from the daughter-village of Marache and the second from Nariguala, with 3300 or so heads of goats and sheep."

A request sent in 1662 to the Spanish Crown by Francisco Martin, "maestro de campo" and "casique principal en el pueblo Santo Domingo de Olmos" sheds some light on the actual process by which members of the favored class obtained more workers. Wrote Francisco Martin to the Crown: "...que estando dedicando a la cobransa y entero de tributos de

la corona no tenia tiempo para cuidar una manada de ganado cabrio y se le mueren en cantidad asi mismo se le pierden cuando se encuentran ausenta. Solicita a su majestad por los grandes servicios que presta a la corona solicita se le asigne un mitayo para el cuidado de su referido ganado" (A.D.P. 1662-3). "Because I am dedicated to collecting and payment of majestic taxes I did not have time to take care of my goats and numerous of them perished or disappeared. For the faithful service I give the Crown I ask Your Majesty to assign me one mitayo for watching my herd."

In a long and complicated dispute between Piura Province and the livestock owners concerning prices and quotas of meat provided to the urban markets, it was revealed that organized labor grants (mita) began in 1589, when the colonial administration assigned each livestock owner in Piura a certain number of mitayos. In response to the provincial administration's request to increase meat provision to satisfy growing market demands, the livestock owners asked for more workers (mitayos) (A.D.P. 1679).

In some cases, the exploited Indians complained. The Indians of Olmos, for example, asked to be released from mita on the estancias of Piura. Their argument was that they had traditionally been arrieros 'muleteers' carrying goods and passengers from the north to Lima and they were therefore unaccustomed to herding. They also claimed that working as mitayos obliged them to pay double taxes: once as mitayos on the estancias and again on the yield of their corn fields. Furthermore, they said herding in Piura was hurting their agricultural production because of their long absence from home. The Indians also complained that the estancia wages were too low. The final verdict of the archbishop of Lima was that the Olmos Indians should dedicate themselves to transportation and agriculture and be exempted from the mita (A.D.P. 1679).

Burga (1976, 1979) presents a similar description of the relationship between mitayos and estancias in the valleys of Zana and Tequetepeque. He claims the burden of the mita and the royal taxes was as important as epidemic diseases in depopulating the agricultural valleys. The reduction in the total labor force merely encouraged more livestock production, which is less labor intensive than agriculture (Burga 1976, Ramirez-Horton 1977). Elsewhere, Burga (1979) mentions that the task of each mitayo was to oversee herds of 1000 sheep. Losing some of the estancia's livestock meant additional work for the Indian on the hacienda's cultivated fields.

Evolution and Structure of the Hacienda System (17th-19th Centuries)

The pressure on cultivable land and potential pasturage continuously increased after the 17th century because of the Spaniards' ever-growning demand for estates. The burgeoning European population, the escalating market for agricultural products (especially of Old World species), the value of land as an investment, the availability of capital from mining or commerce, and the opportunity to climb the political ladder after becoming a landlord -- all contributed to the

establishment and development of many haciendas throughout the Peruvian coast and highlands during the 17th century (Keith 1976, Lockhart 1969).

However, the economic success of most haciendas was far less impressive than their increase in size or number. They were not flourishing enterprises, at least not until the advent of modernization and intensive agricultural export in the second half of the 19th century. Landlords usually lived in a nearby city and were only partially involved in the estate's production process. Limited capital and technology also constrained agricultural output on the haciendas, at least until the middle of the 19th century (Singelmann 1981:44).

Labor, however, was perhaps the most bothersome problem of all. Seizure of cultivable land was merely the first step in establishing a hacienda; the second was to staff it with skilled workers. Wolf's view of the hacienda as tied to an Indian community through paternalistic relations, thus ensuring a consistent supply of goods and services to the estate, is either oversimplistic or applicable only to the sierra, where Indian communities have had a "symbiotic hostility" with neighboring haciendas for many years (Wolfe 1966). The situation was very different in the agricultural valleys of the coast. Here, cultivable land was relatively abundant but labor was scarce.

To improve agricultural production on the estates, the "pre-Columbian system of periodic obligatory work" (Keith 1976) in which laborers did not work in the fields fulltime but dedicated part of their time to personal services for the landlord, had to be replaced with a more stable and productive arrangement. Labor relations with the indigenous community as a whole were exchanged for individual arrangements in the form of patron-client ties. The most common arrangements are described below.

- o Sharecroppers rented a piece of land from the hacienda in return for a percentage of the annual or seasonal yield.

- o Colonos (service-tenants) lived on the estate and received usufruct or grazing rights on which their livelihood depended. In return, the colono was obligated to work a certain number of days per month on the estate and/or to perform some personal service for the landlord. In many cases colonos also had to pay rent in money or kind for their house.

- o Yanaconas were also service tenants who received arable land from the patron in return for agreeing to plant crops according to the need and decision of the landlord and to pay for their parcel with a percentage of the yield. In most cases, yanaconas were obliged to market all their yield through the hacienda, where they received a lower price.

- o Peonaje bajo deuda or debt peonage was another mechanism for binding laborers to the hacienda for long periods of time (Morner 1974). The landlords lent money to their

tenants (as agricultural credit, for purchasing foodstuff, or as emergency funds) in such a way that the latter found themselves enslaved in debt which they had to repay by working on the estate (Horton 1973).

In reality hacienda labor arrangements were not confined to one or more of these categories. Each hacendado worked out agreements which best served his interest or production process. The overall trend, though, was to establish and perpetuate campesinos' dependency on the hacienda to provide the estate with permanent, cheap labor. Hacienda religious services, emergency aid, limited social relations (fiestas, compadrazgo), material rewards, and defense of campesinos' land -- all contributed to the longterm, stable, and seemingly cooperative relationships between landlords and workers (Pearse 1975:9-10, 44-45, 46). Such odd relations were rightly termed "hostile symbiosis" by Wolfe because they helped both sides achieve their principal goals (hacendados' labor ensuring, and campesinos' survival) despite the evident "exploitativeness" of such relations. Other scholars point out the importance of the individual relationship between patron and client, calling it an "open triangle", a "baseless triangle" (Singelmann 1981) or "social atomization" (McClintock 1979). In sum, the hacendado created a system wherein campesinos had to compete with each other for benefits granted them individually by the hacienda. The inequality in control over resources naturally facilitated paternalistic relationships. On the one hand, these relations encouraged a complete dependency of each peasant household on the hacendado; on the other hand, they brought segregation, alienation, and conflict into the peasant community.

These labor arrangements and the related socioeconomic interactions were aimed at optimizing agricultural productivity on the estate as much as at ensuring permanent, cheap labor. De Janvry (1975) suggests that a familiar division of labor is determined by these labor arrangements. Campesino men work on the hacienda, while women and children mostly work on the family minifundio 'mini-farm'. In Piura the task of women and children was often to attend the family goats which grazed the hacienda's despoblados (Fernandez 1982).

The labor arrangements described above did not solve all the hacienda's problems. The continuous demand for a cheap and ever-available work force led many landlords to import this "scarce commodity." Slaves had served the Spaniards since early colonial days. The slave trade increased significantly in 1570-1580 due to the economic crisis of the encomienda (Ramirez-Horton 1977). Slaves usually performed personal services, but later they played an important role in the developing industrial sector. Trained black slaves operated sugar mills in Lambayeque (ibid:316) and soap/tallow factories in Piura (Cornejo 1972). During the 17th century Piura had more slaves (5,308) than any other province in Peru, excluding Lima (15,404) (Castillo 1977). But by the mid-19th century, slavery was abolished in Peru. The intensive agricultural operations, especially the coastal sugar plantation, hastened to replace their African slaves with Chinese coolies (Thorp and Bertram 1978: 44-50). However, the impact of these

alien workers was limited in Piura, probably because yanaconaje was sufficient.

Indeed, many of the workers recruited by haciendas were peasants who had previously lived on the very same land. The profit- and market-oriented nature of hacienda agriculture and the proletarization of the peasant gave these estates a distinctly capitalistic character. The structure of labor relations and their non-monetary or rental nature, however, resembled the classic feudal system (Kay 1982, Keith 1971:438, Morner 1974:766-69). Hindes and Hirst (1975) consider "feudal rent as the principal feature of the pre-capitalist systems." This refers to the production system in which peasants, subordinated politically and ideologically to the patron, are legally forced to donate their surplus labor to the patron and to produce a surplus product, i.e., the rent. This is not to say that under cacique rule, similar feudalistic relations did not exist, however.

As late as 1920, just before coastal agriculture was mechanized, the large hacienda Pabur, in the upper Piura valley, had the following arrangements with the campesinos living on its land. Some colonos received chacras de balde 'parcels in gratis' and a meager wage in return for 15 days' work on the estate each month. Other colonos received plots of more fertile soil on which they were obliged to plant rice and maize. These colonos were required to give the hacienda two sacks (around 100 kg) of shelled maize and 15 arrobas (one arroba equals 25 pounds) of unhulled rice from the annual yield of each plot (Zenon and Vargas 1977).

Calle (1909) provides a vivid description of the hacienda /campesino relationship at the turn of the century in the province of Ayabaca, in the highlands of Piura. The colonos there had to pay annual rent for each head of livestock they kept on the estate's pastureland. They were also required to work three weeks per year gratis (semana de gracias) on estate maintenance. In some instances, the hacendado provided his laborers with food while they worked for him; but in that case, he was free to call upon them as necessary for a semana de obligacion. Tenants were obliged to sell their livestock or dairy products to the hacienda, and they had very little control over the prices paid them. Another duty of the campesinos was to transport hacienda goods to the coastal markets and back twice a year per household (obligacion de dos mandas). The only compensation they received for this task was food for the road. Perhaps Calle's own words best describe the campesinos' life: "Esa pobre jente no puede levantar cabeza" 'this poor people can barely raise their heads'.

Goat keepers in Piura had been treated as colonos. They were permitted to live on the estate property, usually on remote, non-agricultural lands (despoblados) and to use the hacienda's pastures for raising goats. In return, ganaderos had to pay a portion of their herd's annual yield as tax or rent to the patron. In Pabur, as in many other haciendas, the charge was 8% of the herd size. Ganaderos living on rangelands owned by Pabur also had to gather 50 arrobas (1,250 pounds) of algarrobo pods for the hacienda's cattle (Zenon and Vargas 1977). In other cases (e.g., Hacienda Mallares), ganaderos were

required to work as vaqueros 'cowboys' or guardianes 'watchmen' overseeing the hacienda's cattle when they were driven to the despoblados in the green season. As, Don Santiago from the despoblado of the ex-hacienda Mallares recounts:

> Once a year in June a representative of the hacienda arrived at the despoblado, selected the best young goats (10% of the herd) as the annual rent, and cut a mark in their ears. The ganaderos were then responsible for bringing the goats to the hacienda headquarters at the request of the administration. These goats were either consumed in the hacienda, sold, or given to agricultural laborers as reward or compensation. Only campesinos with fewer than 20 goats were exempted from this tax.

Across the region the annual rent was 6-12% of the herd size after the kidding season (Castro Pozo 1947). In most cases, the jefe del campo 'field headman' of the hacienda determined the actual number of goats taken and made the selections. The hacienda often granted the headman part of the resulting revenues as an incentive. The campesinos naturally made every effort to establish strong social relations with the headman; needless to say, he was a very popular godfather in the region. They hoped thereby to receive special tax treatment. Once in a while, especially when El Nino rains hit Piura, the ganaderos cultivated their rain-fed plots. There was no official tax on this production, but every campesino felt obliged to bring the hacendado some of the first harvest; by so doing, the tenant hoped to enhance his personal relations with the patron.[6]

The Cotton Plantations of Piura (1850-1969)

Agricultural production on the Peruvian coast, and particularly in Piura, underwent drastic changes during the second half of the 19th century and the early 20th century. The demand for cotton on the international market increased as a result of declining supplies during the U.S. Civil War (1861-1865). This motivated many Peruvian landholders to re-orient their agricultural enterprise from crops for local or regional consumption to export crops (Rubin de Celis 197.). Because of favorable environmental conditions in the valleys of Piura, cotton became the dominant crop there; in the early 20th century, it covered 70-80% of the cultivated land.

Changes in agriculture stimulated technological developments -- new cotton varieties, deep wells, big water pumps, modern irrigation systems, and later, intensive use of fertilizers and pesticides. However, the most significant developments were mechanization and the introduction of modern business institutions like banks and export/import houses. Together, these shifts considerably improved agricultural production, but they also pressured landlords to increase the amount of land under intensive cultivation to take advantage of an economy of scale. Suddenly, as a result of a rapid capitalization and intensification, land -- and particularly large units of land -- became the limiting factor in economic growth. The labor arrangements previously so advantageous to the hacienda now became an obstacle to

development since they allocated much of the cultivable land to campesinos working less productively on small, individual plots. "Hostile symbiosis" now became "hostile conflict." The hacienda wanted its land back in order to introduce new crops and more productive techniques; but campesinos were obviously unwilling to render up their only source of subsistence.

Yanaconaje was more common in the highlands; but Piura, with 1,301 yanaconas in 1961, had more tenants than any other coastal department (Castro Pozo 1947, Matos Mar 1976). Matos Mar reveals much about the conflicts between hacendados and yanaconas. For example, the Haciendas Yapatera and Morropon, in the upper Piura valley, tried to force their yanaconas out by allowing them irrigation water only on Saturday. Other haciendas preferred to sell yanaconas their parcels, but in such a way that the workers were later forced to sell the land back to the landlord (Kay 1982, Matos Mar 1976, and Zenon and Vargas 1977). Constant disputes between landlords and workers finally forced the government to issue the Law of the Yanaconas (Ley 10885) in 1947-48. This decree attempted to regulate owner/worker relationships to prevent further conflict. Nonetheless, the expulsion of yanaconas and other tenants from hacienda lands continued throughout the 1950s as a consequence of increasing modernization, mechanization, and intensification on the cotton plantations (Collin-Delavaud 1967).

The labor arrangements which now developed on the coastal export plantations were quite different from those of the lightly capitalized haciendas. Mechanized production called for fewer permanent, but more skilled, workers. The labor force of most haciendas in Piura traditionally was composed of permanent and temporary (usually two months) workers in a ratio of 1:5.5-11 (Collin-Delavaud 1967). But the plantations relied on a permanent, salaried workforce of proletarized agricultural peasants or emigrants from the highlands. Working relationships under this system were less personal and more professional (Handelman 1981). Plantation agriculture also required a massive seasonal workforce, especially during cotton pest-control campaigns and harvesttime. In this regard, the new agricultural enterprises encountered problems. But in consequence, the goatkeepers of the despoblados found themselves in a very favorable position.

The interests of the reformed and reorganized hacienda are obvious: to retain a small group of skilled workers, to maximize field size, to facilitate mechanized cultivation, to increase profitability, and to ensure enough cheap seasonal labor for the critical periods. In order to keep a small group of skilled laborers, the hacienda offered housing, small plots of arable land, and grazing rights on the estate (Collin-Delavaud 1967:269). Nevertheless, the vast majority of campesinos lost their small plots or their tenant rights as a result of the plantations' encroachment. For these people, there was little opportunity or hope in the new agricultural system.

This was the time when massive emigration from rural to urban areas began. Those campesinos who remained on the hacienda pressured landlords to provide them with a permanent source of income or subsistence. The profit-oriented hacendados naturally resented this

pressure. Horton (1973) even claims that some hacendados deliberately lowered agricultural production in order to reduce the permanent labor-force and thereby increase productivity in the long run. Rubin de Celis (1977) argues that the new economic structure created a mutually dependent co-existence between highly capitalized systems (cotton haciendas) and neighboring pre-capitalist ones (campesino communities). The principal linkage between these two systems was seasonal work on the cotton fields. Day workers (enganchados or jornaleros) were recruited by a labor-organizer (contratista) from nearby villages or among seasonal emigrants from the sierra. For low wages and no additional benefits these day workers performed any task required by the hacienda and demanded no longterm commitments from it (Collin-Delavaud 1967:270-71).

Plantations also made seasonal labor arrangements with the goat herders living on estate despoblados. These herders paid the regular rent for utilizing hacienda resources, but they enjoyed exclusive access to the cotton stubble fields. In return, they provided the hacienda with temporary workers, especially during the cotton harvest in July-November, when natural forage becomes scarce in the dry habitats. The mutual advantage here is clear. The hacendado was assured cheap seasonal laborers who applied little pressure for yearround employment or high wages since goat raising was their principal pursuit. His costs were also minimal; he merely allocated the cotton stubble to "his" ganaderos. The arrangement is also very beneficial for the ganaderos. Usually the hacendado did not charge them for using the stubble. Scarcity of pasturage on the despoblados during the dry season drives them to seek supplementary fodder for their goats. Cotton stubble is an excellent forage -- especially if it is free of charge. In any event, herding on the cotton fields means migrating from the despoblado to the vicinity of the agricultural fields. Taking the family along and putting them to work to earn some extra money seems only logical from ganaderos' point of view.

The relationship between the patron and the ganaderos can also be interpreted in another way. Singelmann (1981) suggests that landlords' favorable treatment of campesinos is merely an "exchange" of materialistic goods for political stability. Still, considering that the despoblados of Piura have never been a core area for mass peasant mobilization (in contrast to some agricultural areas; cf. Yambert 1982) plus the evident social fragmentation of the ganaderos, the "exclusive grazing rights in return for seasonal work" model seems to offer the best explanation for the evolution of hacendado/ganadero relationships in Piura. I do not suggest, however, that the mutual interest implied by this explanation had generated any special social relations between campesinos and hacendados other than the "baseless triangle" or patron-client ties.

When a severe drought hit the despoblado of Mallares in the 1960's, ganaderos lost many goats and had difficulty in paying their rent in livestock to the hacienda. Don Santiago talked his companeros (fellow-herders) into organizing to ask the hacienda to temporarily abolish the tax. But when he actually tried to recruit someone to join him on his trip to meet the estate administrator, no one volunteered.

They feared retaliation against complaining campesinos. It is interesting to note that Don Santiago nevertheless succeeded in repealing the rent for all ganaderos living within the hacienda limits during the drought.

The ganaderos from the campos of Hacienda Mallares likewise enjoyed free, exclusive grazing rights on the hacienda's vast cotton fields. (Mallares was the largest hacienda in Piura before the agrarian reform.) They also received veterinary services from the hacienda. It was not out of generosity that the landlord provided this service, but rather fear that the goats would transfer diseases to the estate's precious milk cows, which were driven to the despoblados when there is green pasture there. Exclusive, and in most cases free, grazing access to cotton stubble fields was also granted ganaderos living on the property of the ex-haciendas Ventarrones, Golondrina, and Tangarara in the lower Chira Valley, and Chalacala and La Pena in the upper Chira. Ganaderos living in the despoblado of Pabur had priority in using stubble fields; but they rarely did so because their pasture lands were located in a more favorable environment than that of goatkeepers from the despoblado of Sullana, near the Chira river (Ch. 4, Systems E and G). Ganaderos in the Pabur area were asked to help pay for deep wells dug in the despoblado from which both the hacienda's cattle and the goats were watered.

Free and exclusive access to agriculture stubble was not limited solely to herders who lived in the despoblado and seasonally migrated to the cultivated area. It was also a privilege of campesinos who lived in villages in the agricultural region near the hacienda and who worked for the estate. The same rationale applied to despoblado herders was also applied to agricultural laborers. It was in the hacendado's interest to support, though with minimum costs, an alternative source of income for his seasonal workers rather than to rent them land or give them higher wages or yearround work.

In Pacchas, in the Upper Piura, campesinos could use not only the cotton fields but also algarroba fodder in the exclosures (potreros) owned by the estate. Campesinos could graze their herds in the exclosure but they were not allowed to gather, store, or sell this nutritious fodder. In many haciendas of lower Piura, where natural pasture in nearby scrubland is virtually non-existent, campesinos raised their goats on weeds taken from the hacienda's cotton fields between January and March, on cotton stubble from July to November, and on algarrobo and roadside vegetation the rest of the year.

The foregoing history of social relations and land tenure has certainly had an impact on ganaderos' present behavior and social organization. These effects must be taken into consideration in development planning.

The Agrarian Reform

The agrarian reform was undertaken in Peru during the 1960s. Its aim was the redistribution of vast amounts of cultivable land,

controlled or owned by a small group of holders, to a large group of people who had almost no land at all. The first attempts at land reform were initiated by a democratic government in 1964-65. But they had very limited success, mainly because of political difficulties which prevented full implementation. It took a radical military regime to design and impose a revolutionary agrarian reform in Peru during 1968-75. A comprehensive discussion of the Peruvian agrarian reform is beyond the scope of this report, but the impact of the reform on land tenure systems and resource control is important to an understanding of goat herding in Piura today.

The agrarian reform granted control over the agricultural fields of ex-haciendas to 'cooperatives of agricultural production' or CAPs. These were composed of all the permanent workers previously employed by the estate.[8] These ex-employees do not actually own the land in the sense that they cannot sell it even if they reach communal agreement to do so. However, theoretically they all participate in management decision-making and share CAP income equally. Management actually is carried out by a set of committees which are democratically elected by the general assembly, composed of all the cooperative's members (Horton 1973). Horton sees the cooperatives as an "hacienda without an hacendado" because of similarities to the previous estates in production planning, organization, and management, However, income is leveled and much of it is invested in social services like health care, education, and culture (Horton 1973). Horton also points to the similarity in economic strategy between the hacienda and the cooperative in that both attempt to maximize profit, although their motives seem different. The limited income from agriculture must be distributed among all members of the cooperative, whose overall population (including spouses and children) is constantly growing; this income also supports development of community social services. This makes for a great deal of pressure to maximize revenues or profits. But international economic changes (especially in the cotton market), national economic policies (price control, tight credit, centralized export), mismanagement and corruption both in national/governmental agencies and in local cooperative management, and the lack of any genuine cooperative spirit in many of the cooperatives--all foster empty cooperative treasuries (see e.g., Cleaves and Scurrah 1980, Horton 1973, Kay 1982:155-56, Sinamos 1974).

The following citation may best exemplify the financial difficulties many cooperatives face: "The [administrative] committee was forced to do whatever financial operation possible in order to obtain the money so needed; such was the case when they had to cut and sell a grove of algarrobo trees in order to be able to pay the monthly salaries to the members" (SINAMOS 1974). In other words, the cooperative may be forced to liquidate portions of its means of production -- the algarrobo pods serve as livestock fodder or are sold for cash. Inadequate revenues are perhaps the most onerous problem cooperatives and their administration face. This new economic situation also has far-reaching effects on herders and goat production.

The agrarian reform has benefitted only permanent workers of the estate who became cooperative members; temporary workers

have received almost no benefits from the agrarian reform (McClintock 1979). Herders were granted no rights whatsoever by the agrarian reform except for abolishment of the rent paid for using hacienda pastures. Although herders had been tenants and clients of haciendas for generations, only a very few qualified to become members of agricultural cooperatives. Moreover, the state was very hesitant to give them any title to the pasture lands they had traditionally used.

One direct consequence of the new socioeconomic and political agrarian organization was that goatkeepers no longer had exclusive and free access to cotton stubble fields. The agricultural cooperatives now controlling these lands have had continuous financial problems, so they lease these fields for a substantial fee. Since the cooperatives are interested, first of all, in maximizing revenues they also open the stubble fields to whoever can afford to pay. On the other hand, the cooperatives are saturated with their own, usually underemployed work force, so they have no need to ensure cheap seasonal labor. As a result, goatkeepers now find themselves in tough competition for a critical pastoral resource for which they must pay considerable sums. Compared to pre-reform days, this situation has a devastating effect on goat raising, especially in dry years when stubble is so vital to livestock survival.

During July to December 1982, ganaderos paid S/10 per goat per day for grazing the animals on fields of the cooperatives of Terela (middle Piura), Yapatera (upper Piura), Velasco Gallo (lower Piura), and Tangarara (lower Chira). In Mallares (Chira), San Isidro (upper Chira), and Pacchas (upper Piura) the charge was S/15. Herders using the stubble of the Cooperative Simbila in lower Piura had to pay S/20. Some cooperatives first use the stubble for their cattle and then lease the field. Some rent out the stubble in one plot while others are still being harvested. Fines of S/5/animal or S/500 per incident are imposed on ganaderos whose livestock invade the unharvested fields. Other cooperatives lease stubble fields by area. The charge in this case ranges from S/3,000-4,000/hectare of rice straw per herd (Curumuy, Mallares, Tangarara) to S/8,000 for a hectare of cotton residues (Seren). In upper Piura the fields are rented for the whole season; the charge is S/10,000 per goat for four to five months in Pampa de la Hacienda, and S/18,000 in La Pilca. (At this time, S/90.9 = U.S. $1.00.)

Rental payments are due immediately. Some cooperatives even ask for advance payment for ten days; others insist on a weekly payment. Ganaderos who must rent agricultural residues are forced to sell more animals or to produce more cheese in order to pay the rental fees. If they have a large herd (more than 50), the sales of goat cheese will cover this expense.

In additon to the costs and competition of stubble rental, other changes in agricultural operations have also contributed to herders' difficulties. Low cotton prices on the international market have forced many cooperatives to switch to rice production. From the point of view of goat production, the problem is the poor nutritional quality of rice straw compared to cotton stubble. Even more significant is the fact

that harvesting takes much longer in the cooperative system than it did in hacienda days, mainly because cooperatives cannot afford to hire seasonal workers, and its own members must also attend to their individual parcels. The overall result is a prolonged harvesting season. This considerably shortens the time that stubble is available for grazing, since by December the fields must be prepared for the next growing season.

The cooperatives attempt to "squeeze" not only the ganaderos but also their own members, who are rarely allowed to use stubble fields gratis. In Mallares only those members with 20 goats or less are not required to pay. In Pacchas the assembly voted to charge members the same rental fees as non-members. (Apparently the majority of members in this cooperative own no goats.)

Herders face still other problems triggered by the agrarian reform. The despoblado scrubland was formerly controlled very efficiently by the hacienda, due both to hacendados' economic self-interest in the natural resources and to their foremen's effective supervision of this land. The agrarian reform granted all cultivated portions of an hacienda to its workers but left the despoblados under governmental control. In reality, this control is almost non-existent. The operational problems of the regional agency of the Ministry of Agriculture have already been discussed elsewhere in this report (Ch. 8). Suffice it to say here that organizational and financial limitations prevent the responsible agencies from efficiently controlling the despoblados and its resources. As a result, in good years the ganaderos must compete for green pasture with cattlemen (engordaderos)who take advantage of the open range and the "free" forage to drive their cattle to the scrubland. When the hacendado controlled the area, cattlemen could not exploit it unless he leased grazing rights to them--something that rarely happened.

In dry years, when the despoblados are readily accessible, lenadores 'woodcutters' also invade the area. Equipped with big trucks, they cut dead and "dying" trees to sell as firewood in the urban markets. Although ganaderos are aware of the damage this causes to the range, they can do very little about it. Indeed, herders or their children are often contracted to work with the lenadores. Woodcutting was absolutely forbidden during hacienda times; even ganaderos themselves were required to get permission to cut dry trees for domestic use. It was one of the duties of the foremen to prevent any unsanctioned use of the estate's resources.

An extreme example of the impact of the agrarian reform on one group of herders in Piura is Ganaderia Amazonas, the Amazon Ranch located along the Pan-American Highway between Piura and Chulucanas. This enterprise was founded jointly by the government and private businessmen in order to exploit the ample despoblado pasturage following El Nino of 1972. A large area was fenced and many cattle were imported to Piura from Central America to establish a beef industry. For a year or two, forage was sufficient to maintain the livestock; but then several dry years followed, and imprudent management of the enterprise started to take its toll. In a rescue attempt, the ranch management tried to expel the goat herders, who had lived in this region for many

years. Only the political intervention of a strong peasant organization and the sympathetic decison of a local court allowed the ganaderos to retain their traditional grazing rights. This case is only one of many examples of how the agrarian reform -- originally designed to create a more just and fair economic environment -- in fact hurt certain peasant groups. Many government actions or initiatives directly conflicted with peasant interests, contrary to the basic principles of the agrarian reform.

Still, the impact of the agrarian reform on the pastoral sector was not all negative. First, the annual tax on herd production, which almost every hacendado placed on ganaderos living within the limits of his estate, was abolished. Presently, herders pay no fee for using public land. In some places, they have even succeeded in obtaining communal control over the scrubland. This has come about principally on land previously owned by lumber haciendas. These estates had no agricultural fields; they relied on tax revenues from goatkeepers using the hacienda's land and on leasing lumber resources to entrepreneurs. Most of these estates were located in the eastern lowlands--Las Lomas and La Tina region--where timber is dense and plentiful. As part of the agrarian reform, ganaderos living on these ex-hacienda lands could establish grupos campesinos 'peasant groups' and thereby achieve some control over the resources.

Two Communal Systems of Land Tenure

Grupo Campesino. These 'peasant groups' were established by the agrarian reform in the rare cases when an agricultural estate was divided into small fields, to be given to its ex-workers. The socioeconomic organization of the group is supposed to grant campesinos some of the advantages enjoyed by communal units of production like cooperatives and SAIS -- e.g., credit, marketing, technological advice. Grupos campesinos are found mainly in the highlands, where either ecological or social factors prevented the establishment of a cooperative. Horton (1973) calls these groups pre-cooperative units.

However, the grupos campesinos of Piura are quite different. Here, the agrarian reform office encouraged certain ganaderos, known locally as arrendtarios because they rented range from the hacienda, to organize themselves in order to get control over the communal resources of the non-agricultural ex-hacienda. The main problem in establishing this new social structure was that these people historically never formed an integrated social unit. This lack of a corporate unit was a result of: the "divide and conquer" strategy employed by the patron in his relations with peasants; the nature of range subsistence, which called for small, isolated households; the absence of a communal social center; and the demographic mobility of the population (recall Ch. 5). Given these factors, the loose social structure of goat herders is easily understood.

With the help of government development agencies, herders from the ex-lumber haciendas were organized into groups with a structure similar to that of agricultural cooperatives: management committees elected by

all the group's members. The main difference between an agricultural cooperative and a peasant group is that the former officially owns the means of production while the latter does not. Most grupos campesinos were promised that, if they succeeded in managing their communal affairs well, their status would be elevated to that of livestock cooperative.

There is only one example in the department of Piura of a group of ganaderos which has succeeded in obtaining official control over the rangeland they use. This is the ex-lumber hacienda Jahuay Negro, near the Ecuadorian border in the province of Sullana. An initiative taken by a few members of the community and some helpful political assistance during the early post-reform days allowed the 326 families of the group (living in 21 hamlets) to purchase the ex-hacienda's 48,145 hectares from the government. But the complicated legal process and final determination of what the group does own or control has not yet ended. And the group is already involved in land disputes. A very important piece of the territory--the ridge of Angolo--which serves as a grazing refuge in dry years was expropriated by the government in order to establish a game-reserve. The grupo campesino, the official owner and user of the land, was not even consulted before the reserve limits were declared. An even more serious conflict arose when the governmental agency in charge of civil development in the department (ORDENORTE) leased lumber rights to private entrepreneurs to cut timber on the group's land. Since the trees were still potential fodder producers, the ganaderos complained about the damage to their economy and the violation of their property. ORDENORTE justified its action by claiming, first, that the group owns only the land but not the lumber on it; and second, that the revenues from leasing this resource would be used to develop educational and health facilities in the province, and so would help all the residents including those from Jahuay Negro. Fortunately for the ganaderos, it was discovered that most of the money from this initiative ended up in the pockets of ORDENORTE officials, so the whole operation was halted (El Tiempo 1982).

Participant observation of decision-making processes in the grupo campesino El Progreso reveals three conspicuous considerations:

- o the demographic mobility of group members--this makes communication and efficient contact a practical obstacle to organizing an active socio-political group;
- o the inexperience of local leaders in handling public affairs (contacts with outsiders, passing decisions in the general assembly, etc.);
- o the unwillingness of individual ganaderos to give up their own interests on behalf of the group interest--this may be a remnant of intra-group competition and conflict during hacienda times.

These functional problems in the political mechanisms of the grupo campesino were observed when the group was advised to write a letter requesting financial and technical aid to solve a water shortage

in some of its hamlets. Help was promised if people could reach a communal decision and produce a group-supported petition. Although the issue was critical to at least some members of the group, it took the group's leader two months to organize a general assembly. When the assembly finally met, it took many hours of debating and voting to get agreement to apply for unconditional and free aid. The main obstacle was the unwillingness of the members who did not suffer from the water shortage to support the initiaitve because they feared obligatory future costs or commitments in return for the aid.

Despite problems in organizing the political process, some peasant groups have made encouraging decisions regarding resource management. There is a communal agreement that no member can cut timber or firewood in commercial quantity. Even cutting wood to build or repair one's house must first be approved by the administrative committee--as must, too, clearing a despobaldo plot for agriculture. New members and even relatives of veteran members are accepted into the group only upon presenting a letter of recommendation from authorities in their previous residential area. They also undergo an observation period before an acceptance decision is reached. The group can, and sometimes does, expel members because of abuse of communal or private property.

The grupo campesino's management of natural resources seems more efficient and rational than the lumber haciendas', mainly because all members of the group share a single economic interest--the welfare of their livestock. The hacendado, on the other hand, was primarily concerned about lumber revenues; livestock production was of interest only if it affected his rent income. Collectively, the grupo campesino now forbids any commercial lumbering. It also forbids non-members' cattle or goat herds in its territory, thus minimizing the threat of overexploitation. Since little intragroup cooperation is required among members and since any individual concessions are compensated by a contribution to the individual's main source of subsistence--goat herding--this political structure seems less liable to the individual/group conflicts so characteristic of cooperatives.

The conclusion is, then, that the agrarian reform has significantly improved conditions among herders in grupos campesinos. Their principal problem is insecure land tenure. The fact that they do not officially own the land makes them doubt whether they will be able to maintain longterm control over the resources and to prevent re-encroachment by new patrons. From these herders' point of view, only official title to the land and its resouces would provide a permanent solution to such potential problems. And many members still question whether a communal organization like a cooperative or a loose, individualistic political structure might not be better.

Comunidad Campesina. The 'peasant community'--or as it was previously known, comunidad indigena--is a remnant of the traditional Indian community structure. The communities control the basic means of production--water, land, and pasture. They usually allocate individual cultivation rights to communal lands and attempt to regulate water or pasture utilization in a way most beneficial to all members. Much has been written on the social, political, and cultural background of Peru's

comunidades campesinas, and especially on their continuous struggle against landlords' seizure of their limited resources. The peasant communities in Piura are mostly agricultural and located in the lower part of the Chira and Piura river valleys, in the upper portion of the Piura valley, and of course in the highlands. In the economic life of these communities goats play only a secondary role (Ch. 4, Systems A and B). The following discussion is therefore confined to two, more "pastoral" communities--Olmos and Salas--located on the northern plains of Lambayeque Department.

Despite efforts by the Spanish colonial administration to prevent exploitation of the Indians, the history of each community is full of incidents of abuse by colonial and state officials and by landlords. Catholic priests, too, had easy access to the peasant communities, and many priests took personal advantage of it. O'Phelan (1979) describes the techniques by which community priests abused their people. Free labor on fields owned by the priest and free supervision of his goats were very common. Priests also made free use of community resources, especially pasturage. A typical case of abuse is described by Modesto de Rubinos (1936), for the Indian community of Morrope. There, the local priest and the corregidor (Spanish magistrate) united to extract free Indian labor for their livestock operation.

The communities have also had difficulty maintaining exclusive control of their vast natural pastures. A long and complicated dispute arose in the 17th century between the Indians of Copiz (near Olmos) and ranchers who grazed their livestock on community rangelands without permission. The livestock not only depleted the community's forage resources but also caused damage to agricultural fields and irrigation canals. Only a decree by the Virrey of the time was able to end these abuses (A.D.P. 1591-1820).

In many cases, penetration of outside economic forces was abetted by members of the community itself. In an enlightening document, Olasibal Soplopuco presents a 450-year historical overview of disintegration and conflict in the peasant community of Olmos (Olasibal 1982). He shows that as early as 1605 a Spanish rancher received 12 mitayos and grazing rights to community pasture land. Only a conspiracy with the cacique of the community enabled such violation of community and colonial rules. Further conflicts are recorded between 1650 and 1677, when the caciques leased still more pasture to ranchers. The ranchers even tried to forbid local peasants to gather algarrobo pods for their own livestock!

This continuous struggle over natural pasture in Olmos led in 1893 to the decision to allocate communal land to individuals. Each comunero received a parcel of four cuadras (23,000 square meters), fenced it in, and made it a potrero--an exclosure in which pasture could be kept for the dry season. If water were available, portions of the parcel were also dedicated to temporary agriculture. The community ruled that when the fence collapsed of age, the land would return to community control. Comuneros of course could not sell their potreros. The rest of the community's territory, usually rangeland of secondary quality, remained communal property with free access for all community members. This

system of land tenure has continued to the present in Olmos and in the neighboring communities of Salas and Motupe.

Conflicts between peasants and ranchers over resource utilization were of economic and political origin. But from an ecological point of view, it made little difference who actually used the pasture. However, this situation was drastically altered in the first half of the 20th century when commercial charcoal preparation began. The peasant community of Olmos did not fully succeed in controlling the charcoal industry. Aside from taxing charcoal taken from its territory, the community did nothing to prevent over-expolitation of its trees. Again, through political manipulations some comuneros obtained more charcoal concessions than others. In 1945, when the economic status of the community was deteriorating, these rich comuneros loaned the community money in return for further rights to community resources. This perpetuated an internal process of economic stratification based on differential access to communal resources. This process climaxed in the 1950's when the community's rich elite associated itself with businessmen and financiers from Piura in order to intensify agriculture (deep wells, credit, mechanization, export crops) on community land (Olasibal 1982). The growing evidence of variation between, and stratification within, peasant communities motivated Orlove and Custred (1980) to suggest a new model of Peruvian agrarian society emphasizing household corporate groups and socioeconomic networks in place of the old view of Indian communities as egalitarian and cooperative units.

Herders living in small hamlets within the territory of the peasant community of Olmos have complained of the community's current policy of leasing pasture during the green season to outsiders, especially rich ranchers. Comuneros in these hamlets find themselves competing with outsiders who have purchased grazing rights from the community central office. Needless to say, rarely is the rent money invested in communal development in the hamlets most affected by this policy.

The agrarian reform has had little effect on pastoral communities of the northern coast. Its main contributions there were to discourage entrepreneurs who coveted communal resources and to reassure and strengthen peasants' rights to property.

CHAPTER 8

DO GOATS OVERGRAZE THE DESPOBLADOS OF PIURA?

Overgrazing is one of the most serious and widespread problems associated with livestock production. Overgrazing the range on which livestock are reared presents two sets of problems. One is the shortterm, usually reversible, outcome of overexploitation -- a decline in forage productivity, which necessarily leads to a decrease in a livestock operation's economic returns. The second problem is the longterm deterioration of range conditions, including the cover and composition of the vegetation community and erosion of the topsoil. This second problem often cannot be reversed for decades or centuries.

Overgrazing has frequently been observed in the developing world, where limited technology and capital along with sociocultural and political constraints make efficient range management difficult (Norton 1976). Nevertheless, many modern, technologically advanced grazing systems also reach a stage of overexploitation accompanied by resource depletion (Sheridan 1981). There is some evidence that many traditional pastoral societies developed socio-cultural mechanisms to regulate grazing pressure and prevent overexploitation of natural resources (Gilles and Jamtgaard 1981). But government interventions, changes in land tenure, loss of access to pasture land, sharp increases in human population, and growing economic pressure have deprived these adaptive mechanisms of much of their effectiveness.

Two principal approaches to the overgrazing problem can be identified within the context of development projects. First, range managers are mainly concerned with irreversible damage or longterm changes in the range ecosystem: soil erosion, replacement of desirable plants with less desirable ones, and major declines in plant cover or range productivity. One or more of these alarming signals is interpreted as indicating inefficient or irrational land use (Talbot 1969, Whitaker and Wennergren 1978).

The second approach is that of social scientists, who maintain that the foregoing view is partial and one-dimensional. They instead see overgrazing not as a simple and direct outcome of improper management, but as part of a broader issue. For them, overgrazing is not a result of "primitive" technology or irrational conduct. Rather, it is a response to external pressures like taxation, centralist government removed from regional conditions, forced sedentarization, and land expropriation (e.g., Darling and Farver 1972, Jodha 1982, Swift 1977). Social scientists are accused by the more biologically-oriented range experts of advocating maladaptive human practices that lead to irreversible environmental damage and therefore also to economic losses for local people and for the nation. But rarely are these opposing opinions discussed together -- as the complexity of the issue requires.

The role of social science in the overgrazing controversy is not only to shed light on social factors involved in this seemingly biological issue; it is also -- and perhaps more importantly -- to

examine the circumstances surrounding "accusations" of irrational overgrazing. The socioeconomic context of grazing systems, their relationship to regional and national politics and policies, and sociocultural aspects of the relations among herders, officials, scientists, and foreign experts -- all are important dimensions of the overgrazing problem. Social scientists are the most qualified to tackle these issues, but surprisingly they traditionally have been excluded from their scientific discussions (Dyson-Hudson 1983). Only a study combining objective, quantitative, and longterm range evaluation with social analysis can provide a sound basis for aid programs for traditional pastoral groups.

The purpose of this chapter is to examine overgrazing in the department of Piura. Issues are discussed from both a biological and a social perspective. The aim is to test the validity of reports of overgrazing by goats in this region and to anlayze the socioeconomic and political context of these reports. The biological discussion concentrates on ambiguities in defining and determining overgrazing as versus overutilization of rangelands. The sociological discussion focuses on sociocultural, political, and economic factors associated with allegations of overgrazing in Piura.

Overgrazing in Piura

Peruvian officials and scientists agree that the despoblados of Piura are severely overgrazed. Peasant herders are generally blamed for this overexploitation; they are alleged to manage their goat herds irrationally. As early as 1940, goats were accused of environmental destruction on the northern coast (Rossi 1940). Common opinion has hardly changed; recently, it was again claimed that "in the last half century the desertification process found an ally in man and the exotic livestock, especially goats" (Antunez de Mayolo 1981). According to Malleux (n.d.), the dry savanna woodland covering more than 490,000 hectarees in Piura is believed to be the "consequence of an irrational exploitation and overgrazing." Tree cutting and "extensive, irrational grazing" have drastically altered the natural environment of Peru's northern coast, claims Dourojeanni (1981). Dourojeanni also argues that the region was previously forested, and consequently enjoyed a very different climatic regime and supported a richer wild fauna than at present. Tosi (1960) accuses both herders, who fell trees, and their goats, which graze the vegetation, of destroying the environment along the northern coast. He believes that areas presently covered with sand were created by the destructive activity of goats and their keepers.

Nolte (1980) summarizes the problems commonly believed to result from allegedly high stocking rates of goats in Piura.

- decrease in seed production and plant re-establishment due to grazing premature vegetation
- decrease in the number and vigor of seedlings due to browsing

- o decrease in tree and shrub production due to browsing of twigs, buds, and regrowth
- o increased soil erosion on rangelands from trampling
- o replacement of desirable/palatable plants with less desirable ones, and consequent increases in spiny or poisonous species and cacti
- o reduction in vegetative cover and even disappearance of the vegetative component from the habitat, leading to desertification, sand encroachment, and eolic or pluvial erosion

Nolte also mentions several destructive agents other than goats: other domestic animals, lumber and firewood removal, and climatic changes. The consensus of six prominent Peruvian range scientists and ecologists, as cited by Nolte, is that "el pastoreo irracional y los habitos alimenticios de las cabras, como uno de los grandes causas del empobrecimiento de diversas formaciones vegetales y asociaciones bio-climaticas." ("The irrational management of goat herds and the grazing habits of goats are two of the factors causing the impoverishment of various vegetative formations as well as of bioclimatic associations." A similar opinion has also been expressed by Arauzo (1973).

The solution commonly proposed by Peruvian range managers has been to convert the current system of livestock management to a "rational" one, namely to convert the present extensive, meat-producing system to an advanced, intensive milk-producing one (Luna de la Punta 1966, Savilla 1980, Tosi 1960). The main difference between these two systems is that the latter relies heavily on capital -- especially for purchasing forage and concentrated fodder to supplement and balance the goats' diet. In contrast, the extensive system depends almost entirely on natural resources, with very little capital input. Almost all the labor for extensive herding is family-supplied, while intensive operations rely mostly on hired workers.

Grazing Dry Savanna: A General Discussion and the Piuran Case

The nature of native vegetation -- its composition, climax stage, dominant life cycle, and adaptation to high grazing pressure -- is of utmost significance in any discussion of overgrazing. Some vegetative associations are more susceptible to overgrazing than others. High stocking rates and year-round grazing have different effects on different floral types. Perennial grasses seem to be less resistant to heavy grazing than annual grasses, at least in arid or semi-arid environments. Bartolome et al. (1980) show that when maximum range productivity in the next season is sought in perennial grasslands, the amount of vegetation that must be left as dry mulch (ungrazed material) at the end of the growing season is at least 30% higher than for annual grasses.

The accessibility (a function of size and form) and availability (a function of growing season) of perennial grasses and low shrubs to grazing animals is obviously very high. Grazing in excess of a certain amount of the vegetative biomass will lead to decreased plant vigor, seed production, and in the long run, range productivity. On the other hand, the limited physical accessibility of high shrubs and trees and the shortterm availability of resilient annual grasses make it more difficult to overgraze dry savanna. Dry savanna is composed of trees, high shrubs, and annual grasses; it seems to be well adapted to grazing. Dry savanna[1] is the dominant vegetative type in the despoblados of Piura, where most of the pastoral activity takes place (Ch. 2).

In order for overgrazing to occur in dry savanna, grazing pressure has to be high enough to reduce drastically the green biomass of the annual vegetation and shrub and tree re-establishment. Certain levels of reduction in herbaceous biomass generate a decline in the region's seed pool. It may also significantly lower the dead standing biomass (mulch) at the end of the growing season, thus exposing the soil to higher radiation and potential erosion. Fewer seeds available for germination mean decreased cover and biomass of the annual grasses in the next growing season. Mature trees and big shrubs can rarely be browsed so severely that their cover or productivity is significantly impaired. Browsing young seedlings, however, may compromise future re-establishment of the species.

It is still an open question whether the adaptation of dry savanna to heavy grazing is a result of long utilization by wild and/or domesticated herbivores, or whether it is merely a side-effect of biological adaptation to dry climatic conditions. The first argument implies a coevolution between herbivores and pasturage leading to a dynamic equilibrium between herbivores' grazing habits and plants' defense mechanisms. The second view emphasizes that many biological adaptations to dryness are also adaptive for heavy grazing. Short life cycles (annuals vs. perennials), production of large numbers of seeds, delayed germination, and flexible seasonal dormancy are good examples of such double-purpose adaptations.

When grazing pressure on dry savanna is exclusively caused by extensive as versus intensive livestock operations, overgrazing is even less likely. Extensive operations invest a minimum of capital in the production process, and natural pasture is the main fodder. Thus, livestock are more subject to variations in rangeland productivity due to seasonal or annual climatic changes. In effect, the size of herds grazing the savanna at the beginning of a growing season has already been determined by the quality and quantity of pasture in the preceding dry season(s). Drought or a sequence of dry years will reduce herd size dramatically and will keep the stocking rate well below carrying capacity, at least temporarily.

Extensive operations utilize limited capital or credit. In fact, the breeding herd itself is the main source of cash, and obviously it is used only in emergencies. This is the primary reason why livestock are rarely purchased even if herd size declines or abundant pasturage presents new production opportunities. Selling producing females in

order to buy others makes sense only if there is some genetic difference in breed. In Piura, even if herders are interested in purchasing goats in good years, they are unlikely to find another ganadero willing to sell. 87% of 149 Piuran herders interviewed claimed that they do not buy does in order to increase their herd even in good years.

If no livestock are added to the system from the outside -- as is the case in most traditional, extensive systems -- then stocking rates likely will not be high enough to reduce significantly the cover of green annual grasses during the two to three months it takes to produce seeds. However, if a dry year follows after a couple of abundant years when herds were built up, temporary overgrazing does occur because forage is not sufficient to maintain all the livestock. A sharp decline in productivity (kidding rate) and high mortality, especially among kids, is expectable in such dry years. Herd size will be also reduced by the growing need to sell adult, productive does either to meet household economic necessities or, in extreme conditions, to purchase supplementary fodder (cottonseed meal, rice straw) for the remaining livestock. The scale of such temporary overgrazing (overutilization?) and its impact on the range can be assessed only with concrete rangeland and livestock data. If the green annual biomass is not sharply reduced while it is still green and producing, sufficient seed will be produced and the longterm productivity of the range will not change.

Continuous grazing and removal of most of the dry material at the end of the growing season can indeed induce severe erosion and irreversible damage to the range. This also makes for a harsher microclimate for germination in the next season. However, two factors work to protect the dry grass from heavy grazing. First, the considerable fluctuations in herd size keep stocking rates well below carrying capacity, at least during some years (see following section). Second, in dry savanna grasses are usually accompanied by shrubs and trees, which provide alternate forages, particularly for browsing animals, once the grasses dry up.

Also note that in many dry habitats the original vegetation cover is not high enough to prevent erosion; in such cases, the distinction between "natural erosion" (occuring with or without grazing) and "grazing-induced erosion" is vague. These two causes of erosion correspond to soil scientists' terms "normal erosion" and "accelerated erosion" (Brady 1974).

To summarize the main argument here, overgrazing is less likely in dry savanna when the only livestock present are raised extensively. The dominant vegetative community in Piura is composed of trees, high shrubs, and ephermal annuals -- a community not very susceptible to overgrazing. Although temporary overgrazing may occur, during dry years following a sequence of abundant years, other characteristics of the environment and the livestock production system of Piura make the longterm overgrazing argument untenable. These aspects are discussed in the following sections.

Herd Dynamics

The dramatic climatological changes so characteristic of Piura -- cycles of alternating rainy and dry years, torrential storms and severe droughts -- were reviewed in Chapter 5. This erratic climate inevitably causes fluctuations in forages; this in turn affects herd dynamics, particularly in extensive livestock operations.

Data from Piuran slaughterhouses demonstrate the sharp decline in kid production during dry years and a resulting increase in sales of adult, producing does in order to meet herders' economic needs (Ch. 6). Sixty-four percent of 149 herders reported significant decreases in herd size during the drought of 1982. In most other cases, herds were kept in the agricultural valleys where they maintained their size thanks to stubble and residues. In 1982 the Piuran goat herder lost, on average, 48.8% of his herd because of sales of producing goats, high mortality rates (disease, abortions, starvation), and lack of alternative income sources (rainfed agriculture). Of the interviewees whose herds declined, 17.3% lost "only" 10-30% of their animals; 30.7% lost 30-50% of their herd; and 36.2% lost 60-100% of their pre-drought stock. Most herders in Piura do not purchase goats even if there is enough pasture to support rapid herd build-up; and 87% of 78 interviewees claimed they do not buy additional does under any circumstances.[2] The recovery of herds after very dry years therefore requires some time.

There is much evidence of significant reduction in forage and hence in herd size under drought conditions in other semi-arid environments. Barnes (1979) argues that fluctuations in herbage of 200% (between 1000 to 3000 kg of dry matter per hectare) are not uncommon in semi-arid rangelands. Walker (1979) claims that the carrying capacity of semi-arid ecosystems may vary between years by 500% or more. Kelly and Walker (1976) show that above-ground herbaceous production of annual grass in the semi-arid region of Rhodesia fluctuates up to 400% in response to changes in rainfall.

Sanford (1982) has questioned the utility of the carrying capacity concept in arid and semi-arid environments because of their high variation in rainfall. If carrying capacity cannot be determined reliably, how then can proper stocking rates be calculated or rational management strategies planned? Any extensive livestock operation in such environments is bound to experience significant declines. Le Houerou (1979) reports 70% mortality when drought strikes northern Africa; Pratt and Gwynne (1977) give the same figure for livestock losses during very dry years among the Masai in East Africa.

In sum, climate-linked herd size fluctuations in Piura and the infrequency of livestock purchases together mean that stocking rates will seldom be high enough when the annual grasses begin their growing season to cause overgrazing. It is therefore implausible that overgrazing will frequently occur over the whole region for long periods of time. At most, the Piuran range may be overutilized temporarily. Actual climatic patterns and livestock reproductive capacities determine grazing pressure in any particular year.

Persistence of Pasture

Only longterm range studies can support or disprove the hypothesis that overgrazing is unlikely in extensive livestock raising on dry savannas with an erratic climatic regime. As noted earlier, charges of overgrazing are seldom accompanied by hard evidence; claims that the despoblados of Piura are overgrazed have never been substantiated with longterm data on range conditions. In fact, very few range studies have been conducted on the northern coast of Peru. Nonetheless, there is some partly circumstancial evidence supporting the assertion that the region has not been severely overgrazed in recent years.

Parodi and Zambrano (1967) studied annual pastures in Piura after the extremely wet season of 1965. They defined three ecozones differing in cover and composition of annual vegetation. Ecozones A, B, and C correspond with ecozones C, A, and B in Figure 2.5 respectively.

A. Alto Piura/Chulucanas - 15,992.8 kg wet (green) material/hectaree
B. Catacaos/Tambogrande - 13,113.0 kg
C. San Lorenzo/Las Lomas - 22,348.3 kg

Of the 18 most common annual species, seven belonged to the Gramineae family (grasses) and six were legumes. However, each ecozone contained a significantly different mix of these species. In all three zones the percentage of palatable plants was higher than 95. Legumes (usually "ice cream" plants) accounted for 8%-10% of the cover in zones A and B, but only 3.3% in zone C. Generally speaking, these range characteristics do not imply poor range productivity or conditions.

In other words, when water is available, these ranges can produce large amounts of high quality forage. According to local herders, some of this forage remained on the range for two to three years following. This implies that the herbage produced during the abundant year was greater than the annual requirement of all the livestock in the despoblados at that time. A corrolary of this conclusion is that water, and not forage, is the primary limiting factor in this system. Climate and grazing independently affect the status of a range. In Piura, the influence of climate appears to be greater.

Barnes (1979) has also argued that "overuse of the herbaceous component by grazing animals...commonly induces changes similar to those engendered by continued moisture stress." The erratic climate of most semi-arid savannas enhances the similarity between and the confusion of overutilization and drought-induced effects. Fluctuations between severe drought and torrential rains certainly have been found drastically to affect herbaceous vegetation in Piura, regardless of grazing pressure.

Parodi and Zambrano (1967) also observe that most grasses in the Piuran rangeland produce seeds in 45 days or less from the time of germination. To reduce range productivity significantly, grazing must

be very heavy during these 45 days. It takes legumes much longer to produce seed; but the fact that legumes were well represented on the range (8%-10% of the green biomass) implies that grazing has never been intense enough to affect future germination. Unfortunately, this study provides no information on dry standing biomass or mulch, so no conclusions can be drawn regarding the degree of utilization at the end of the year or exposure to erosion.

Another abundant year, 1975, stimulated a second study of annual vegetation, this time in the Olmos region of Lambayeque Department (Solano 1977). It took 63 days from the time of germination for 50% of the vegetation to dry up. The peak standing crop occurred after 40 days of growth and totaled 3,512.1 kg of dry matter per hectare. This compares favorably with the productivity of other semi-arid savannas. More than 90% of the forage was found to be grazable. The average digestibility of the dry matter was 68%, and it averaged 6.3% protein. These values again make it difficult to conclude that this range is severely overgrazed or in poor condition.

The optimal stocking rate calculated by Solano on the basis of the Olmos range's average production and average livestock nutritional requirements is 0.56 animal units per hectaree per year. This figure is slightly higher than the one derived by Parodi and Zambrano ten years earlier for a very similar range in Piura -- 0.46 A.U./hectare/year. This similarity suggests that there was no deterioration in range conditions between 1965 and 1975 despite seemingly heavy goat grazing. Nevertheless, both studies speak of "irrational" use of pasture resources and constant range degradation. It is important to note that calculating actual stocking rates in the despoblados is extremely difficult -- as it is for most extensive traditional herding systems. Authorities have only a vague idea of the number of goats on the range, yet this is a crucial component in determining grazing pressure. The annual census, at least of goats, is in fact not more than a crude estimate (Ch. 3).

1981 was an average year for precipitation. Nevertheless, as late as November there was enough grass in Piura (ecozones B and C) and Olmos to provide most of the goats' diet. Chemical analysis of this forage showed that it contained 6%-13% protein.[3] These observations indicate that even in average years, six to seven months of continuous grazing does not clear all available herbage from the range. In other words, stocking rates in 1981, a second average year in a row, were probably below the carrying capacity. Field observations in late 1981 also suggest that as herbaceous vegetation becomes too dry or scarce, goats switch from grazing grass to browsing shrubs and trees in the same habitat. (See also Garcia 1982.)

Questions on pasture availability and persistence in previous years were included in the general herder survey distributed throughout the region. They sought to establish the latest dates or months in which grass was still available for grazing in the various ecozones under different climatic conditions. In order to test the reliability of herders' information, it was compared against existing meteorological

data. Responses with many discrepancies were excluded from analysis. The results are presented in Table 8.1.

To conclude, it seems from the scant quantitative data available on range productivity in Piura that grazing pressure (or stocking rate) is not high enough to exhaust dry grass in regular years. In wet years, the standing biomass is so high that it can last two to three years despite continuous grazing. The quality of pasture also seems quite adequate. These observations do not support the contention that the range has been deteriorating. Such results, if substantiated, may disprove overgrazing claims. Meanwhile, they cast serious doubts on the assertion that goats and goat herders harm the despoblados of Piura.

Table 8.1

PERSISTENCE OF HERBACEOUS ANNUAL VEGETATION IN DIFFERENT HABITATS OF PIURA

	Rainfall		Last Date of Vegetation Presence	
	Total Amount	Reliability	Average Yr	Abundant Yr
Despoblados of Sullana	50-150 mm	low	June/July (75%)[1]	1-2 years (75%)[2]
Alto Piura	150-300 mm	moderate	Sept (42%) Dec (58%)	all year (68%)[2]
Las Lomas/ Suyo	300-500 mm	high	Sept (29%) Nov (53%)	2-3 years (88%)[3]

1 The percentage refers to number of informants supporting a certain response (total number of interviewed herders -- 80, divided more or less equally between the geographical zones).

2 The grass remains dry but still grazable if the next year is not very wet.

3 It is not likely that dry grass will last in this region more than one year because normally there is enough annual precipitation to destroy the dry residues of the previous year.

The Impact of El Nino on Rangelands and Herding Systems in Piura

1983 gives vivid testimony to the effect of weather on Piuran rangeland and pastoralism. By the end of 1982 -- a very dry year -- Piura was practically bare. Almost no herbaceous vegetation grew during the drought of 1982, and many shrubs and trees remained dormant all year long. The region looked grim and bleak, just as heavily overgrazed

areas are supposed to look. Rains started in December 1982 and continued for six long months until mid-June 1983; normally the rainy season in Piura occurs between January and March. The intensity of the rains, the high air humidity, the unusually warm sea-water temperatures, and other signs indicated that 1983 would be an El Nino year. As a matter of fact, it was one of the most severe El Ninos to hit Piura in recent history. (Climatic records for Piura have been kept since 1925).

In Piura City, where the average annual rainfall is around 50 mm, more than 2200 mm were recorded from January through June of 1983. Chulucanas, a small city southeast of Piura near the mountains, received the most rain--3145.6 mm vs. its normal 260 mm. The rivers overflowed and flooded nearby fields and villages in the agricultural valleys, especially in the lower and middle sections of Rio Piura. The flow of the Rio Chira is presently controlled by the Poechos dam and reservoir, so damage in the river's lower basin was less. But cities and transportation systems throughout the entire region were badly damaged and daily life in the whole department was disrupted for a long time. Misery, starvation, and disease became common in the cities and river valleys of Piura, and infant mortality rose considerably.

For pastoralists in the despoblados, however, El Nino caused only limited damage, and brought much hope and prosperity. Livestock suffered for a short while from the rains and from humidity-related diseases; but once the environment dried up, goats took full advantage of the vast green pasturage in the despoblados. As a result, milk and kid production picked up.

The change in cover, biomass, and community structure of the Piuran range after the torrential rains is incredible, especially compared to its state only one year earlier. Even the Sechura Desert, one of the most arid deserts in the world, was covered with a low carpet of grass. Farther to the east a complete cover of herbaceous vegetation (mostly grasses and legumes), vines, and annual and biannual shrubs has established itself. The perennial shrubs and trees, so bare and dead-looking during the drought, were covered with dense green foliage; some were already even in bloom by July 1983. The Piuran vegetation community after El Nino resembled the dry tropical forest of the eastern slopes of the sierra rather than a dry savanna.

Quantitative data on the new forage resources are not yet available. But local herders predict two to four more years of continuous utilization of this natural pasture if another season of heavy rains does not destroy the dry herbage. The Peruvian government has also realized the Piuran rangelands' potential; it plans to import cattle and establish a temporary ranching enterprise there. (For more details of the 1983 El Nino's impact on goat herding in Piura, see Perevolotsky 1985.)

1983 was perhaps unique in its excess of precipitation, but very wet years are by no means exceptional in Piura. El Nino years are known to have formed part of the Peruvian coastal ecosystem for hundreds of years (recall Ch. 5). El Nino occurs approximately once every decade in a quasi-periodical pattern. The last recorded events were in 1972,

1965, 1953, 1943, 1941, 1939, 1932, and 1925. Droughts also hit Piura frequently, but reliable data on their occurrence pattern do not exist.

Any characterization of range conditions in Piura must take into consideration these extreme climatic and environmental fluctuations. Severe drought obviously affects herds and ranges negatively; but these effects are usually mitigated by subsequent abundant years. A very wet year affects the range and livestock production for several consecutive years. Data on average conditions (rainfall, forage biomass, or herd size) or on performance (livestock production and productivity) make little sense under such circumstances. Degrees of range utilization or optimal stocking rates at any particular time are almost meaningless for longterm management. Only a longterm quantitative study which includes both drought and El Nino years can elucidate range trends towards deterioration versus dynamic equilibrium, or determine the relative contribution of livestock versus precipitation to range conditions in Piura. Meanwhile, there are certainly enough data to challenge the prevailing assumption that the region is seriously overgrazed.

Evenness of Grazing Pressure

In Piura, as in many traditional pastoral systems, grazing pressure is uneven. The location of pastoral settlements and favorite grazing grounds is not primarily determined by pasture availability or livestock density so much as by physical accessibility and distribution of water sources. Figure 8.1 depicts the *despoblado* of Sullana, a zone inhabited almost exclusively by goat herders. This region is grazed most of the year, but a circular area with a radius of four km is a fair estimate of the land actually grazed. It is evident from the map that the small pastoral hamlets (*caserios*) are concentrated in the lowlands, while the hills are less densely populated. In some cases, seasonal migration between low and high habitats was observed. *Caserios* also tend to be found in places where an unpaved road can easily be built. Such roads allow for commercial transportation to and from urban centers; these are the roads by which most goats are taken to market, and food and provisions reach the herders. Assuming that herders use all the area around their *caserios*, this utilization pattern leaves many areas un- or only slightly grazed. These areas may serve as annual vegetation "refuges" from which seed may be transported to more heavily utilized patches. Goats typically use these habitats only in very dry years, usually for browsing.

To test this idea of vegetation "refuges," some observations were made of dry annual range in the vicinity of Senquelo and Inculas -- pastoral *caserios* in the Olmos region. Biomass/standing crop measurements were taken in late 1981, almost at the end of the grazing cycle and just prior to the onset of the rains. Unfortunately, the severe drought of 1982, and therefore the almost complete absence of grass on the rangeland, precluded repeating these observations as planned. Table 8.2 presents a summary of the findings.

Figure 8.1

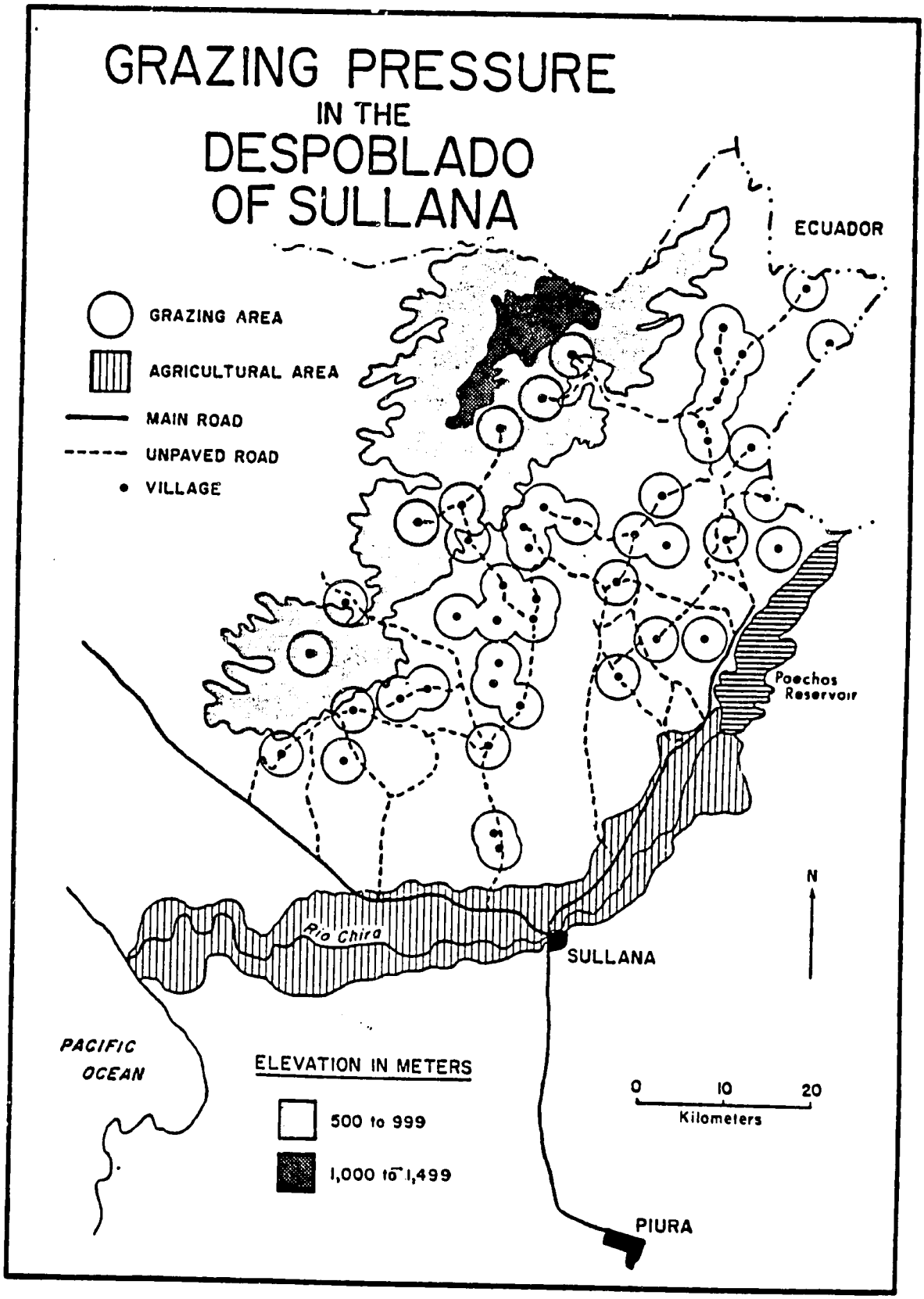

GRAZING PRESSURE
IN THE
DESPOBLADO
OF SULLANA
ECUADOR
GRAZING AREA
AGRICULTURAL AREA
MAIN ROAD
UNPAVED ROAD
VILLAGE
Poechos
Reservoir
N
Rio Chira
SULLANA
PACIFIC
OCEAN
ELEVATION IN METERS
500 to 999
1,000 to 1,499
0
10
20
Kilometers
PIURA

Table 8.2

DRY STANDING BIOMASS OF HERBACEOUS VEGETATION AT VARIOUS DISTANCES FROM A PASTORAL HAMLET (NOVEMBER 1981)

Site	Distance from Village Center	Average Vegetation Height	Biomass (kg/ha)
Senquelo	0 meters	less than 10 cm.	516.7
	500 meters	35 cm.	1055.1
	1500 meters	50 cm.	4091.0
Inculas	0 meters	10 cm.	430.6
	500 meters	42 cm.	2583.80
	2300 meters	55 cm.	4414.0

The Table shows that vegetation within village limits had almost disappeared by late November due either to grazing pressure and/or to trampling and human activity in this crowded area. Less than one km from the village center, however, there is still considerable vegetation cover, even this late in the year. Less than two km from the village, vegetation seems to be intact. These findings call into serious question the regional overgrazing argument. Given the likelihood that much of the rangeland does not sustain significant damage from livestock and that seeds from these relatively intact areas can be transported to more heavily grazed ranges, the contention that the lowlands of Piura are severely overgrazed seems unsubstantiated. However, local or patchy overgrazing, especially near settlements or water sources, remains a problem in Piura -- as it is, too, in modern and intensively-managed production systems (U.S. Department of Agriculture 1965).

Adaptation of Woody Species to Grazing

Goats are browsing herbivores. Van Dyne et al. (1980) have shown that the caprine diet includes, on average, 59% shrub material, 29% grass, and 12% forbs. In comparison, the diet of sheep and cattle includes much more grass (50-70%) and very little browse (13-20%). Many researchers have taken these dietary differences as yet another indication of goats' destructive impact on rangelands (e.g., Cloudsley-Thompson 1970). However, while the fact that goats sometimes prefer browse means additional grazing pressure on woody vegetation, it also implies some relief for the dry, heavily utilized grasses. Late in the year when grass becomes scarce and the rangeland reaches a dangerous degree of exposure to radiation or rainfall, switching to woody material can be advantageous. Therefore, to examine fully the goat/rangeland relationship, particularly in the woody dry savanna of Piura, one must also understand the dynamics of browsing. Unfortunately, very little is known about this subject.

Algarrobo (Prosopis Juliflora), the most common tree in Piura, has numerous uses in the local culture (National Academy of Science 1979). Its nutritious, highly palatable pods have been an important livestock food since early colonial days (de la Calancha 1639). The question is: do goats significantly reduce the algarrobo population on Piuran rangelands by browsing its seedlings and consuming its pods, as many "capriphobes" claim? Or is this yet another biased and unsubstantiated contention? There is convincing evidence that goats actually contribute to the algarrobo's dispersal and recruitment.

Algarrobo seeds are well protected by a thick covering which enables them to withstand unfavorable conditions, especially drought. Before the seeds can germinate, they must be mechanically scarified or subjected to the mechanical and chemical activity of a mammalian digestive tract (Meyer and Morton 1971). Heavy grazing of algarrobo pods will eventually lead to an increase of germinable seeds on the range and therefore of algarrobo trees. Some scholars have suggested that the same process actually triggered the western U.S. mesquite invasion--a cogeneric species of algarrobo (Fisher 1950). It may well be the force behind the algarrobo's survival in Piura despite centuries of grazing, removal, and other types of human exploitation.

In the summer of 1983, after the heavy rains ceased, massive germination of algarrobo seedlings was observed in Piura. Much of this growth was found near herders' huts and corrals, thus supporting the hypothesis that goats actually assist in the germination and distribution of algarrobo. In some cases, the algarrobo seedlings were so thick around the ganadero's house that a path had to be cleared to keep the entrance open.

In an inclusive ecological study of the Prosopis genus it was shown that young algarrobo seedlings have more alkaloids in their leaves (Simpson 1977). This toxic material constitutes the algarrobo's defense against insects and heavy grazing. The likelihood that young seedlings will be destroyed by goats is therefore rather small. Support for these claims comes from an experiment on native goats' diet and nutrition conducted in Lambayeque as part of the CRSP Goat Project (Robert Cochran, pers. com.). When green algarrobo leaves were given to young goats as the sole fodder, a sharp decline in the kids' live weight was observed. The animals ate only a very small amount of the leaves, even though that was their only feed. The same behavior was also observed with the leaves of Zapote (Capris sp.), another common tree in Piura. Still, dry algarrobo foliage (puno) is a highly desired fodder for all types of livestock (Lara Perez 1969).

It sum, through natural selection a coevolutionary process between livestock and natural forage seems to have arisen to prevent overgrazing of the dominant woody species. Such coevolution is a longterm process. It may be the result of long interaction with native cameloids (llama, alpaca, guanaco, vicuna) or other native herbivores (e.g., deer). There is ample evidence that native cameloids grazed the rangeland of the Peruvian coast prior to the Spanish conquest in 1532 (Rostworowski 1981). At present, however, the cameloids are confined to the highlands, probably as a result of competition with introduced

livestock. The high incidence in Piura of plants with thorns (e.g., faique, analague, mosquera) or other defense mechanisms (e.g., the gluey liquid in overal fruit, an abortive substance in zapote fruit) also indicates a longstanding association between woody plants and herbivores.

Today, many range managers consider the distinctive ability of goats to browse woody vegetation an advantage rather than a threat to rangelands. Goats are used to control woody plant biomass so as to increase herbage production, to keep shrubs from encroaching on grasslands, and to balance off various components of the vegetative community (Malechek 1982). In other words, certain levels of goat activity can improve range conditions.

If so many theoretical and practical questions surround the issue of overgrazing and resource degradation in Piura, statements like the following seem curious: "In the savanna (of coastal Peru)...indiscriminate grazing of livestock, especially goats, is diminishing the forage value and decreasing the natural seedling establishment of shrubs and trees. All this leads to the breaking of the restoration cycle of organic matter and the subsequent reduction in the agricultural-livestock potential" (Contreras and Gasto 1978).

Such scientific "observations" evidently underlie government policies and bureaucratic objectives, as exemplified in the following citation from a policy document of the Peruvian Ministry of Agriculture: "The objectives of the program (for development in the goat sector) are to dictate norms in the agrarian zones (administrative units) for fulfillment of intended actions of organizing, controlling, and improving the technology of goat husbandry, with the objective of finding an integral solution for the social, agricultural, sanitary, and ecological problems (my emphasis) that this activity raises, as well as to increase the quantity, improve the quality, and to diversify the use of the products of goat husbandry" (Direccion General de Produccion Agricola 1976).

Part of the overgrazing problem is the difficulty of determining whether overgrazing even occurs at all, to what extent it occurs, and whether grazing or environmental conditions are responsible for reductions in vegetation in Piura. However, I believe that the root of the controversy more likely lies in the political, rather than the ecological/biological, realm. Whether goats overgraze the despoblados is not the only question at issue here; hopefully, this report has cast some doubt on this claim. Equally relevant questions, not only for Piura but also for many other parts of the world are: who originates and perpetuates allegations of resource degradation and what are the motives behind such allegations?

The Socio-Political Context of the Overgrazing Controversy

In discussing political aspects of overgrazing, several dimensions of the problem must be distinguished. Each of these contributes, at

least in part, to making goat herding a "social, agricultural, sanitary, and ecological problem." Among these dimensions are:

- o "anti-goat" prejudice
- o scientific or "pesudo-scientific" trendiness and biases
- o production-related or resource-control politics
- o bureaucratic politics
- o sociocultural conflicts

Figure 8.2 displays the interrelationships among these dimensions graphically.

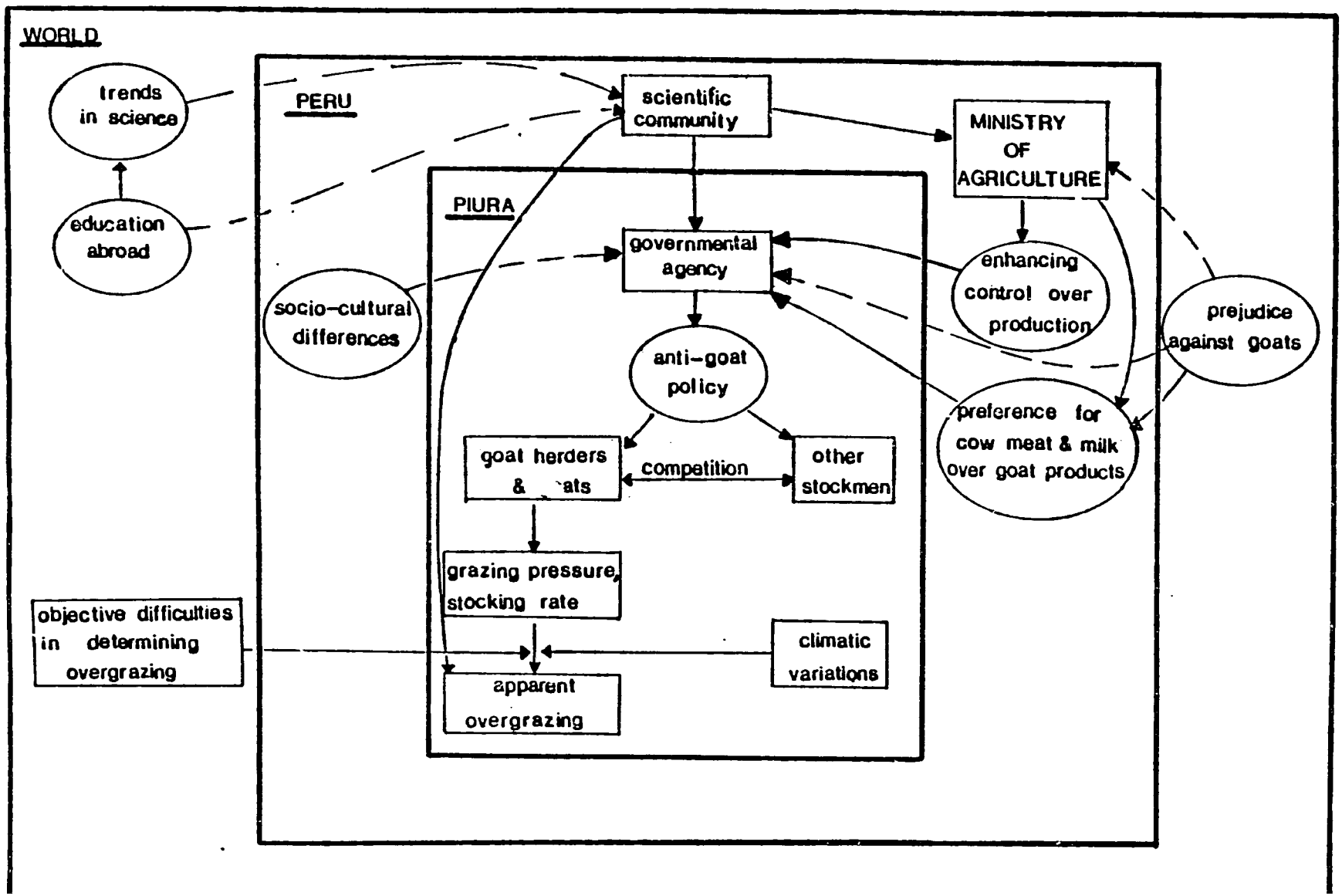
"Anti-goat" Prejudice. A major bias contributing to the overgrazing controversy is "anti-goat" prejudice. Goats have long been branded the primary culprits in range deterioration and overgrazing in the Old World and some regions of the New World. Norris (1982) rightly notes that the goat as an "individual entity" does not cause damage and desertification; rather, it is owners' mismanagement and misuse of goats. Nevertheless, the cultural bias against goats is so deeply rooted that it is not surprising to find, in a new and respected text on ecology, the following passage: "Of all domestic animals the goat is chiefly responsible for enlarging the deserts of Asia and Northern Africa" (McGinnies 1979).

Smelser (1982) describes the image of goats in ancient mythologies and religions. Goats were associated with peace and prosperity in old Mesopotemia; in the Near East, ancient Greece, India, Northern Europe, and China, they served as symbols of dieties. It is only the Judeo-Christian tradition which holds a negative image of goats. For example, an old Jewish custom sent a buck from the temple in Jerusalem to the Judaean desert once a year as an offering to the Devil. Jesus Christ was identified as the Good Shepherd of lambs, while goats were associated with Christianity's Devil. Modern-day Greek Sarakatsan shepherds raise both sheep and goats. Campbell (1964) mentions the Sarakatsan parallelism between livestock type and human sex: "sheep and goats, men and women, are important and related oppositions with a moral reference." Sheep are "God's animals," so male shepherds are more likely to take care of them. Women, however, are in charge of goats because they "are inherently more likely to have relations with the Devil and goats were originally the animals of the Devil" (Campbell 1964:26).

The route from religious symbols through sociocultural values to biased scientific perception seems evident. Much of western scientific endavor reflects our own culture, so it is not surprising to sometimes find pseudo-scientific confirmation of cultural biases. Given the bad reputation of goats in many societies and the paucity of quantitative data on goats' impact on the environment, we should expect the discrediting of goats to continue. However, in recent years more objective studies of goats and of their importance in peasant economies have been published.

Figure 8.2

THE HUMAN CONTEXT OF THE OVERGRAZING CONTROVERSY



Short (1982) claims that "there is probably more bias toward goats than any other food producing animal" and that prejudices against goats arise from their "association with poverty and destitition." Short also argues that agricultural planners and decision/policy makers are very sensitive to this negative cultural bias and thus reject professional specialization on improvement programs in goat production. For example, Peru has only one animal scientist who specializes in goats despite the fact that there are more than two million head of goats in Peru. A similar situation obtains for the study of cameloids; although these animals are very important to the national economy of Peru, they are strongly identified with poor peasantry and sierra Indians.

Kolars (1966) shows how goats were actually used as "scapegoats" for deforestation of mountainous Antalya in Turkey. It was the woodman's ax which in fact destroyed most of the timber resources. In Kolars' words "It is at this point that the favorite villain of economic development specialists, particularly those concerned with the semi-arid lands, obtrudes his bearded chin. The goat has so long been regarded as a prime agent of destruction in landscape processes that surely the time has come for someone to play Zola for this malodorous Dreyfus."

Unfortunately, in Peru and in Piura, goats are still viewed very negatively -- especially by state officials and policy makers. In part this is because of the cultural and social attitudes just discussed. In contrast, no one in Piura mentions the environmental impacts of cattle on the vast rangelands of Pabur and Ganaderia Amazonas even though trampling is a visible problem in these regions, particularly in dry years.

Scientific Trendiness and Bias. This refers to a set of factors affecting the practice of the scientific process in either a conscious or subconscious way. These factors influence the objectivity of scientific work. The most important one is the desire to be in step with the latest scientific ideas, movements, and "fashions." A favorite issue in biological-ecological circles during the last decade has been environmental degradation and desertification. International and national conferences and far-reaching research programs dealing with these problems have burgeoned, and voluminous texts have been published (e.g., Eckholm 1976, Glantz 1977). Most of the systems studied in this scientific enterprise are located in developing countries. My claim is that in many cases (but definitely not in all, and perhaps not even in the majority) the urge to be fashionable replaces reliable evidence. Claims about resource depletion and degradation are accepted without convincing scientific data.

I believe that, in most cases, the blind acceptance of the prevailing paradigm (traditional herding-overexploitation-degradation) is not deliberate on the part of local scientists or technicians. Instead, it results from a lack of critical tools to assess assertions made by outside authorities. There is also a moral facet--the genuine concern and worry for fragile and heavily used environments. Such concern may lead people, consciously or subconsciously, to support certain opinions even at the price of scientific accuracy. This is not

to say, however, that overexploitation and deterioration never occur; rather it is to emphasize the responsibility to support such contentions with objective, and preferably quantitative, evidence collected over an adequate length of time.

In fact, overgrazing (in its irreversible sense) is very difficult to demonstrate, at least under certain circumstances. This only compounds the opportunity for "scientific" bias. Even under the best conditions it is difficult to distinguish between overutilization and overgrazing; and the extreme fluctuations in rainfall in dry savanna make such a distinction almost impossible. Many research resources must be invested over long periods of time in order to establish a claim of irreversible range deterioration. Without such study, charges against traditional pastoralists of irrational herding must be taken with some skepticism.

The interests of the international scientific community and the availability of research funds play a major role in initiating research projects, in selecting study objectives and methodology, and in determining the manner in which findings are presented. The overgrazing problem in Piura and the hostile conclusions concerning goat activity there are, in my opinion, examples of faddish foreign assumptions being applied to local conditions by national technical staffs without the training, resources, or perhaps the motivation, to verify them empirically.

Production-related Politics. This refers to the political economy of livestock raising and competition among various interest groups over access to and control of pasturage and agricultural markets. At least four groups are involved in such politics in Piura: cattle ranchers (engordaderos), dairy cow owners, milch-goat keepers, and meat (kid)-producing goat herders. The first three groups are usually wealthy entrepreneurs -- city dwellers who belong to the local middle or upper class. The goat herders are mostly peasants whose economic and social status is low.

The political implications of these differing socioeconomic statuses are obvious. The ranchers and milk-producing stockmen enjoy greater access to and influence upon high-ranking officials in government agencies--not to mention that many officials themselves keep livestock as a secondary source of income. Peasant herders, on the other hand, have almost no influence on decision-making with regard to livestock policy. Moreover, in an attempt to discredit goat herders, wealthy producers frequently argue that the irrational utilization, overexploitation, and unhygienic management associated with goat production ought to be replaced by modern, rationally-managed cattle/milk operations.

There are similarities between this political inequality and "capture theory." This theory states that some interest groups enjoy more access to and sympathy from agencies and thus can "capture" the agency's interest and manipulate its policies to their own ends (Culhane 1981). The stockmen elite often exercise their political power to gain more, or even exclusive, access to green pasture in the despoblados and

to obtain special market opportunities, e.g., with the dairy plant in Sullana.[4] The distribution of cotton seed meal among the various interest groups also illustrates economic discrimination based on political inequality (Ch. 5). Distribution of this important fodder is determined by Ministry of Agriculture quotas which favor the wealthy stockowners. The herders, who enjoy none of the political advantages of the ranchers, can do very little about their plight.

An intriguing example of this political aspect of livestock raising in Piura is Ganaderia Amazonas. This ranch was created by a partnership between private businessmen and the government aimed at profitable and efficient utilization of the vast quantity of grass covering the sandy despoblados in the Piura-Culucanas area after the torrential rains of 1972-73. Range estimates were made, the carrying capacity of the area was calculated, and based on these findings a massive number of cattle were introduced into the newly fenced area. But the calculations of pasture potential proved wrong, primarily because they were based on static, one-point observations taken during a very abundant year following an El Nino, and so failed to take into consideration the effects of drier years. Subsequent dry years and imprudent management had a noticeable impact on the condition and number of livestock on the ranch.

In response to this crisis, the ranch administration attempted to exclude all the campesinos' goats from the fenced area, despite the fact that goat herders had used this range for generations. The ranch management argued that the decline in forage quality and quantity was a result of caprine grazing habits and peasants' inadequate husbandry. Only a court decision allowed the herders to retain their traditional grazing privileges. These privileges had never before questioned -- not even by the hacendados, who were notoriously unsympathetic to the campesinos.

Bureaucratic Politics. Both scientific and political-economic considerations tend to affect, directly and indirectly, the decisions and policies of governmental agencies. Ministry officials naturally draw much of their knowledge about environmental issues from the scientific community. New scientific trends, ideas, and information, such as the flurry of interest in desertification and overgrazing, have been introduced to the bureaucratic establishment mainly through academic channels. A problem arises when policy and actions are based on "half digested" scientific information or unsubstantiated statements, sometimes imported from distant and non-comparable environments. Official policies regarding goat production are also affected by competition over pasture and fodder, and are likely influenced by wealthy and powerful stockmen.

However, still other considerations are generated from within the bureaucracy itself. The title of a policy document cited earlier -- "National Plan of Crops and Livestock Raising: Organization, Technical Improvement, and Control" -- introduces internal biases in policy-making. This title includes the four principal functions of the regional agency of the Ministry of Agriculture. First, it must provide a reliable estimate of, and an operational plan for, agricultural

production in the upcoming year(s) based on annual observations and censusing. Second, the agency is expected to initiate and implement improvement programs. Third, it is in charge of organizing and coordinating activities related to agricultural production (research, marketing, export/import, international aid), and of providing producers with extension services and technological information. Finally, but less importantly, the agency considers itself the controlling arm of the ministry or the government. Expansionism and control maximization are principal features of bureaucracies. This represents "the necessity to increase power if the agency is to survive and flourish in an administrative habitat crowded with other agencies" (Holden 1966).

In the Peruvian case the suggestion that the Ministry is seeking to exercise control must also be understood in light of the agrarian reform (Ch. 7). The reform granted the Ministry of Agriculture a long-sought active role in agricultural production in Peru. In the pre-reform era agricultural policies were mostly determined by the rich, influential landlords (hacendados) while official agencies had little say. McClintock (1979) even argues that the minimal involvement of government agencies in the actual agricultural process, and their e ecutives' resulting frustration, were among the factors leading to the agrarian reform. Today the Ministry's agencies participate in planning, execution, and development of production systems. Such involvement can be achieved only through a certain amount of control over production.

The principal means by which the agency secures this control is tight supervision of the distribution of the two most essential agricultural prerequisites -- capital and water. Little wonder, therefore, that the Ministry of Agriculture is deeply involved not only in the development of irrigation projects, but also in the daily allocation of water from new reservoirs. With regard to capital, the Banco Agrario, which is largely controlled by the Ministry of Agriculture, is the exclusive source of governmental credit. By governing water and credit, Ministry officials are in a position to dictate the type of crops planted, the size of area allocated to each crop, and/or management practices.[5]

In their study of agriculture, bureaucracy, and government in Peru, Cleaves and Scurrah (1980) argue that "the implementation of D.L. (decree law) 17752, governing the distribution of water, concentrated considerable influence in the hands of state officials, who could use water allotments to favor specific interests and to encourage certain cropping patterns." Cleaves and Scurrah also point out that the Ministry of Agriculture has in fact replaced traditional power groups (hacendados) in Piura, chiefly through controlling water -- the principal means of production in dry environments.

In many conversations and interviews, state officials complained they had no control, information, or influence on goat production on the despoblados. Traditional extensive goat production requires no government supplied capital or water. For other types of livestock, especially cattle, owners are required by law to vaccinate their herds. The Ministry provides cheap veterinary service and thereby gains access to the production system. By law, certain veterinary requirements must

be met by almost all stock production systems in Peru -- all, that is, except goat herding. Or in the words of a state official from Piura, "goats are outlaws here." The goat owner's dependence on official services is minimal; consequently, authorities' control over production is limited.

Financial and budgetary problems only increase the frustration of government agencies attempting to control goat production. Most goat herds are located far from agricultural areas. Transport and time are required to maintain close relations with owners and their herds. The Ministry's limited resources barely allow officials adequate contact with farmers in the more accessible river valleys.

Controlling goat production and correcting the resource degradation allegedly caused by goats serve as arguments for officials to acquire a larger slice of the budget pie. Bureaucracies are continuously endeavoring to increase their budget, to expand, and to annex other offices or assume more responsibilities (Niskanen 1973). I suggest that the local Piuran bureaucracy uses the overgrazing argument to increase its budget and/or control over livestock production. "Demonstrating" the ecological damage -- overgrazing, desertification, environmental degradation -- caused by extensive goat herding in the *despoblados* is the first step in the agency's struggle to gain funds and control. Emphasizing the role the agency can play in reorienting goat owners and thereby alleviating ongoing destruction is the second tactical step.

Sociocultural Conflicts. The negative image of goat herding in Piura is also related, in my opinion, to the sociocultural gulf between herders and officials. Almost all goat herders are *campesinos* of at least partial Indian origin (*cholos*). Although the term *campesino* chiefly refers to a distinct occupational and economic group, whereas *cholo* glosses an ethnic or cultural identity (Yambert 1982), the two words are used interchangeably. A *campesino* is almost always also a *cholo*, and vice versa. State officials, bureaucrats, and managers are all *mestizos* or *criollos* -- urban middle (or upper) class members who are racially, or at least ideologically, removed from Indians and peasants. By emic definitions, *mestizos* and *criollos* bear some Spanish blood and trace their descent to Spanish or Hispano-Peruvian ancestors (van den Berghe and Primov 1977). But their higher education, relative wealth, and political connections give *mestizos* the advantage in social life in Peru. Based on these qualifications they manage to fill almost all bureaucratic posts and to control private business. Such occupational inequality only perpetuates the socioeconomic, cultural, and racial gap between peasants and *mestizos*. Policy makers and top bureaucrats are members of yet another social class -- the *vecinos notables* 'prominent citizens'. They constitute the local elite, which is itself socioculturally distanced from the other groups.

In the view of officials -- *mestizos* or *vecinos* -- peasants agricultural practices account for Peru's backwardness. The race of livestock owned by the *campesino* is inferior, production is very low, and management is inefficient. For these officials, agricultural improvement means "mestisizing" the *cholos*. The more sophisticated officials believe that importing new technologies or exotic varieties of

crops or livestock from the developed countries (where many of them completed their professional education) will solve the problems of Peruvian agriculture.

I suggest that blaming campesinos for overgrazing and environmental destruction fits nicely into the mestizo worldview. It is inevitable that the "primitive" peasants will misuse rangelands, so it is the mestizo's role to correct their mistaken ways. By the same token, mestizo officials find other mestizo's ranch operations more appealing and "developed." According to the mestizo worldview, overgrazing and trampling of rangelands can only be induced by peasants' goats. (But recall the case of Ganaderia Amazonas.) And only goat herders are believed to dilute milk with water, while mestizo owners of milk cows are above such suspicion. (Recall, too, that this is the main reason for not using goat milk in the undersupplied dairy plant in Sullana.)

The antagonistic relationship between officials and producers is by no means solely a Peruvian phenomenon. To mention but one case among many, Perrier and Craig (1983) provide a similar example from northern Nigeria, where conflicts frequently arise between producers and the officials responsible for "developing" livestock production.

This chapter has reviewed various aspects of the controversial overgrazing issue in Piura, in order to show how speculative and ill-supported are most arguments implicating goats and goat herders in the destruction of the despoblados. In sum, I believe that the dry, variable-rainfall Savanna of Piura is not severely and irreversibly overgrazed under an extensive goat management system. Instead, social, cultural, economic, and political arguments account for the widespread agreement that goats destroy the Piuran scrublands. Figure 8.2's schematic analysis of these factors may also be applicable to many other cases where traditional extensive pastoralism is practiced in similar ecological niches.

To conclude, little has so far been said about objective changes in the Piuran environment. There is no doubt that Piura has suffered some serious environmental alterations in the last few decades. The charcoal industry denunded vast tracts of land during the first half of this century; in the second half, the urban market for firewood and parquet has been responsible for much of the degradation. Using woody vegetation as fuel in urban centers is a common problem in many arid and semi-arid environments (Eckholm 1976, Glantz 1977). Dourojeanni (1981) provides some data on intensive tree felling in northern Peru. He claims that governmental disinterest in forest resources, bureaucratic inefficiency and disorganization, and the lack of any public conservation norms, are the main causes of the on-going destruction of natural forests.

Goat herders are only indirectly involved in wood cutting; they occasionally serve as hired hands for urban firewood merchants. When a group of goat keepers succeeds in obtaining political control over its pasture land, as is the case in some comunidades campesinas or grupos campesinos (Ch. 7), that group attempts--though not always successfully--to prevent commercial tree cutting on its property. The

reasons why tree cutting has not received its fair share of criticism in the Peruvian desertification controversy is beyond the scope of this study; but, like goat herding, it must be examined in sociocultural and political context.

CHAPTER 9

CONCLUSIONS

This report presents information from an 18 month study of the environmental context and the human factors of goat herding in the Piura region of Peru. It shows that like any other agricultural process in a developing country, goat production can be understood only in a broad, comprehensive context. Here, the most significant findings from these researches are summarized.

1. Goat management in Piura is very extensive--the result of minimal capital investment, which in turn dictates a strong reliance on natural forage along with limited diet supplementation and minimal veterinary care (Ch. 3).

2. Nine goat production systems were defined in Piura. They differ in principal features such as the degree of peasant's economic dependency on livestock raising, or the main forage sources used by herds. Each production system has a characteristic size and composition of herd, similar production parameters (age at first kidding, peak period of kidding, or number of kiddings per year), similar management features (supplementation, migration, weaning), and similar marketing patterns (milk or cheese selling, age and period at which kids are sold). Obviously, each system also manifests characteristic limiting factors. The various production systems are spatially distributed in relation to natural and agricultural ecozones, and to the socio-political organization of the group. However, this does not mean that in each geographical site or village one may not encounter operations belonging to different production systems (Ch. 4).

3. The size and composition of family herds in Piura are quite variable. They are determined, among other factors, by the family's dependency on livestock for subsistence, the nature of other economic activities, and the ecozone (natural or agricultural) in which the herd is located (Ch. 4).

4. Productivity of goats is mostly dependent on the availability and nutritional quality of forage which, in turn, is a function of dramatic fluctuations in precipitation (the El Nino and anti El Nino) (Ch. 3, 4, 5).

5. Goats are selected, first and foremost, for maximum kid production. Since milk production is an important factor in the survival of young kids, the overall outcome of selection is prolific does wth moderate milk yield (Ch. 3).

6. Selection among goats is not practiced by modern techniques but through marketing decisions; does are culled at any age once their kid production becomes unsatisfactory (Ch. 3, 6).

7. Census estimates of the goat population in Piura were found to be inaccurate for a variety of reasons (Ch. 3). A new censusing method, based on numbers of hides traded regionally, is suggested in qrder to improve demographic estimates.

8. The kidding cycle is a function of availability of the principal forage. Kidding in June is related to the availability of algarrobo pods during December-January. Kidding in December is a result of grazing on stubble fields in June-July. Kidding in September is connected with grazing on herbaceous vegetation during March-May (Ch. 3).

9. Kidding rates range between 1.3% and 2.0%, with a high twin percentage. Considering the very extensive management and the seasonality of forage, goat productivity in Piura is high (Ch. 3).

10. If enough forage is available, most adult does kid twice a year. This natural tendency is further enhances by selective culling (Ch. 3, 6).

11. The age of first kidding is also a function of forage availability and quality, and may occur from 12 to 24 months. Intentional selection by the herder keeps this age low (Ch. 3).

12. The mortality rate of kids is quite low -- only about 10%. This results from frequent sales of young kids (cabritos de leche) and from the dry climate and the spatial distribution of the herds, which together prevent diseases from spreading rapidly (Ch. 3).

13. The absence of reproductive controls or weaning techniques in Piuran goat husbandry may be related to the maximization of kid production and survival (Ch. 3).

14. Milk and cheese production is generally considered secondary. It is conditional upon a surplus of milk, which is in turn a function of forage abundance. Milk is almost never marketed except in milk-producing operations which rely on urban markets. In contrast, half-dry cheese (queso) is produced mostly for marketing (Ch. 3).

15. The Piuran goat is a moderate milk producer: 0.5-1.0 liter/goat/day (see conclusion #5) (Ch. 3).

16. In many cases, goat graze the despoblados without any human supervision; in most other cases a family member (usually a child) shepherds them (Ch. 3).

17. Self-consumption of goat meat is quite low (1-2 goat/months). The herder usually prefers to purchase meat in the village store or at a nearby market rather than to slaughter a goat from his own herd (see conclusion 22) (Ch. 3).

18. Most of the marketed goats are either maturing male kids or adult does whose productivity has significantly declined (Ch. 3, 6).

19. The age at which kids are sold depends on the economic status of the family (a function of alternative sources of income), on forage conditions, and on the survival prospects of the young kids (Ch. 4, 6).

20. Campesinos who own small cropping plots in the dry ecozones of Piura (e.g., Catacaos) sell kids at any age according to economic need --

particularly for seasonal investment in the agricultural operation (Ch. 4, 6).

21. People who own moderate or large agricultural plots in a favored ecozone (e.g., Morropon) sell maturing kids whose weight, and therefore price, is higher (Ch. 4, 6).

22. Goatkeepers who subsist exclusively or primarily on their herds sell very young kids (1-3 months old) in dry years and maturing kids (10-15 months) in abundant years. During droughts, herders are also compelled to sell productive does, thereby decreasing herd size. However, in good years they attempt to increase their herds, and sell livestock only if money is required (Ch. 6).

23. The average age for culling goats in Piura is 5-6 years (Ch. 3).

24. Piura has a long history of highly developed trade in goat hides. At present, as in the past, most of the hides are exported to centers of leather industry (Ch. 3, 7).

25. The principal causes of mortality among adult goats in Piura are: epidemics, most commonly septicemia and pneumonia; intoxication from borrachera (Impomaea carnea); and predation by mountain lions. In some area rustling is a disturbing problem. By and large, mortality rates are not very high -- only about 10% (Ch. 3, 4).

26. An elaborate system of relationships between farmers and herders was observed and documented. Such relations are based on social and cultural connections -- kinship, compadrazgo, fiestas, religious gatherings. These relationships help people cope with the capricious climatic conditions of the region. While farmers gain access to the more abundant despoblado forages of wet years, herders gain access to resources in the agricultural areas (Ch. 5).

27. In addition to spatial bilateral relations between herders and farmers (e.g., livestock transactions under the al partir agreement), there is also a demographic exchange between the two groups. Moves from one subsistence system to the other are largely triggered by climate-induced economic crises (drought vs. flooding) (Ch. 5).

28. The particular history of relationships between campesinos and landlords or between peasants and the central government has had a significant impact on the peasant subsistence economy in general, and on goat herding in particular. The land tenure system which for centuries prevailed in Piura was one of large estates controlling both cultivated land and scrubland. This appears to have prevented the evolution of migration cycles between lowlands and mountain slopes. But such migration may in fact allow more efficient and complete exploitation of the forage resources, thereby improving livestock production (Ch. 7).

29. The agrarian reform has had various effects on goat raising in Piura.
    - o The abolition of grazing fees charged by landlords.
    - o Some groups of herders gained control over their traditional pasturelands by forming grupos campesinos.

However, such groups still suffer from organizational instability, and they have won only partial recognition from government agencies.

- o Control over resources in the despoblados (now the property of the state) has been drastically weakened. As a result, in wet years, local herders suffer stiff competition from cattle ranchers; and in dry periods, the scrubland is destroyed by wood merchants.
- o Because of new agrarian organizations, difficulties have developed in using stubble in the agricultural fields. Priority today goes to members of cooperatives; "outsiders" are charged considerable grazing fees. Before the reform, many herders enjoyed free (or cheap) and exclusive access to haciendas' cotton stubble (Ch. 7).

30. Communities have not yet found a mechanism to control members who misuse communal resources (wood felling, charcoal making) and thus damage community pasturelands (Ch. 7).

31. Goat herders in Piura are accused of overexploiting and overgrazing natural resources. A biological analysis of this issue, both from a theoretical standpoint and from field observations, does not support such allegations. It seems that an extensive livestock production system which relies on internal capital sources (the herd itself) and which imports little supplementary fodder cannot induce very high grazing pressure. Also, if the availability of forage fluctuates considerably from year to year, such a system is not very likely to cause any serious overgrazing problems. Rather, it seems that social and cultural factors such as "anti-goat" prejudice, scientific biases, production-related conflicts, bureaucratic politics, and sociocultural differences underlie the accusation that goats and their owners destroy the Piuran scrubland. However, it should be noted that intensive wood cutting does take place in Piura and that it has a significant impact on the natural ecosystem. But herders participation in this activity is limited.

This report has emphasized two aspects of goat herding--the environmental context and the human factor. In too many cases environment is considered as stable or constant. But in Piura, cycles of drought and abnormal rains (El Nino) have an important impact on the herding system in terms of production and productivity, management, and economic returns. The human factor--the social structure of the herding community, its political strength, the land tenure system, the relations between different socioeconomic groups--is an equally important determinant of the herding system. Only an inclusive analysis which takes both these aspects into consideration can shed some light on herders' rationales. And only thus can proposals of development or planned interventions in traditional agroecosystems be made feasible.

NOTES

Chapter 2

[1] This section is based on information from various publications of the Peruvian Ministry of Agriculture and from the Atlas Historico Geografico del Peru (1970).

[2] A department is a geographical-administrative unit. Peru is divided into 22 departments. Each department is divided into provinces which are further divided into districts.

[3] This section is based on information from the Atlas Historico Geografico del Peru (1970), the Plan de Desarrollo Agricola del Proyecto Chira-Piura (here after referred to as PDAPCHP 1975) and from various publications of SENAMHI (Servicio Nacional de Meteorologia y Hidrologia).

[4] Sources: Mapa Geologica del Peru 1973, PDAPCHP 1975.

[5] Sources: SIPA 1963, ONERN, Mapa de suelos, Dept. de Piura.

[6] Sources: Tosi 1960, Macbride 1936, Malleux n.d., ONERN, Recursos naturales en el Dept. de Piura

[7] Sources: National census 1972 and 1981.

[8] The EAP is defined by the Peruvian census as including all persons between age sixteen to sixty. It is assumed that this is the potential working force.

[9] Sources: various publications of the Peruvian Ministry of Agriculture, PDAPCHP 1975.

Chapter 3

[1] According to interviews with Mr. Guillermo Galvez, the Commerce executive of Sociedad Mercantil Lima.

[2] The author is thankful to Dr. Helido Vidal the Director of the nutritional laboratory in the Universidad Nacional "Pedro Ruiz Gallo" in Lambayeque for his help.

Chapter 5

[1] Compares are co-godfathers. A strong social tie is established between a child's parents and selected friends and acquaintances who serve as godfathers for the child on various occasions (baptism, first nail/hair cutting, confirmation, wedding, etc.).

[2] The characterization of the El Nino presented here relies heavily on information from Cane 1983 and Wyrtki et al. 1976.

Chapter 6

[1] These data are found in monthly reports of the various slaughterhouses of Piura, published by the departmental office of the Ministry of Agriculture.

Chapter 7

[1] Probably researchers' fascination with the efficient organization of the Inca empire has led to an overemphasis on sierra socio-agricultural organization and an underemphasis of the structure in pre-Inca coastal civilizations. By and large, our knowledge and understanding of pre-Columbian coastal organization is rather limited.

[2] Piura has never attracted much archeological research, so extensive surveys of the *despoblados* have never been carried out.

[3] A similar process of livestock expansion as a consequence of indigenous depopulation and the opening up of previously cultivated land to grazing, is also reported for Mexico (Jacobson 1982).

[4] As was mentioned before, the Indian population was supposed to pay an annual tax to the Spanish Crown. The *encomendero* was responsible to extract this tax in return to a certain percentage.

[5] This section is based on information from Kay 1982, Keith 1976, Matos-Mar 1977, Pearse 1975, and Singlemann 1981.

[6] The information summarized in the last two paragraphs is based on numerous interviews conducted during the author's fieldwork.

[7] The information summarized in the last four paragraphs was gathered through conversations and interviews with *campesinos*, ex-hacendados and *mayordomos* (chief-administrators of haciendas) in various sites in the lowland of Piura.

[8] In some cases, land was given back to peasant communities to whom it had belonged historically or to a more complex social unit, the SAIS (Sociedad Agricola de Interes Social). SAIS's include cooperatives, communities, and service centers lumped together in one economic, but not productive, structure.

Chapter 8

[1] Dry savanna is in principle similar to 'semi-arid savanna' -- a region predominantly covered by continuous grass cover, with scattered to numerous trees and shrubs (Walker *et al*. 1981). The *despoblados* of Piura, at least on the eastern side, appear to resemble the Brazilian Caatinga: "a dense scrub about 3 meters tall with scattered overtopping trees to 5-6 meters" (Giten 1982).

[2] This behavior likely results from the unavailability of capital or credit to most herders. A herder's principal means of generating capital is selling goats. However, it makes very little sense to sell part of one's producing herd in order to purchase new producing goats. Besides, almost all potential sellers of goats are other herders, and they are not inclined to sell productive does, especially not when pasture is abundant.

[3] Diet of goats in Piura was monitored by following three herds, located in different econzones, once a month during October 1981 to May 1982. Garcia et al. (1982) describe the diet pattern of goats grazing in the Olmos region. The chemical analysis was conducted in the laboratories of Universidad Nacional Pedro Ruiz Gallo in Lambayeque. I am thankful to Dr. E. Vidal for his help.

[4] The plant's policy is not to purchase goat milk from peasants producers because of the suspicion that water was added to this milk. Dairy cow owners are, for some reason, above such suspicion.

[5] The "control" argument does not necessarily carry a negative connotation. The efficient utilization of communal resources distributed among many individual producers, or the accomplishment of national-level goals, objectively require a fair amount of control by a central entity.

BIBLIOGRAPHY

Antunez de Mayolo, S.
1981 Nutricion en el antiguo Peru. Lima: Banco Central de la Republica.

Anuario Estadistico Agropecuario
1963-1976 Lima: Ministerio de Agricultura.

Arauzo Benavidas, Oscar Raul
1973 Situacion actual de la produccion caprina en el Peru. Thesis, Univesidad Agraria, Nacional La Molina, Lima, Peru.

Archivo Departamental de Piura (A.D.P.)
1591-1820 Corregimiento no. 192, Causas Civiles, Logajo 14.

1662-1663 Corregimiento Civiles, Expediente 126, Legajo 9.

1679a Corregimiento no. 208.

1679b Prot. de Escr. Pub., Legajo 24, Fol. 70, 3 V.

1681 Prot. de Escr. Pub., Joseph de Cespedes, Legajo 24, Testament de Dona Juana de Ortega.

1695 Prot. de Escr. Pub., Escritor Valencia Domingo, Legajo 132, Fol. 386, 26 XI.

Aronson, D.
1980 Must nomads settle? In P.C. Salzman (ed.) When Nomads Settle: Processes of Sedentarization as Adaptation and Response. New York:Preager-Bergan.

Atlas Historico Geografico y de Paisajes Peruanos
1970 Lima: Instituto Nacional de Planificacion

Barnes, D.L.
1979 Ecology and management of the world's semi-arid regions. In B.H. Walker (ed.) Management of Semi-Arid Ecosystems. Amsterdam: Elsevier

Barth, F.
1964 Nomads of South Persia. New York: Humanities Press.

1973 A general perspective on nomad-sedentary relations in the Middle East. In C. Nelson (ed.) The Desert and the Sown. Berkely: Research Series No. 21, Institute of International Studies, University of California.

Bartolome J.W., Stroud, M.C. and Heady, H.F.
1980 Influence of natural mulch on forage production on differing California annual range sites. Journal of Range Management 33(1):4-8.

Bement, R. E.
1969 A stocking-rate guide for beef production on blue-grama range. Journal of Range Management 22:83-86.

Benzaquen, L. and Callacna, M.
1982 Evaluacion preliminar del comportamiento de caprinos criollos en areas semi deserticos. A paper presented in the meeting of the Peruvian Association of Animal Production, Cajamarca, November 1982.

Brady, N.C.
1974 The Nature and Properties of Soils. New York: Macmillan (8th edition).

Breman, H. and deWit, C.T.
1983 Rangeland productivity and exploitation in the Sahel. Science 221:1341-1347.

Burga M.
1976 De la encomienda a la hacienda capitalista: El valle del Jequetepeque del Sigle XVI al XX. Lima: Instituto de Estudios Peruanos.

1979 San Jacinto de Ucupe: Una estancia colonial en el valle de Zana. Analysis 2-3:183-200.

Callacna, M., Puicon, J. and Quijandria, B.
1982 Analisis de la produccion de leche por campana y otras caracteristicas productivas en cabras criollas. Paper presented in the meetings of the Peruvian Association of Animal Production, Cajamarca, November 1982.

Calle, O.W.
1968 Observaciones en la crianza y determinacion de algunos standards biometricos de la cabra criolla en Piura. Thesis, Universidad Agronomo de La Molina, Lima, Peru.

Calle, T.
1909 La ganaderia en la provincia de Ayabaca. Thesis, Escuela Nacional de Agricultura y Veterinaria, Lima.

Campbell, M.
1964 Honour, Family, and Patronage: A Study of Institutions and Moral Values in a Greek Mountain Community. Oxford: Clarendon.

Cane, M.
1983 Oceanographic events during El Nino. Science 222:1189-1195.

Capps, T. L.
1983 Preliminary results of the Piura goat survey: Basic goat production parameters.

Castillo, Roman J.L.
1977 Los rezagos esclavistas en Piura en el siglo XIX 1800-1854. Tesis en Historia, Universidad Nacional Mayor San Marcos, Lima.

Castro Pozo, H.
1947 El yanaconaje en las haciendas Piuranas. Lima: Compania de Impresiones y Publicidad.

Censo Agropecuario
1972 Lima: Ministerio de Agricultura y Alimentacion.

Chudleigh, P.
1976 The use of classification and description of animal production systems in the formation of priorities for agricultural research in Kenya. Agricultural Systems 1:281-299.

Cieza de Leon
1932 La cronica del Peru Madrid: Espasa (1550) Calpe.

Cleaves, P.S. and Scurrah, M.J.
1980 Agriculture, Bureaucracy and Military Government in Peru. Ithaca: Cornell University Press.

Cloudsley-Thompson, J.L.
1970 Animal utilization. In E.H. Dregne (ed.) Arid Lands in Transition. Washington: American Association for the Advancement of Science.

Cobo, Barnabe
1653 1956 Historia del Nuevo Mundo. Madrid: Biblioteca de autores espanoles.

Cole, H.H.
1966 Introduction to Livestock Production.

Collin-Delavaud, C.
1967 Consecuencias de la modernisacion de la agricultura en las haciencdas de la costa norte del Peru. In H. Favre, C. Collin-Delavaud, and J. Matos Mar La Hacienda en el Peru. Lima: Instituto de Estudios Peruanos.

Connolly, J.
1976 Some comments on the shape of gain-stocking rate curve. J. Agricultural Science (Camb.) 86:103-109.

Contreras, D. and Gasto, J.
1978 Description and transformation of the agricultural-pastoral ecosystems for the benefit of man in Bolivia, Chile and Peru. In D. Hyder (ed) Proceedings of the First International Rangelands Congress. Denver:The Society for Range Management.

Cordero, T., Velez-Nauer, M. and Callacna, M.
1977 Parametros reproductivos de caprinos Anglo-Nubian en la costa norte del Peru. Chiclayo: Informe Tecnico No. 96, Ministerio de Alimentacion.

Cornejo, Raul-Estuard
1972 Las fuentes de Matalache. Revista del Consejo de la Universidad Peruana #11.

Cuche Deynes
1975 Poder Blanco y Resistencia Negra en el Peru. Lima: Institute Nacional de Cultura.

Culhane, P.J.
1981 Public Lands Politics: Interest Group Influence on the Forest Service and the Bureau of Land Management. Baltimore: The John Hopkins University Press.

Dahl, G. and Hjort, A.
1976 Having Herds: Pastoral Herd Growth and Household Economy. Stockholm, Sweden, University of Stockholm, Department of Social Anthropology, Stockholm Studies in Sociology and Anthropology 2.

Darling, F.F. and Farver, M.A.
1972 Ecological consequences of sedentarization of nomads. In T.M. Farver and Y.P. Milton (eds.) The Careless Technology. New York: The Natural History Press.

de Janvry, A.
1975 The political economy of rural development in Latin America: An interpretation. American Journal of Agricultural Economics 57:490-499.

de la Calancha, A.
1639 Cronica Moralizada de la Orden de San Agustin en el Peru. Barcelona (cited in Burga 1976, pp. 28).

Devendra, C. and Burns, M.
1970 Goat Production in the Tropics. Bucks: Common-wealth Agricultural Bureaux.

Daniel, R., Perevolot , A., and Shkolnik, A.
1980 Is a black coat in the desert a means of saving energy? Nature 283:761-762.

Derteano, Carlos
1964 Crienza y explotacion del ganado cabrio lechero en Piura. La Vida Agricola:243-245.

Direccion General de Produccion Agricola
1976 Plans nacionales de cultivos y crianza, directivo #09-DGPA/DPP, organizacion, tecnificacion y control de la ganaderia caprina. Lima, Peru.

Dobyns, H.F.
1966 Estimating american population. Current Anthropology 7(4).

Dourojeanni, M.J. (ed.)
1981 Bosques y desarrollo rural en Lamboyeque. Boletin de Lima 15:65-77.

Duckham, A.M. and Masefield, G. B.
1970 Farming Systems of the World. Chatto & Windus, London.

Dyson-Hudson, N.
1966 Karimojong Politics. New York:Oxford University Press.

Dyson-Hudson R. and N.
1980 Nomadic pastoralism. Annual Review of Anthropology 9:15-61.

Dyson-Hudson R.
1983 Desertification as a social problem (a book review of B. Spooner and H.S. Mann Desertification and Development. Science 221:1365-1366.

Eckholm, E.P.
1976 Losing Ground: Environmental Stress and World Food Prospect. New York: Norton

Eguiguren, V.
1895 Las lluvias en Piura. Boletin de la Sociedad Geografica de Lima 4:241-248.

Faye, J.
1979 Farmer participation and accounting for the needs of the most disadvantaged groups: Some ideas on participation at the outset of a research program. In J. G. Ryan (ed) Proceedings of the International Workshop on Socioeconomic Constraints to Development of Semi-arid Tropical Agriculture. India, Andhra Pradesh: ICRISAT.

Feijoo de Sosa
1763 Relacion descriptiva de la cuidad y provincia de Trujillo. Madrid: Impresa Real.

Fernandez, F.
1982 La mujer en la Chira. Piura:CIPCA.

Fisher, G.
1950 The mesquite problem in the southwest. Journal of Range Management 3(1):60-70.

Foster, George
1960 Culture and Conquest. New York: Wenner-Gren Foundation for Anthropological Research.

Garcia, H. et al.
1982 Habitos de pastoreo en caprino criollos bajo crianza extensiva en Olmos. A paper presented in the Peruvian Animal Science Association meetings, Cajamarca, November 1982.

Garcia, H. C.
1983 Habitos de pastoreo del ganado caprino en la pradera natural de Olmos. Thesis, Universidad Nacional Lambayeque "Pedro Ruiz Gall".

Gilles, J. L. and Jamtgaard, Keith
1981 "Overgrazing in Pastoral Areas: The Commons Reconsidered." Sociologia Ruralis 21(2):129-141.

Giten, G.
1982 Brazilian "savannas." In B.J. Huntly and B.H. Walker (eds.) Ecology of Tropical Savanna. Berlin: Springer-Verlag.

Glantz
1977 Desertification: Environmental Degradation in and around Arid Land. Boulder, CO: Westview Press.

Hampe, T.
1977 Relacion de las encomenderos y repartimientos del Peru en 1561. Historia y Cultura 12:75-117.

Handelman, H.
1981 Peasants, landlords and bureaucrats: The politics of agrarian reform in Peru. In H. Handelman (ed.) The Politics of Agrarian Change in Asia and Latin America. Bloomington: Indiana University Press.

Hardin, G.
1968 The Tragedy of the Commons. Science 162:1243-1248.

Hart, R.
1982 An ecological systems conceptual framework for agricultural research and development. In W.W. Schaner, P.F. Philipp, and W.R. Schmehl (eds) Readings in Farming Systems Research and development, Westview, Boulder, CO.

Heady, H.
1975 Rangeland Management. New York: McGraw-Hill.

Herskovits, M.J.
1926 The cattle complex in East Africa. American Anthropologist 28:230-272.

Hindes, B. and Hirst, P.Q.
1975 Pre-Capitalist Modes of Production. London: Routledge, Henley and Boston.

Holden, M.
1966 "Imperialism" in bureaucracy. American Political Science Review 60:943-951.

Horton, D.
1973 Haciendas and Cooperatives. Research paper no. 53, Land Tenure Center, University of Wisconsin-Madison.

Innis, G.S., Noy-Meir, I., Gordon, M. and Van Dyne, G.M.
1980 Total-system simulation models. In A.I. Breymeyer and G.M. Vang Dyne (eds) Grasslands Systems Analysis and Man. Cambridge: Cambridge University Press.

Jack, Michael
1978 Zur intensivierungsmoglichkeit der Ziegenhaltung - Untersuchungsland Peru (a report on possibilities to intensify goat management). Liebig, Univ. Giessen.

Jacobson, N.
1982 Livestock complexes in late colonial Peru and New Spain: An attempt at comparison. Paper presented at the symposium on Hispano-American Economic and History of the Late Colonial Period: Mexico and Peru 1760-1810. University of Bielefeld (September 2-4, 1982).

Jimenez de la Espada
1881 Relaciones Geograficas de Indias. Madrid.

Jodha, C.
1982 The role of administration in desertification: land tenure as a factor in the historical ecology of western Rajasthan. In B. Spooner and H. S. Mann (eds.) Desertification and Development: Dryland Ecology in Social Perspective. London: Academic Press.

Kautz, R.R. and Keatinge, R.W.
1977 Determining site function: A north Peruvian coastal example. American Antiquity 42(1):86-97.

Kay, C.
1982 Achievements and contradictions of the Peruvian agrarian reform. J. of Development Studies 18(2):141-170.

Keith, R.G.
1970 Origen del sistema de hacienda. In R.G. Keith, et al. (eds) La Hacienda, La Comunidad y El Campesino en El Peru. Lima: Instituto de Estudios Peruanos.

1971 Encomienda, hacienda and corregimiento in Spanish America: A structural analysis. Hispanic American Historical Review 51(2):431-446.

1976 Conquest and Agrarian Change: The Emergence of the Hacienda System on the Peruvian Coast. Cambridge:Harvard University Press.

Kelly, R.D. and Walker, B.H.
1976 The effects of different forms of land use on the ecology of a semi-arid region in south-eastern Rhodesia. Journal of Ecology 64(2):553-576.

Kolars, J.
1966 Locational aspects of cultural ecology: The case of the goat in non-western agriculture. Geographical Review 56:577-584.

Laning, E. P.
1967 Peru Before the Inca. Englewood Cliffs, N.Y.: Prentice-Hall.

Lara Perez, Y.
1969 El Puno en raciones para vacas lecheras. Thesis, Universidad Nacional de Piura.

Le Houerou, H.N.
1979 Long-term dynamics in arid-land vegetation and ecosystems of North Africa. In D.W. Goodall and R.A. Perry (eds) Arid-land Ecosystems: Structure, Functioning and Management. Cambridge: Cambridge University Press.

Lequanda, Joseph Ignacio
1965 (1793) Descripcion geografica del partido de Piura, perteneciente a la Intendencia de Truxillo. Mercurio Peruano 8:167-229. Facsimile of the 1793 edition. Lima: Biblioteca Nacional del Peru.

Lockhart, J.
1969 Encomienda and hacienda: The evolution of the great estate in the Spanish Indies. Hisp. Am. Hist. Rev. 49(2):411-429.

Lopez Albujar, E.
1936 Los Cabaneros del Delito. Lima.

Luna de la Punta, C.
1966 Explotacion intensiva de caprinos en el Peru. Seminario, Department de produccion animal, Universidad Nacional Agraria La Molina, Lima, Peru.

Macbride, L.F.
1936 The Flora of Peru. Publication 351, Botanical Series, Vol. 13, Field Museum of Natural History.

Mackenzie, David
1967 Goat Husbandry. London: Faber & Faber.

Malechek, J.C.
1982 Grazing management of goats in extensive rangeland production systems. Proceedings of the 3rd International Conference on Goat Production and Disease. Scottsdale, Arizona: Dairy Goat Journal Publication.

Malleux Orjeda, J.
n.d. Mapa forestal del Peru. Lima:Universidad Nacional Agraria La Molina.

Mapa Geologica del Peru
1973 Lima: Instituto Geographico Militar.

Marx, E.
1980 Wage labor and the tribal economy of the Bedouin in south Sinai. In C.P. Salzman (ed.) When Nomads Settle: Process of Sedentarization as Adaptation and Response. New York:Prager-Bergan.

Matos Mar, J.
1976 Yanaconaje y reforma agraria en el Peru. Lima: Instituto de Estudios Peruanos.

1977 Sharecropping on the Peruvian coast. . In R.G. Keith (ed.) Haciendas and Plantations in Latin America History. New York:Holmes and Meier.

McClintock, C.
1979 Peasant Cooperatives and Political Change in Peru. Princeton:Princeton University Press.

McCorkle, Constance M.
1983 Meat and Potatoes: Animal Management and the Agropastoral Dialectic in an Indigenous Andean Community, with Implications for Development. Ph.D. Dissertation, Stanford University.

McDowell, R. E. and Hildebrand, P. E.
1980 Integrating crop and animal production: making the most of resources available to small farms in developing countries. Paper presented at the Bellagio Conference, 18-23 Oct. 1978 (cited in W. W. Shaner, P. F. Phillip, and W. R. Schemel, 1982).

McGinnies, W.G.
1979 Arid-land ecosystems common features throughout the world. In D.W. Goodall and R.A. Perry (eds.) Arid-land Ecosystems: Structure, Functioning and Management. Cambridge: Cambridge University Press.

McNaughtom, J.
1979 Grassland-herbivore dynamics. In A.R.E. Sinclair and M. Norton-Griffiths (eds) Serengeti: Dynamics of an Ecosystem. Chicago: University of Chicago Press.

Mendoza, S. E. et al.
1978 Incremento de la produccion de leche y carne de ganado caprino en la Quebrada de Parinas. Piura: Convenio--Universidad Nacional de Piura y Ministerio de Alimentacion.

Meyer, R.E. and Morton
1971 Morphology and anatomy of honey mesquite. U.S. Department of Agr. for Ser. Tech. Bull., No. 1423.

Modesto de Rubinos, Jr.
1936 Un manuscrito interesante: Sucesion cronologica de los curas de Morrope y Pacora. Revista Historia 10:289-363.

Morley, F.H.W.
1981 Management of grazing systems. In F.H.W. Morley (ed.) Grazing Animals. Amsterdam: Elsevier.

Morner, M.
1974 La hacienda hispanoamericana en la historia: Un esquema de reciente investigacion y debate. Desarrollo Economico 13(52):741-773.

Mott, G.O.
1960 Grazing pressure and measurement of pasture production. Proceedings of the 8th International Grassland Congress (pp. 606-611).

National Academy of Science
1979 Tropical Legumes: Resources for the Future. Washington: Academy of Science.

Newman, M., Quedraogo, I., and Norman, D.
1979 Farm-level studies in the semi-arid tropics of West Africa. In J.G. Ryan (ed) Proceedings of the International Workshop on Socioeconomic Constraints to Development of Semi-arid Tropical Agriculture, India, Andhra Pradesh: ICRISAT.

Niskanen, W. A.
1973 Bureaucracy: Servant or Master? London: The Institute of Economic Affairs.

Nolte, Enrique
1978 Produccion de Caprinos. Lima: Ministerio de Agricultura y Alimentacion.

1980 Relacion Cabra-Monte. Lima:Universidad Nacional Agraria La Molina.

Nolte, E. Y. Arauzo, D. R.
1973 Situacion actual de la ganaderia caprina en el Peru. Lima: Dept. de Producion Animal, Universidad Nacional Agraria La Molina.

Norman, D. W., Simmons, E. B., and Hays, H. M.
1982 Farming Systems in the Nigerian Savanna: Research and Strategies for Development. Boulder, CO: Westview Press.

Norris, J.J.
1982 Desertification and the goat. In Proceedings of the 3rd International Conference on Goat Production and Disease. Scottsdale, AZ: Dairy Goat Journal Publication, (p. 409).

Norton, B.
1976 The management of desert grazing systems. In M. Glantz (ed.) The Politics of Natural Disaster - The Case of the Sahel Drought. New York: Prager.

Olasibal Soplopuco, J.
1982 Proceso de configuracion y desintegracion de la Comunidad "Santo Domingo de Olmos" (1540-1981). Thesis, National University "Pedro Ruiz Gallo," Chiclayo, Peru.

ONERN
n.d. Mapa de suelos, Dept. de Piura. Unpublished report.

n.d. Recursos Naturales en el Dept. de Piura. Unpublished report.

O'Phelan, S.
1979 El norte y las revueltas anticlericales del siglo XVIII. Historia y Cultura 12:119-135.

Ordenorte
1980 Caracterizacion de la provincia de Sullana.

Orlove, B. S.
1973 Abigeato: La organizacion social de una actividad ilegal. Allpanchis Phuturinga 5:65-82.

Orlove, B.S. and Custred, G.
1980 The alternative model of agrarian society in the Andes: Households, networks, and corporate groups. In B.S. Orlove and G. Custred (eds) Land and Power in Latin America. New York: Holmes and Meier.

Parodi, G. and Zambrano, R.
1967 Evaluacion forajera de pastos naturales en el departamento de Piura. Veterinaria y zootecnica 53:16-30.

Pearse, A.
1975 The Latin American Peasant. London:Frank Cass

Perevolotsky, A.
1985 The Impact of the El Nino of 1983 on Goat Herding in Piura. SR-CRSP Technical Report #33, Department of Rural Sociology, University of Missouri-Columbia.

Perrier, G.K. and Craig, P.S.
1983 The effects of the 'development approach' on long term establishment of a grazing reserve in Northern Nigeria. Overseas Development Institute, Agricultural Administration Unit, Pastoral Network Paper.

Piqueras, S. J.
1981 Plan de desarrollo de la ganaderia caprina de leche en el bajo Piura. ORDENORTE-Proyecto Especial Chira-Piura, Piura.

Pitt, M.D. and Heady, H.F.
1978 Response of annual vegetation to temperature and rainfall patterns in Northern California. Ecology 59(2):336-350.

Plan de Desarrollo Agricola del Proyecto Chira-Piura (PDAPCHP)
1975 Piura: Ministerio de Agricultura y Alimentacion, Direccion Ejecutiva del Proyecto Especial Chira-Piura (5 vol.)

Pratt, D.J. and Gwynne, M.D.
1977 Rangeland Management and Ecology in East Africa. Hunington, N.Y.: Krieger.

Primov, G.
1981 The regional structure of distribution of mutton in Cusco, Peru. Small Ruminant CRSP, Sociology Technical Report Series. University of Missouri-Columbia.

Ramirez-Horton, S.
1977 Land Tenure and the Economics of Power in Colonial Peru. Ph.D. dissertation, University of Wisconsin, Madison.

Renan Iglesia, Wilmer.
1975 Estudio de las inundaciones en Piura, ano 1972. Thesis, Universidad Nacional Agraria La Molina, Lima.

Revesz, B.
1980 Estructura de la Produccion en el Agro Piurano. CIPCA, Piura.

Rossi, H.
1940 Los rios costaneros de los departamentos del norte y la influencia que ellos tienen sobre los bosques cisandinos del Peru. Boleten de la Sociedad Geografica de Lima.

Rostworowski, M.
1961 Curacas y Sucesiones, Costa Norte. Lima: Imprenta Minerva.

1977 La estratificaion social y el hatun curaca en el mundo andino. Historica 1 (2):249-286.

1981 Recursos Naturales Renovables y Pesca: Siglo XVI y XVII. Lima: Intituto de Estudios Peruanos. pp. 51-52.

Rubin de Celis, E.
1977 Las CAPs de Piura y sus contradicciones. Piura: CIPCA.

Saint, W. S. and Coward, W. E.
1977 Agriculture and behavioral science: Emerging orientation. Science 197:733-737.

Sanford, S.
1982 Pastoral strategies and desertification: Opportunism and conservation in dry land. In B. Spooner and H. S. Mann (eds.) Desertification and Development: Dryland Ecology in Social Perspective. London, Academic Press.

Sevilla, V.
1980 Estabulacion de ganado caprino: diseno de establo para 300 madres en San Lorenzo. Thesis, Universidad Nacional Agraria La Molina, Lima.

Shaner, W. W., Philipp, P. F. and Schmell, W. R.
1982 Farming Systems Research and Development: Guidelines for Developing Countries. Boulder, CO: Westview Press.

Sheridan, D.
1981 Desertification of the United States. Washington: Council on Environmental Quality.

Short, C.
1982 Cultural attitudes and their effect on the role of the goat. Proceedings of the 3rd International Conference on Goat Production and Disease. Scottsdale, AR: Dairy Goat Journal Publication (p. 293).

Sibille A.
1972 Algunas parametros de la reproduccion en la especie caprina del departamento de Piura. Thesis, Universidad Nacional Agraria La Molina, Lima.

Simpson, B. B.
1977 Mesquite: Its Biology in Two Desert Scrub Ecosystems. Pennsylvania: Dowden, Hutchinson & Ross.

SINAMOS
1974 CAP Miraflores, Informe:Centro de Estudios de Participacion Popular. Piura: Serie monografias, documento de trabajo.

Singelmann, P.
1981 Structures of Domination and Peasant Movements in Latin Amercia. Columbia:University of Missouri Press.

SIPA
1963 Estudio Prelimenario del Potencial Agricola del Departamento de Piura, Lima.

Smelser, R.E.
1982 Images of goats in art. Proceedings of the 3rd International Conference on Goat Production and Disease. Scottsdale, AR: Dairy Goat Journal Publication (p. 293).

Sobro, G.M.
1977 Nomads on the scheme - A study of irrigation agriculture and pastoralism in eastern Sudan. In P. O'Keefe and B. Wisner (eds.) African Environment - Land Use and Development. London:International African Institute.

Solano Zamora, H.
1977 Redimiento y valor nutritivo de los principales pastos naturales de la zona de Olmos en condiciones naturales y cultivados. Thesis, Universidad Nacional "Pedro Ruiz Gallo", Lambayeque, Peru.

Spedding, C. R. W.
1975 The Biology of Agricultural Systems. New York: Academic Press.

Stern, Steve
1981 The Rise and fall of Indian-White alliances: A regional view of "conquest" history. Hispanic American Historical Review 61(3):461-491.

Swift, J.
1977 Desertification and man in the Sahel. In P. O'Keepe and B. Wisner (eds.) Land-Use and Development. London: International African Institute.

Talbot, L.M.
1969 Ecological consequences of rangeland development in Masailand, East Africa. In T.M. Farver and J.P. Milton (eds) The Careless Technology. New York: The Natural History Press.

Thorp, R. and G. Bertram
1978 Peru 1890-1977: Growth and Policy in an Open Economy. New York: Columbia University Press

Tosi, J.A.
1960 Zonas de Vida Natural en el Peru. Lima:Instituto Interamericano de Ciencias Agricolas de la O.E.A.

U.S. Department of Agriculture
1965 Improving cattle distribution on western mountain rangeland. Farmers' Bulletin, No. 2212.

Van den Berghe, P. and Primov, J.
1977 Inequality in the Peruvian Andes: Class and Ethnicity in Cuzco. Columbia: University of Missouri Press.

Van Dyne, G.M., Brockington, N.R., Szocs, Z., Duke, J. and Ribic, C.A.
1980 Large herbivore subsystem. In A.I. Breymeyer and G.M. Dyne (eds.) Grasslands, Systems Analysis and Man. Cambridge: Cambridge University Press.

Velez-Nauer, M. and Callacna, M.
1976 Die Ziege als Fleischtier in Trockengebieten aus Peru. Unpublished manuscript.

1980 Crecimiento de cabritos Anglo-Nubian y criollos y composicion corporal. Boletin Tecnico No. 104, INIA, Chiclayo.

Vincze, Lajos
1980 Peasant animal husbandry: A dialectic model of techno-environmental integration in agro-pastoral societies. Ethnology 19(4):387-403.

Walker, B.H.
1979 Management principles for semi-arid ecosystem. In B.H. Walker (ed.) Management of Semi-Arid Ecosystems. Amsterdam: Elsevier.

Walker, B.H., et al.
1981 Stability of semi-arid savanna grazing systems. Ecology 69:473-498.

Walker, B.H. and Nay-Meir, I.
1981 Aspects of the stability and resilience of savanna ecosystem. In B.J. Huntly and B.H. Walker (eds.) Ecology of Tropical Savanna. Berlin: Springer.

Whitaker, M.D. and Wennergren B.E.
1978 Common-property rangeland and overgrazing: Resource misallocation in Bolivian agriculture. In D. Hyder (ed.) Proceedings of the First international Rangeland Congress. Denver: The Society for Range Management.

Widstrand, C.G.
1975 The rationale of nomad economy. Ambio IV:146-153.

Witcombe, J. R.
1977 The distribution of cropping systems in Northern Pakistan. Agroecosystems 3:285-290.

Wolf, E.
1957 Closed corporate peasant communities in Mesoamerica and central Java. Southwestern J. of Anthropolgy 13:1-18.

Wolfe, M.
1966 Rural settlement patterns and social change in Latin America. Latin America Research Review 1(2):5-64.

Wyrtki, K., et al.
1976 Predicting and observing El Nino. Science 191:343-346.

Yambert, K.A.
1980 Thought and reality: Dialectics of the Andean community. In B.S. Orlove and G. Custred (eds) Land and Power in Latin America. New York: Holmes and Meier.

1982 Peasant Politics and the State: Agrarian Reform in Piura, Peru. Ph.D. dissertation, University of California, Davis.

Zenon, E. and M. Vargas
1977 Algunas notas sobre el desarollo economic de la hacienda Pabur. Estudios 3:85-118.

Zuniga, A.
1955 Crianza de caprinos en los despoblados de Piura. Thesis, Escuela Nacional de Agricultura, Lima.