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DROUGHT ASSESSMENT
AND
FUTURE STRATEGIES
FOR THE LIVESTOCK
SECTOR OF PUNO, PERU

A Report to USAID/Peru

Lima, April 1984

TABLE OF CONTENTS

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The team acknowledges the confidence that Mr. George Hill and Mr. David Bathrick had in the Small Ruminant Collaborative Research Support Program to invite the participation of researchers from the project for this consultory work, and to Dr. Benjamin Quijandría and Mr. Keith Jamtgaard for their effort to insure that we had all the facilities and support needed to carry out our activities.

Lima, Peru
March 21, 1984

PREFACE

The team wants to point out that this report is the opinion of the group based the results of approximately three weeks of visits to the affected areas, and interviews with institutional officials and producers in the department of Puno.

This report should serve as a basis for developing a plan to help in reducing the negative effects of future droughts on human and livestock populations in the southern Peruvian sierra. However, since this document deals mainly with livestock and range, other information available on drought effects, as well as existing plans to reduce the effects, should be consulted when regional strategy is planned.

Many of the recommendations are similar to those previously proposed by other groups and/or agencies. It is fair to say that our results were arrived at independently and therefore substantiate both our results and recomendations and those presented by others, as being appropriate actions to face the effects of the drought. On the other hand, some of the recommendations are contrary to actions already being planned. Justifications for these and the reasons for questioning these recommendations are also presented.

LIST OF TABLES

EXECUTIVE SUMMARY

The department of Puno has the largest area dedicated to native rangelands and livestock. Approximately 15 percent of the total native rangeland, 50 percent of alpacas and llamas, 20 percent of sheep and 15 percent of cattle of Peru belongs to Puno.

In January and February 1983, the normal season for rainfall and the maximum forage growth in the southern sierra, a drought began, which lasted to February 1984. Although, this drought was reported to be the worst in several decades, drought cyclicity is a usual problem in the southern sierra of Peru.

The objective of this work was to assess the effects of the drought on the livestock-forage production system and to recommend short, medium, and long term actions to relief the disastrous impacts of the cyclical droughts in Puno.

After travelling to the affected area and visiting with local agencies (CORPUNO, INP, and INIPA-CIPA XV), producers, and researchers, the team identified three groups of affected livestock producers. Those communities around Lake Titicaca, which were the most severely impacted. Those communities not around the lake which were affected, but not as severeley. And the large producers (SAIS'S, CAP's, EPS's, and large ranchers).

The difference in the affected areas related directly to stocking rates rather than to differences in rainfall. Losses of livestock due to mortality and culling attributed to the drought were estimated to be 23, 26, and 7 percent for cattle, sheep, and alpaca, respectively. Further, the area of the department of Puno is composed of primarily native pastures; very little effort is devoted to research and extension in this area.

Since the primary impact of the drought was on the peasants in the small communities, it is recommended that most of the drought relief and future planning efforts be directed toward these communities.

The main problem was the inbalance between livestock numbers and forage available. Therefore, to reduce the impact of future droughts, this need to be brought into closer balance by a combination of reducing livestock, improving native pasture management, developing cultivated pastures or annual

forages, developing irrigation systems, and improving feed storage. Programs need to be initiated to control parasites, so that the animals can take advantage of what forage is available. Further synchronizing parturition with the rainy season would increase the reproductive efficiency of the animals. During a drought, supplemental or stored feeds need to be allocated to those times of highest physiological demand.

During a drought, governmental intervention is needed in the marketplace to prevent decapitalization of the producers caused by reduced prices; also, the government could provide "food for work" programs to prevent migration to urban centers when the peasants have no crops or livestock to tend. Availability of of the appropriate agricultural inputs (seeds) following the drought must be ensured. Officials agencies would have to prepare for future droughts by improving marketing channels and infrastructure, providing processing of surplus meat, and improving the process of obtaining credit.

Risk should to be reduced at the producer level through the development of irrigation programs, promotion of changes in species composition of herds, and encouraging diversification of crop varieties and planting times. Further, a system of drought forecasting needs to be developed, and a high level commission to respond to these forecasts needs to be implemented along with emergency plans at the local level.

Since Puno is primarily a native pastures and livestock department, the resources of INIPA - CIPA XV need to be strengthened or reallocated into the native pasture area. More trained personnel is needed both at INIPA - CIPA XV and UNTA to effectively conduct a program on native pastures. The strengthening of the links between INIPA and UNTA that began during the drought needs to continue. Extension activity at the community level needs to be expanded probably following the model used in Proyecto de Investigacion en Sistemas de Cultivos Andinos -- PISCA project.

As a result of this report, four projects to implement the recommendations are proposed. They are in the areas of Community Development, Pastures, Farming System Analysis, and a Livestock Development that includes range management, animal health development, and a research component.

INTRODUCTION

The department of Puno has the largest area dedicated to native rangelands and livestock. Approximately 15 percent of the total native rangeland, 50 percent of alpacas and llamas, 20 percent of sheep and 15 percent of cattle of Peru are located in Puno.

In January and February 1983, the normal season for rainfall and the maximum forage growth in the southern sierra, a drought began, which lasted to February 1984. Although, this drought was reported to be the worst in several decades, drought cyclicity is a usual problem in the southern sierra of Peru.

According to INP-PUNO, a conservative estimate of the damage that the livestock incurred as a result of the drought over the last two years in the department of Puno, is placed at approximately 40 million US Dollars or 100 billion soles (US$1 = 2,500 soles). Nearly one fifth of the human population of Peru resides in the department of Puno, and of these, nearly two-thirds or over half million people, were affected by the drought.

An evaluation team was brought to Peru to assess the effects of the drought on the livestock forage production system and to recommend short, medium and long term actions to relief the disastrous impacts.

Some actions have already been initiated to reduce the impact of the past drought. In this report suggestions for improved range and livestock practices and possible mechanisms of implementing these practices for future droughts in the department of Puno are also presented.

BACKGROUND

The department of Puno is located in the South of Peru and has an area of 72,384 km , which is 5.6 percent of the country's area. Of this, 82 percent is sierra, between 3,812 and 5,852 m. of altitude. Native range lands cover 4.6 million hectares, or about 64 percent of the total departamental area.

The total population recorded at the 1981 census was 890,258 inhabitants, corresponding to 4.9 percent of the Peruvian population. Most of the Puno's population is located in the rural areas (69 percent). Population density approaches 13.2 inhabitants/km (CORPUNO, 1983). Rural social organization is dominated by two general types of institutions, the Agrarian Reform enterprises and the "traditional" institutions. The Agrarian Reform Enterprises (CAP, SAIS, EPS, etc.), were created during the 1968-1979 period. While these enterprises are extremely important to the economy of the region, the traditional institutions account for a greater share of the human population. These consist of the 460 officially recognized *comunidades campesinas* or peasant communities, and *parcialidades*, which closely resemble the peasant communities in their organization and functioning. It is recognized that there are also a substantial number of independent farmers, but they are discussed with the communities and *parcialidades* due to the essentially private holder characteristics of the traditional institutions in Puno.

The department of Puno is divided into 9 provinces. The most affected by the 1983 drought were Puno, Chucuito, Azángaro, Lampa, Huancané, Melgar, and San Román. Carabaya and Sandia were less affected. For this report, the affected populations were grouped into three socio-climatic groups:

A. Communities around the lake (average temperature between 6 and 10 degrees C, and 3,810 to 4,100 m of altitude).

B. Communities not around the lake (average annual temperature between 4 and 7 degrees C, and 4,100 to 4,800 m of altitude), and

C. Agrarian Reform Institutions (cooperatives, SAIS, communal farms, and social property enterprises).

These groups were choosen because the drought impact was different for each one of them. The most affected sector corresponded to the communities around the lake (group A), followed by the communities in the highlands (group B). The associative farms (group C), due to their advantage in resource availability as well as administrative and technical capacity, were less affected.

Of the estimated 570,340 drought affected persons (CORPUNO, 1983), slightly over three-fifths were located in communities surrounding Lake Titicaca, 29 percent were from communities away from the lake, while less than 10 percent were members and families of the Agrarian Reform enterprises in Puno.

PHYSICAL FEATURES

The Peruvian Altiplano is a flat high altitude basin rising 3800 m above sea level and stretching between 14 and 17 S and 69 71 W. This high plateau constitutes an ecosystem characterized by low temperatures, erratic and limited rainfall, and a relatively short growing season. The predominant subsistence activity of highland people has been pastoralism of native cameloids and cultivation of locally domesticated crops including the potato and Andean pseudo-cereals. This system continues today in rural areas and is supplemented with sheep, cattle, and crops introduced by early European immigrants. In contrast with this traditional system of pastoralism is the practice of progressive ranching by livestock associations established by the agrarian reform and a few private ranchers.

The climate of southern Peru is harsh. The high altitude alpine areas are characterized by a seasonal change of temperatures with warm summers and cold winters (Table 1). The mean monthly temperatures in the Altiplano vary only a few degrees within a year. The rainy season in the Altiplano begins in August and continues through April; however, effective precipitation does not occur until December. Approximately 75 percent of the annual precipitation comes from December to March (Table 2). The warmest weather occurs in October and November while the coldest weather occurs from June to August. The annual climate for the Altiplano has been subdivided into three periods:

1. The rainy summer (December through March), when approximately 75 percent of the precipitation occurs,

2. The transitional months (September through November and April) during which about 20 percent of the precipitation occurs, and

TABLE 1. AVERAGE MONTHLY TEMPERATURES FOR THREE LOCATIONS IN THE DEPARTMENT OF PUNO, PERU.

MONTH	PUNO	DESAGUADERO	CHUQUIBAMBILL
January	9.5	10.3	8.4
February	9.2	10.5	8.4
March	9.1	10.2	8.2
April	8.1	8.8	7.5
May	7.2	6.6	5.9
June	5.9	4.2	4.0
July	5.5	3.6	3.6
August	6.3	4.9	4.6
September	7.6	7.4	7.2
October	9.2	8.7	8.2
November	9.5	9.6	8.7
December	9.3	10.0	8.8

TABLE 2. AVERAGE MONTHLY AND ANNUAL RAINFALL (mm) FOR THREE LOCATIONS IN THE DEPARTMENT OF PUNO

MONTH	PUNO	DESAGUADERO	CHUQUIBAMBILL
January	120	125	140
February	135	132	136
March	134	95	131
April	37	29	51
May	14	13	16
June	1	4	1
July	3	4	4
August	4	6	2
September	30	22	25
October	36	18	47
November	53	41	71
December	121	119	154
TOTAL	687	607	778

3. The dry winter (May through August) when only 5 percent of the precipitation occurs.

In the vicinity of Lake Titicaca, where the landscape is mainly flat and somewhat swampy, humic gley and calcareous humic gley soil are predominant. Solonetz and Solonchack also occur on local salty spots. Beyond the flats, the general surface is at a mean elevation of 3850 m and has undulating to hilly topography. North of the lake, volcanic parent materials are common and the dominant soils are Mollic Andosols, associated with Gleysols, Histosols, Humic Cambisols and Kastanozems. Many of the soils are of moderate to heavy texture and are developed in old lacustrine sediments. Shallow lithosolic soils occur in the surrounding hilly land and shallow Rendzinas have developed where the parent materials are calcareous.

The Peruvian Altiplano is covered mostly by grasslands. However, on the scattered hilly and rocky formations, the vegetation is strikingly different. Generally, the north and west facing slopes are warmer and are characterized by sparse vegetation. South and east facing exposures are colder and wetter and support more vegetation.

The vegetation on these slopes consists mainly of xerophytic shrubs and grasses. The most conspicuous woody taxa are *Polylepis*, *Chiquiraga*, *Escallonia*, *Satureja*, *Ribes*, *Colletia* and *Puya raymondii*. Species of *Astragalus*, *Lupinus*, *Tetraglochin*, *Vicia*, *Epilobium*, *Nicotiana*, *Solanum*, *Calciolaria*, *Plantago*, *Stevia*, *Epatorium*, *Muhlenbergia*, and *Bromera* are other conspicuous components.

Polylepis (*P. besseri* and *P. Somentella*), commonly called "Kenoa", constitutes the only native tree of the Altiplano and forms localized woodlands. The other components of the slopes and hilly terrains are the Lussock grass communities dominated by "yurak ichu" (*Festuca dichoclada*), "ichu" (*Stipa ichu*), and "tisña" (*Stipa obtusa*).

Yurak ichu communities occur on shallow hilly terrains with considerable rainfall. Species of *Hieracium*, *Hypochocris*, *Ephedra*, *Poa*, and *Stipa* are the other components of this community. Ichu communities are broadly distributed either along the hilly formations or in the drier degraded plains. *Stipa ichu* is a tussock grass with extensive shallow roots growing in association mainly with taprooted plants such as *Hypochloeris*, *Tetraglochin*, *Liabum*, *Euphorbia* and *Ephedra*. On the other hand the *tisña* communities develop on black colluvial soils occurring at higher elevations and form relatively pure stands. The only other plants growing within this community are species of *Cajophora*, *Urtica*, *Stellaria*, and *Opuntia*.

The natural grasslands of the plains and rolling hills of the Altiplano can be differentiated into two major communities. In one side, *Festuca dolichophylla* and *Muhlenbergia fastigiata*, and in the other side *Calamagrostis antoniana*. The *Festuca-Muhlenbergia* community forms the "unbroken grasslands" when they are growing together. *Festuca dolichophylla* is a tussock grass and *Muhlenbergia fastigiata* is a short rhizomatous "carpet-like" grass locally called "chilliguares". Other components of this community occupying well drained and less profound soils, primarily of the humic Andosols, are *Calamagrostis*, *Poa*, *Hordeum*, *Paspalum* (*P. pigmaeum*), *Vulpia*, *Heleocharis*, *Trifolium*, *Geranium*, *Hypochloeris*, *Liabum*, *Nototriche*, *Acaulimalva*, *Gentiana*, *Cerastium*, *Plantago*, *Alchemilla*, *Gomphrena*, *Oxalis*, *Valeriana*, and *Sisyrinchium*. Species which readily invade deteriorated areas of this community are *Boutelona simplex*, *Aristida enodis*, *Stipa sp.* and the annual *Muhlenbergia peruviana*, as well as species of *Poa*, *Bromus*, *Calamagrostis*, *Erodium*, *Bidena*, *Gnaphalium* and *Tarasa*.

Calamagrostis antoniana, locally called "phorke" occupies mostly the humic gley and calcareous humic gleysols. Important genera associated with this community are *Poa*, *Muhlenbergia*, *Distichlis*, and *Ranunculus*.

The predominant species on the river banks and on sandy soils are *Festuca ortophylla*, *Aciachne prelvinata*, *Tetraglochin strictus*, and *Calamagrostis sp.* All of these species except *Calamagrostis* have sharp-pointed leaves, therefore, they are unpalatable. Sometimes *Festuca ortophylla* attains the height of a man. These species are invaders, but they form part of the natural climax at higher elevations, especially on highlands located on the west slopes (dry Puna).

Less important and very localized are the communities of *Distichlis humilis* with species of *Poa* and *Juncus* which occupy saline (Solonchack) soils. *Salicornia sp.* may be found on marshy saline soils.

Vegetation of the shallow waters near the shore of Lake Titicaca is composed of "totora" (*Scerpus totora*), "llachu" (*Myriophyllum elatinoides*), "chanku" (*Elodea potamogeton*), and *Ruppia maritima*, all of which are used as feed for cattle and sheep. Species of *Lemna* and *Chara* are other conspicuous components of the litoral zone of the lake.

Overlooking the Altiplano and its lower hillside is the high andean territory on alpine subtropical pluvial tundra. These high andean ranges in the altiplano basin are at about 4400 m and extend to the snow limit. Sparse vegetation of xerophytic grasses and "semi-continuous" communities of short grasses and cushion like plants alternate with areas of bare ground. Soils supporting this vegetation are of recent volcanic origin (Andosols) and those weakly developed from recent alluvial deposits (Lithos 's and humic cambisols).

The most frequent grasses and grass-like plants include *Festuca*, *Calamagrostis*, *Aciachne*, *Stipa*, *Scerpus*, and *Juncus*. *Azorella*, *Pycnophyllum*, *Distichia* and *Oxychloe* are genera that represent the cushion plants. Shrubs of *Taphala*, *Senecio*, and *Baccharis* may also occur on protected areas.

STOCKING RATES AND CARRYING CAPACITY

An obvious problem for families in communities in the region surrounding Lake Titicaca in the Department of Puno is excess livestock numbers relative to the available forage resource. An example is Camacani community (PISCA, 1982) where the average family has 0.71 ha of cropland and 1.22 ha of natural pastures in this land, each family grazed the equivalent of 58.9 sheep units in 1981 or 26.14 sheep units/ha. If each family grew 6 tons of forage/ha on the 0.71 ha of cropland and fed it all to livestock, this would leave a need for 4.34 tons of forage to come from the 1.22 ha of natural pastures or 3.56 tons/ha. This assumes only a maintenance forage intake 2 percent of the body weight.

It is doubtful that the natural pastures produce even one ton/ha, probably no more than 0.75 ton, thus there is about 5 times more animals grazing the natural pastures than the pastures should realistically be expected to carry. This also assumes no forage is left on the ground to maintain the growing capacity of the plant. A natural consequence of such severe overgrazing is that the more productive forage species are grazed out leaving only those species that produce enough leaves very low to the ground in a way that all the leaves cannot be grazed off. Such species can survive extreme overgrazing, but unfortunately they produce very little forage.

Now assume these lands can produce the maximum under good conditions. The native pastures would produce 2000 kg/ha and the cultivated pastures would produce 5000 kg/ha under dryland conditions. If the 1.25 ha of native pasture are divided into 40 equal segments so that each segment would be grazed completely and 40 days later, the animals would return to the same segment, but not before. This would provide good natural pasture management and allow the plants to grow properly and adequately. Therefore, each day the animal(s) would have access to 250 m which would produce 0.14 kg of forage per day. Sheep produced in this area average 20 kg body weight, therefore, they would require 0.4 kg (2 percent of the animals body weight) of forage per day just to stay alive (and this does not leave any reserve herbage for the survival of the plant). As can readily be noted, even under the best of natural pasture conditions, enough forage cannot be produced daily to support the maintenance requirements of more than one sheep unit.

The sheep unit above must be fed from cultivated crops grown on the other 0.75 ha, thus leaving only limited land for growing crops for human consumption. Assume these cultivated lands are not irrigated and produce an annual average of 5000 kg/ha. Therefore, 189.8 m (or 2.5 percent of the 0.75 ha assigned to cultivated crops) of the cultivated land would be required to produce sufficient feed to keep one sheep unit alive for one year. The above example does not allow sufficient forage for reproduction, nor does it illustrate the requirements of one cow which would be equivalent to approximately 8 sheep units.

If the sheep unit were fed sufficiently to reproduce and lactate, it would require 4 percent of its body weight in forage/day. Therefore 583.7 m (or 7.8 percent of the 0.75 ha assigned to cultivated crops) would be requiried to produced the balance of feed required for one sheep unit/year. As one can readily see, a family cannot adequately survive and produce the number of animals they own on 2 ha of land, regardless of what technological advances are available. In the communities bordering the lake, they are reported to feed bullrushes (totora), *Scerpus totora* as a supplement feed.

From the communities we visited, it appeared that primarily barley and some oats were being used effectively as forage for livestock. Also both provide grain for animal and human consumption. These are quite productive and the potential yield is relatively high. Although no yields were obtained, they have the potential to yield 4 to 10 tons of dry matter/ha depending on local conditions, fertilizer, management, etc. Aftermath or fodder from crops grown for human consumption are well used, as are the weeds plucked from the cropped fields.

CULTIVATED PASTURES

Beginning about 1974, New Zealand researchers began studying the potential for improved pastures for this area and their reserch has provided the major information available for species to use, soil adaptability, grazing management, productivity, seasonal growth, patterns, etc. Although these forage species could be used effectively by the community families, they apparently are little used at this time due to inexperience in their management, cost of seed, and the fact that their use is relatively new.

Alfalfa and *Dactylis glomerata* are suggested as a very productive mixture for the more level soils with good drainage. Areas where water stands (ponds) are not suitable for alfalfa. This forage mixture has the potential to produce 4 to 10 tons of dry matter/ha under dry land conditions and animal gains per head/hectare are very good because the forage quality is very high. Also, the alfalfa fixes soil nitrogen so that fertilizer needs are minimized and the stands are relatively drought tolerant. Potential disadvantages are that animal bloat is a serious problem except in cameloids where it is less. Plant stand maintenance requires a higher level of management, and during dry periods this mixture depends on rainfall for growth as do native pastures unless irrigated. Many cultivated pastures are overgrazed and some of them have deteriorated to the point that native grasses began to invade them and not all species planted were adapted to the soils and the climate.

Other species that are important in cultivated pastures are orchardgrass (*Dactylis glomerata*), ryegrass (*Lollium perenne*), and clovers (*Trifolium sp.*). Ryegrass/clover pastures apparently must be irrigated and they cannot tolerate the intense level of grazing sometimes imposed upon them. Both alfalfa and white clover (*T. pratense*) have been interseeded into native range. These interseedings have been successful when soil/water relationships are suitable.

Use of improved pastures in the communities will be limited somewhat, because of the need for growing human food crops on the croplands now being used. However, there should be significant portions of lands now in natural pastures with deep enough soil or land that is fallow (to allow the soil to recover some degree of fertility) that could be planted to improved pastures and which would allow for increased forage production. Because the legume and grass mixtures, if properly managed, are good soil-building crops, they could possibly be used on fallow land in a beneficial way. Again, well thought out management would be necessary to make this a useful practice. Where irrigation water is available the forages found most useful are white clover and perennial ryegrass, although such forages may have to compete with higher value food crops and possibly cash crops in the communities. This would probably not be the case in SAIS or other associative productive units.

In general, the CAPS, SAIS, and the larger private farmers of the highlands maintain an economic base of livestock, native pastures and cultivated pastures that is large enough to allow them flexibility in their management programs. The large producers in the highlands have primarily alpaca and sheep whereas at lower elevations cattle replaces alpaca. Most of the producers visited culled out at least 25 percent of their herds annually.

The producers who have access to irrigation water and cultivated pastures are able to produce additional forage for either grazing, hay, or silage. These irrigated cultivated pastures are also used to fatten animals for market or slaughter. Also, the larger producers usually have sufficient land (both native pastures and cultivated pastures) to allow some rotation of their livestock. Therefore, the pastures are rested for at least portions of the year, allowing a greater production of desirable forage species on a sustained basis. In conclusion, cultivated pastures have a place in management of the Southern Sierra, but they must be used with discretion.

LAND TENURE

In the department of Puno, as in most of the country and particularly in the higher parts of the Sierra, distribution of land among agricultural units is uneven. There coexist very large co-operative-like firms along with very small family holdings. Thus, any study trying to understand the reality of the agricultural sector should take into account these important differences.

According to the last available census figures (1972), there were almost 150,000 agricultural units (See Table 3 for details) in Puno, occupying 3.9 million hectares. Thirty-one percent of these units had a size of less than 1 hectare, comprising only 0.42 percent of the land area. These two figures reveal clearly the spread of minifundia, most of which is concentrated in the zone around the lake. Agricultural units below 10 hectares account for 91.7 percent of the total, comprising only 11.6 percent of the land. These units are all family units although, in most cases, family units are grouped together into communities or *parcialidades*. Among the 54 associative firms (described in the following pages) that include groups of workers, there is none below 20 hectares.

On the opposite side of the spectrum, i.e. the larger agricultural units of over 500 hectares each, there are only 901 land holdings (0.6 percent) comprising almost 2.7 million hectares (67.8 percent of the land). With very few exceptions, all these larger units are associative enterprises created after the 1969 Agrarian Reform. Most of these larger units lie on natural rangelands and their main activity is livestock production.

TABLE 3. LAND TENURE IN PUNO.

Size Range (hectares)	Number of Units		Total Area (hectares)	
	Qty.	Pct.	Area	Pct.
Less than 1	46467	31.43	16688	.42
Less than 0.5*	27288	18.46	7689	.19
Less than 0.5	7106	4.81	762	.02
From 0.5 to 1	12073	8.17	8238	.21
From 1 to 5	67868	45.91	167636	4.24
From 1 to 2	29257	19.79	32428	.82
From 2 to 3	13327	9.01	41969	1.06
From 3 to 4	14433	9.76	46875	1.19
From 4 to 5	10851	7.34	46364	1.17
LESS THAN 5	114335	77.34	184325	4.67
From 5 to 500	42531	28.77	1085150	27.48
From 5 to 10	21283	14.40	139929	3.54
LESS THAN 10	135616	91.73	459869	11.64
From 10 to 20	12383	8.38	136353	3.45
From 20 to 50	6391	4.32	185878	4.71
From 50 to 100	2181	1.48	147839	3.74
From 100 to 200	1289	.87	172320	4.36
From 200 to 500	1004	.68	362929	9.19
OVER 500	901	.61	2679716	67.85
From 500 to 1000	388	.26	267975	6.79
From 1000 to 2500	299	.20	440803	11.16
Over 2500	214	.14	1970939	49.91
T O T A L	147842		3949191	

* These agricultural units are the ones that are below the established limits in terms of livestock. The information about these units is very limited.

Source: FAO, 1979

COMUNIDADES CAMPESINAS

Peasant communities, or *Comunidades Campesinas*, are one of the most important forms of rural social organization in Puno, as well as throughout the Andes. These institutions contain many of the productive and organizational features of pre-Columbian *ayllus*, but were also extensively modified by the Spanish and their conception of *comunidades*. Common property was regarded as a barrier to the greed inherent in man, and was encouraged as a part of the reorganization that took place during the Toledo period of 16th century colonial Peru.

Peasant communities in Puno are somewhat unique, however, particularily in their patterns of land tenure. Unlike most of their counterparts throughout rural Peru, a relatively small proportion of land is regarded as being commonly held.

Table 4 shows that while nearly three-fifths of the communities outside of Puno surveyed in a 1977 study (DCCN, 1980) had half or more of their land held in common, over four-fifths of the communities in Puno, had little or no commonly held land.

ASSOCIATIVE FIRMS

This name is used to comprise the non-individual agricultural firms that were created after the Agrarian Reform Law was enacted in 1969. There are several different forms of organization, three of them being the most common in Puno department: Agrarian Societies of Social Interest (SAIS), Agrarian Production Co-operatives (CAP), and Social Property Enterprises (EPS).

In terms of organization, they behave somewhat as co-operatives engaged directly in production. Either directly or indirectly, their workers share ownership and intervene in management. These agrarian firms were established on the basis of former haciendas, i.e. private ranchs and farms.

In Puno there are more than 50 of these firms, that together own over 1.5 million hectares, 93.5 percent of which are range and improved pastures, and 5.7 percent useless land. The remainder may be considered as cropland, mainly dryland. Sizes are quite variable. The largest firm, CAP "Gigante",

TABLE 4: LAND HELD IN COMMON IN PERUVIAN PEASANT COMMUNITIES

	Half or More	Little or None	TOTAL
Puno	19%	82%	366
All other Departments	59%	41%	2,348
TOTAL			2,711

Source: Dirección de Comunidades Campesinas y Nativas, 1980 owns about 200,000 hectares, while there are other associative farms as small as 20 hectares. (See Table 5 for detailed information.)

The number of associated members (heads of family) is more than 3500 workers. The main economic activity is livestock production, particularly sheep, alpaca and cattle.

It is known that many of these firms face severe internal and management problems. There is a clear lack of entrepreneurial expertise, together with many other social, political and economic problems. However, their importance lies in the fact that they supply an important part of the livestock products consumed and exported. Technology in these firms also varies, but both range and herd management tend to follow the modern technology of developed countries.

There are cases in which these firms have made achievements in terms of capital accumulation and in the provision of social services.

LAND USE

CROP PRODUCTION

Agriculture is the most important economic activity in Puno with a share of about 42 percent of the gross internal product of the department. Cropping is done mainly in the area surrounding Lake Titicaca because the natural conditions are more favorable for this activity. There is also considerable crop production in the highland area. The principal agricultural products produced by the three groups considered in the report are: potatoes, oca, barley, quinua, and barley and oats for forage. At the department level the production of potatoes in 1982 reached approximately 264 thousand MT of potatoes, 21 of oca, 17 of barley and 11 of quinua (Table 6). Productivity per hectare in all these products is relatively low if compared with the rest of Peru. Table 6 shows the evolution of the planted area and the total production during the period 1981 - 1983. The area planted has increased in case of forages, as well as in terms of production. The productivity for most of the agricultural products increased over the last decade, for example in cañihua and quinua. Potatoes also increased in the area planted accompanied by a moderate increase in productivity.

TABLE 5. ASSOCIATIVE ENTERPRISES IN THE DEPARTMENT OF PUNO

1979

	Name	Type	Area (Has)	Native Range	Cropland	Associate Members
1	Gilatamarca	CAP	18466	17323		31
2	Limache	CAP	6339	6339		24
3	Corumas	CAP	25018	20947	3592	113
4	Rio Grande	SAIS	34206	33312		1147
5	Puno	SAIS	57977	54432	2530	828
6	Camata	COMD	20	9	11	82
7	Molloco	COMD	140	58		158
8	Gigante	CAP	222838	200979		1761
9	M.Bastidas	CAP	63419	56987	2145	2147
10	Manco Capac	CAP	44131	44024		866
11	Sta. Lucia	CAP	73847	71100		1171
12	Buenavista	SAIS	48002	34461	2678	2204
13	Yanarico	SAIS	30048	29900	20	151
14	Yocara	SAIS	9421	9392		56
15	Cocollana	COMD	1461	1461		100
16	Hilata Yamoco	COMD	43	22	21	138
17	Muni	COMD	788	775		310
18	Manazo	SAIS	41864	41093	8	341
19	Vilque	SAIS	38447	30343	56	260
20	Combuco	CAP	4039	3789		30
21	Putina	CAP	2979	2979		34
22	Cerro Grande	SAIS	81342	74140		558
23	Churura	SAIS	74854	69352		830
24	Huayna Capac	SAIS	44595	43382	46	675
25	Picotani	SAIS	94940	89679		531
26	Rosas Pata	SAIS	58502	57527		745
27	San Pedro	SAIS	30446	29409		831
28	Pistuni Uyuni	COMD	40	40		122
29	Illary	SAIS	27107	26854	22	563
30	Macaya	SAIS	31314	31018		808
31	San Jose	SAIS	30001	29472		442
32	Sollocota	SAIS	30347	29337		394
33	San Jose	COMD	428	412		133
34	Aricoma	SAIS	70096	67029		320
35	Kenamari	SAIS	31454	28284		104
36	Posoconi	SAIS	15357	15357		244
37	Huanacomayo	SAIS	1141	1118		134
38	Huaman Ruro	COMD	700	694		428
39	Kunurana Baja	COMD	740	386		208
40	Llalli	COMD	1502	1502		380
41	Macari	COMD	325	325		192
42	Tupac Amaru	COMD	1123	1102		49
43	Umachiri	COMD	540	. 540		149
44	Umásuyo	COMD	743	743		
45	Allanza	EPS	38144	36108		108

Continue...

Continued... Table 5

46	Kollepampe	EPS	22485	22073	21	97
47	Kunurana	EPS	29044	37344		131
48	Nunoa	EPS	34788	34774		205
49	Umachiri	EPS	46427	43329		195
50	R. Castilla	CAP	2321	2269	52	29
51	Tupala Ganado	CAP	17245	17245		33
52	Huaycho	CAP	12676	11376		28
53	Churasuyo	COMD	308		306	106
54	Sta.Cruz	COMD	226	226		234
TOTALS			1554794	1462171	11508	21958

Percentage of native pastures: 94.04

Source: FAO, 1979

TABLE 6. PLANTED AREA AND TOTAL PRODUCTION IN PUNO 1981-1983

PRODUCTS	1981 Area (Ha)	1981 Production (MT)	1982 Area (Ha)	1982 Production (MT)	1983 Area (Ha)	1983 Production (MT)
POTATOES	39409	202656	40412	263601	42308	27080
QUINUA	16255	7460	16554	11281	17279	3483
CANIHUA	5148	2298	5477	2543		
BARLEYGRAIN	18142	11277	18533	16766	19013	5857
OLLUCO	846	3060	677	2684	712	2790
OCA	3621	15590	3851	20605	3851	20580
BARLEY FORRAGE	11042	143797	13319	200840		
OAT FORRAGE	11337	186478	12623	231859		

Source: Oficina de Estadistica, Region Agraria XXI, Puno. Unpublished

ANIMAL PRODUCTION

With 4.6 million hectares of native range, Puno had in 1982 approximately 478 thousand head of cattle, 4.3 million sheep, 288 thousand llamas, 1.2 million alpacas and 110 thousand pigs (Table 7), producing a wide variety of products very important economically in the department. In Table 8, the volume of production is presented by species and by principal products. In terms of meat, cattle and sheep are the main sources while alpaca, llama and pork are secondary. Wool and fiber from sheep, alpaca and llamas are very important items if their value is taken into account.

The livestock numbers in the Puno department before and after the drought as estimated by INP are shown in Table 9. Approximatly 70 percent of the total livestock in the Department of Puno are held by small holders in small communities and approximatly 30 percent of the total livestock are in medium and large operations.

A. Communities around the Lake

Livestock production in these communities consists primarily of cattle and sheep with few cameloids. Approximately half of the cattle in the Department of Puno are located in this area. Many of the farmers here market their entire production by feeding livestock the forages and crop residues they raise. The livestock industry in this area also relies to some extent on the use of agricultural by-products. In those communities adjacent to the lake, totora and llacho harvested from the lake are important sources of forage for the livestock (primarily cattle).

The fertility, mortality, growth rate and fleece production of the cattle, sheep, and cameloids is difficult to assess due to lack of data. A study cited by Astorga (1981) suggests that the lambing rate in peasant communities of the Bolivian altiplano is less than 50 percent. Although continuous breeding is practiced by almost all small producers, there appears to be two primary lambing seasons. The first is from October through December and is referred to as "Christmas lambing", and the second is in June and July and is referred to as "San Juan lambing". In interviews with producers in these communities mortality of the "San Juan" lambs is high.

There is no shearing season and the sheep are shorn as necessary to provide wool for the household. The criollo sheep are generally shorn about every 2 years and the fleeces are of poor quality, low yielding, mixed color and are generally sold for about half the market price of wool for improved sheep.

TABLE 7. LIVESTOCK POPULATION IN PUNO 1981 - 1983

Species	1981	1982	1983
CATTLE	473430	478100	381570
SHEEP	4276500	4362000	2348500
LLAMAS	283700	288100	n.i.
ALPACAS	1207230	1279600	1288200
PIGS	110870	114530	n.i.

Source: Oficina de Estadistica, Region Agraria XXI, Puno, unpublished.

TABLE 8. LIVESTOCK PRODUCTION IN PUNO 1981 - 1982

PRODUCT	Unit	1981	1982
CATTLE			
MILK	lt	9713150	11201100
MEAT	kg	11309880	11462520
SHEEP			
WOOL	kg	5310240	5304580
MEAT	kg	8987760	8695520
ALPACA			
FIBER	kg	1426950	1510880
MEAT	kg	2519390	2674460
LLAMA			
FIBER	kg	188740	184150
MEAT	kg	797900	817500
PIGS			
FAT	kg	142710	151000
MEAT	kg	1432000	1501000

Source: INP, Puno, unpublished

TABLE 9. ESTIMATED LIVESTOCK LOSSES IN PUNO IN 1983

SPECIES	INITIAL POPULATION (1-1-83)	POTENTIAL WITHOUT [1] DROUGHT (21-31-83)	FINAL ACTUAL POPULATION (12-31-83	DIFFERENCE (%)
	NUMBER OF LIVESTOCK			
CATTLE	483000	492660	381570	22.5
SHEEP	4450000	4361000	3248500	25.5
ALPACA	1365000	1383120	1288200	6.9

[1] Calculated based on inventory and previous reproductive and culling rates.

Source: INP - Puno, unpublished.

Breeding in cattle is continuous and the cows calve approximately every 18 to 24 months. Producers like to use Brown Swiss bulls but will also use a "good looking" bull from a neighbor. The cattle are generally tethered and allowed to graze small areas or have feed carried to them. During the dry season they are generally fed crop residues or *totora* and *llacho*. In general, the males are about two years or older when they reach slaughter weight. The cows are generally very old when they are sold. They are generally milked once a day by milking 3/4 of the udder and allowing the calf to suckle the fourth quarter.

Parasitism appears to be the major animal health problem. The extent of other health problems is almost unknown. Malnutrition, mineral and vitamin defficiencies and poor management contribute significantly to health related problems.

B. Communities not around the Lake

These communities have more livestock and rangelands, and raise less crops. There are fewer cattle and their numbers tend to decrease as one approaches the mountains. Sheep and cameloid flocks tend to be larger in these communities. More "improved" sheep in these communities were found, compared to those close to the lake, but the proportion is still small. Some of the communities close to the SAIS's and other large producers have been influenced by their production practices and have used improved genetic material.

The sheep are managed in a manner fairly similar to the communities close to the lake, but they are pastured for more hours per day than those close to the lake. They have no distinct lambing season but the fertility level of the sheep is a little higher in these communities. The mortality rate is probably less than in those communities close to the lake and is the highest shortly after lambing. The highest proportion of deaths in lambs is among those born in the dry season, due primarily to lack of milk production by the ewe. Shearing tends to be more organized and will generally occur at a specific time each year. Fleece production, quality, and yields are better than for animals close to the lake. Weaning is not practiced but rather the ewes simply dry up during the dry season of the year, and this weans the lamb. The lambs are marketed or slaughtered at about 18 months of age and produce carcasses of 8 to 9 kg. First lambing generally occurs at about 18 months of age and the ewes are usually culled when they are about 6 years old, but this is probably determined primarily by not having a sound mouth. Animals are sold or consumed more on the need for money or food than for good livestock management practices. Parasitism is the primary disease affecting the sheep and the producers use no periodical control measures for internal parasites.

Mortality in cattle tends to be higher in these communities because during the dry season they do not have the crop residue or forages to feed the cattle that the communities close to the lake have. The calving interval is approximately 18 to 24 months. Calving tends to coincide with the peak of forage production. In these communities the calves and cows generally are pastured together during the day and separated at night. The cows are milked in the morning and then they and the calves return to the pasture to graze for the day.

Some of the milk is consumed but most is made into cheese which is sold in the small towns close to the communities. During the dry season the cows are not milked. In this area there are dry and wet lands. In the dry lands the disease problems are primarly gastrointestinal parasites, lung worms, pneumonia, blackleg, and various types of diarrhea in the calves. External parasites are also a problem. In the wet lands of this area the same problems exist and there is a significant increase in liver flukes.

Alpacas and llamas are mixed with the sheep and managed together. Parturition, breeding, and lactation all occur during the rainy season (from November to March), when the nutritional level is at its highest. Males and females are managed together all year. Fertility in these animals is low primarly due to high embryonic mortality. Neonatal losses are high during lactation primarily due to diarrhea and enterotoxemia. In males hypoplastic and cryptorchid testicle have been shown to be a problem and could also significantly decrease fertility. The age at first parturition may be earlier than in the larger operations because of the year around breeding; however, no data are available. The primary problem with external parasites in alpaca is mange and they appear to be more resistant to internal parasites than sheep or cattle. Shearing can occur at any time, but generally from December through March due to the better price for the fiber. Shearing generally occurs on a biannual basis to obtain adequate fiber length. The alpaca flock is generally of mixed color but due to the better price for white fiber these producers are also trying to obtain white animals. Most animals weigh around 50 kg at slaughter and a detailed report on causes for slaughter and culling is available (Primov, 1983).

C. Large operations and associative Enterprises

In these operations, management is more conventional for sheep. The producers use training and information available from UNTA and INIPA to a much greater extent than do the small producers. There are distinct selection practices and the sheep have generally been graded up to improved breeds. The primary breeds are Corriedale, German Merino, and Junin. They have regular breeding seasons, April 15 through July, with lambing occurring in October through December. They try to synchronize lambing with the onset of the rainy season to take advantage of the increased forage production for lactation and weaning. Most large producers use artifical insemination combined with natural mating. With this type of management, fertility ranges from 60 to 93 percent. Some producers who have a large forage base will breed the non-pregnant ewes in January and February to increase the fertility of the flock.

In general, lamb mortality is around 10 percent. First breeding is based on body weight and they would like the ewes to weigh 30 kg. Shearing generally occurs from January through March and they are all shorn on an annual basis. Culling varies from 10 to 28 percent of the ewes in these flocks. Most producers have records of losses from infectious and non-infectious diseases which varies with management and location. In contrast to the small communities, the producers have regular parasite control and vaccination programs. Neonatal diarrhea is the primary cause of lamb death. Most of them practice docking and castration and separate the sexes.

Cattle are generally confined to the low land areas. The cattle that are found in large enterprises are generally of the Brown Swiss breed and are used as dual purpose cattle managed primarily on improved pastures. Although breeding is continuous, most producers attempt to have cows calve at the start of the rainy season to take maximum advantage of the increased forage production. Milking is done by hand once a day in the morning and then the cows and calves graze together during the day. Most of the producers make cheese or butter but those close to Puno or Juliaca sell milk for local consumption. A few producers use artificial insemination. Bull calves are raised for slaughter and are generally sold for slaughter at 2.5 years of age and weighing 250 kg. In calves pneumoenteritis and brisket disease are the most common disease conditions. In cows, mastitis, nutrition, brisket disease and pneumonia are the most common conditions. Parasitism is also a general problem but has a control program. Liver flukes are a problem in wet marshy pasture areas.

The alpaca population is generally found at the higher elevations. Some of these producers are receiving training in alpaca production from IVITA, UNTA and INIPA. Many of the larger producers are trying to increase the number of alpacas because of the increased price of alpaca fiber relative to that of wool. In these operations, parturition, breeding, and lactation occur during the rainy season. The males and females are managed separately during the rest of the year. The fertility is somewhat higher than in the communities and is approximately 75 percent in well managed programs. The same factors that affect fertility in the communities also affect fertility in these flocks. These producers generally use 6 percent males for breeding. Shearing is usually in October with some shearing in April, and it is made on an annual basis. In these operations the producers try to select for a uniform color and the preferred color is white. Weaning generally occurs at the end of the rainy season. In the young alpaca, enterotoxemia, pneumonia, coccidoisis and alpaca fever, and in the adults alpaca fever, coccidosis, and internal parasites are the most common diseases. Culling rates are around 35 percent. The productive life of an alpaca is around 10 to 11 years as compared to 5 to 6 years in sheep.

LIVESTOCK PRODUCTS MARKETING

The main livestock products in the Altiplano are meat and fiber. (See Table 8). Meat is marketed either as live animals or as carcasses. Little processing is done on fiber prior to leaving the department. There are differences in the use of the output however, depending on the species and on the type of land holding. In the case of community small producers, cattle for slaughter are mainly sold live, and are sold mostly at *ferias* to intermediate buyers (*intermediarios*) who, depending on the shape of the animals, will either re-sell them in the urban and mining markets of Southern Peru (Arequipa, Tacna and Moquegua Departments), or fatten the animals for sale. Sheep are often sold to buyers who travel from community to community. Upon inspecting the animals and negotiating a sale, the animals are frequently slaughtered and leave the community in carcass form.

On the other hand, alpacas and llamas are mostly kept for home consumption because of the fact that fresh cameloid meat is not yet well accepted in urban markets. Typically, cameloid meat is dried and salted to prepare jerky (*charqui*), which is marketed to areas such as the jungle, where meat preservation is difficult.

Regarding marketing of fiber produced by small holders, because of its low quality, wool is not well accepted in the market, and is kept for household use, primarily to make fabrics and clothes. Alpaca, and more recently llama fiber, is sold to intermediate buyers that work for a handful of exporters, or re-sold for the production of handicrafts, whose eventual market is either internal (for tourists) or also for export. While some llama fiber may be kept for home use, the same is generally not true for alpaca fiber.

In the case of the associative enterprises, marketing of slaughtered animals may follow the same channels, but the largest firms hold auctions of their own to obtain better prices. Wool and alpaca fiber are sold directly to the large exporters, or they export directly through Puno's Peasant Enterprises Central, a sort of supra-cooperative grouping many of the department's associative enterprises.

Table 10 shows how meat and fiber were "exported" from Puno department during the period 1978-1983. In terms of volume, the main products were sheep's wool and alpaca fiber. The large variations in volume may be explained by stock retentions in order to obtain better prices.

It is interesting to note that alpaca meat is exported in quantities comparable with those of sheep, while other figures show that most cattle are exported alive. Statistics showing the exports of processed meats (jerky and *chalona*) provide evidence that they are important in generating income for their producers. The time series shows that, besides the variations in fiber volume discussed above, there has been a steady but rather slow increase in the exports of both processed and non-processed meat.

TABLE 10. EXPORTS OF LIVESTOCK PRODUCTS FROM PUNO
(Metric Tons)

		1978	1979	1980	1981	1982	1983
FIBER:	ALPACA	1267.00	3652.00	1421.00	1746.00	1303.00	1583.00
	LLAMA		4.00	25.00	2.00		
	SHEEP	865.00	5839.00	3440.00	3869.00	2647.00	2324.00
MEAT:	CATTLE	2.30	2.80	4.50	12.20	23.10	79.40
	SHEEP	82.50	26.90	55.00	187.50	234.60	310.10
	ALPACA	67.10	18.50	59.20	205.20	265.20	298.30
	LLAMA				5.50		4.60
CHARQUI:	LLAMA	.25	40.45	23.18	38.00	120.85	89.96
	ALPACA	54.90	36.55	31.57	62.10	27.80	41.18
	CHALONA	109.57	98.21	154.55	304.89	142.11	255.75

Source: Oficina de Estadistica, Region Agraria XXI, Puno. Unpublished.

ASSESSMENT OF THE DROUGHT EFFECTS ON LIVESTOCK PRODUCTION

RANGE MANAGEMENT AND NATIVE PASTURES

The drought that occurred in 1983 was significant in that it magnified the problem of too many animals and overgrazing that existed prior to 1983. The precipitation received from September, 1982 to August, 1983 was approximately one half the normal amount, as illustrated by the records from Cabanillas and Puno (Table 11). Although the records were not available for the balance of 1983 and 1984, the precipitation received was far below normal, and significant rains did not come until February 1984.

Droughts are not uncommon in Puno and 4 months of every normal year are dry. Seventy five percent of the rains come December through March. However, parts of the Department of Puno (e.g. Cabanillas) received only 20 percent of its normal precipitation (December 1982 through March 1983). Likewise, precipitation was far below normal in December, 1983 and January, 1984. Since these are the months of peak plant growth, forage production was significantly reduced. In fact, plants in many of the areas remained dormant throughout much of 1983. The quality of forage was also significantly reduced, which was as important as reduction in quantity of forage.

Drought effects on natural hillside pastures was more severe than in the flat areas near the lake where some moisture remained in the soil due to the high water table from the lake. Knowledgeable local range people indicate that because of the long history of heavy overgrazing, this potentially high forage producing area produced in a normal year only about one ton/ha of forage. During the drought these areas produced no more than 0.5 ton/ha. When one considers that a maintenance ration is 2 percent of body weight (for the very small sheep aroung the lake, about 20 kg) about 0.4 kg/sheep/day and if one leaves an equal amount of forage to keep the plants healthy, then each sheep unit would require about 300 kg/year or if one uses a more realistic figure (4 percent of the body weight) then about 440 kg should be allowed per year. This means that during the drought, 2.3 sheep/ha could be grazed. We understand that there are commonly more than 20 sheep/ha grazed, thus it is no wonder that many communities lost 60 to 80 percent of their livestock through starvation. It is also a fact that the natural pastures on steep slopes have less than

TABLE 11. LONG TERM AVERAGE MONTHLY AND ANNUAL PRECIPITATION AND AVERAGE MONTHLY AND ANNUAL PRECIPITATION (mm) FOR SEPTEMBER 1982 - AUGUST 1983 FOR PUNO AND CABANILLAS, DEPARTMENT OF PUNO, PERU.

	CABANILLAS		PUNO	
MONTH	1964-78	1982-83	1964-83	1982-83
September	18.90	48.20	30.50	.00
October	20.20	90.50	35.90	52.90
November	48.70	35.50	47.70	14.40
December	99.40	23.00	107.00	103.30
January	144.60	26.00	140.50	24.50
February	144.30	32.00	125.50	20.70
March	114.90	17.50	133.10	70.40
April	31.20	8.10	40.80	57.60
May	9.20	6.00	9.50	55.50
June	.70	2.80	1.30	14.20
July	1.60	.00	2.20	2.30
August	5.30	3.00	9.80	1.50
TOTAL	639.00	292.60	683.80	417.30

half the forage production of the wet, level areas and that, for practical purposes, no forage was produced. The forage that was produced was dormant and low in nutritional value, again emphasizing that the food to feed the animals belonging to the individual families in most cases had to come from sources other than natural pastures. If stored or purchased feed was unavailable, or the family lacked the money and could not get credit to purchase feed, inveviitably, the animals starved if they were not sold or slaughtered.

Even so, the communities that exist at the higher elevations were not as badly affected by the 1982-1983 drought although it was extremely serious for them also. The major reason is that their land base is larger, their animal numbers per unit area were less and range condition was not as poor. For example, one community in the highlands has approximately 23,000 sheep units of livestock, 7900 hectares of natural pastures and a total area of 9250 hectares. If we assume that each sheep unit needs 440 kg as we did for the Lake Titicaca area, then each hectare of rangeland would need to produce 1290 kg which is not unreasonable. Then overstocking is not nearly as serious. Through better native pasture management practices, this community could bring their animal numbers into better balance with their forage resource.

Effects of the drought in the highlands were not as severe as at lower elevations and around the lake, even though they also received significantly less rainfall (Table 12). When the drought of 1983 became evident, they culled out an additional 10 - 15 percent. This reduced their herd sizes to a stocking level that their native rangelands could support, especially if they also had irrigated cultivated pastures. The proper stocking rate averages about 1 alpaca/ha for the highlands and about 2 sheep/ha for lower elevations.

Unlike many of the communities, most of the larger producers are in the higher altiplano where water was more available. Therefore, they were less affected by the drought than the small farmers of the communities. If, however, these large producers did not have irrigated, cultivated pastures, they had to cull their livestock herds more than the additional 10 to 15 percent. Like native rangelands, dry land cultivated pastures were not productive during the drought; therefore, they did not enhance the carrying capacity during this period of adversity.

First class rangeland (about 10 percent of the total) in the highlands averages about 2000 kg/ha herbage production in a normal year. Second class rangeland (about 65 percent of the total) would average about 800 to 1000 kg/ha herbage production in a normal year and third class rangeland would produce 500 kg/ha herbage, or less. Since the precipitation

TABLE 12. LONG-TERM AND 1982-1983 AVERAGE MONTHLY AND ANNUAL PRECIPITATION (mm) RECORDS FOR CHUQUIBAMBILLA, DEPARTMENT OF PUNO.

MONTH	AVERAGE	1982-83
September	24.3	27
October	44.1	95
November	66.3	154.2
December	116.3	67.9
January	159.6	51.4
February	128	58.1
March	121.3	60.6
April	47.5	47.6
May	8.4	24
June	.4	0
July	3	0
August	4.6	0
TOTAL	723.8	585.8

was significantly reduced during the growing seasons of 1982 through 1983 and 1983 through 1984, forage production was reduced to approximately one third of normal. This significantly reduced the carrying capacity of native and cultivated pastures.

Each sheep unit requires 300 kg/ha for maintenance and reproduction, as was previously described. Proper stocking rates for maintenance and reproduction on first class rangeland in the highlands, in a normal year, would average 4.5 sheep units/hectare/year. Proper stocking on second class rangeland, in a normal year, would average 1.8 sheep units/hectare/year, or less.

The stocking rates for 23 SAIS's and 14 CAP's in the Department of Puno averaged 1.04 to 4.56 sheep units/ hectare/ year in 1978 and 1.31 to 4.55 sheep units/hectare/ year in 1979. Seemingly, these producers were stocked at about the proper carrying capacity preceding the drought. Although they culled their herds heavily as the drought became evident, they were overstocked throughout the drought.

Even though cameloids are among the best adapted animals to the drought in Puno, the females lost a significant amount of body weight because of the poor quality of forage during the peak season of plant growth. The body weight of alpaca females is highly correlated to the growth curve of forage (Figure 1).

The producers who were least affected by the drought were those who had irrigated cultivated pastures (assuming irrigation water was available) and/or those who cut cultivated forages or native grasses and stored them as hay for feed during the drought.

Perhaps a resource that has not been addressed suficiently is the impact of the drought on watersheds. Drought, and the overgrazing that usually accompanies a drought, tend to reduce herbage production on watersheds. Soil compaction and reduction in ground cover reduce infiltration and increase runoff. Therefore, when rains occur following the drought, much, if not most, of the amount that falls runs off. Consequently, severe erosion results causing flooding and removing valuable topsoil.

Although droughts cannot be avoided, their effects can be minimized. If producers would adequately reduce their livestock herds to a level of proper stocking during the drought, the animals they keep would perform better and the pastures would remain more productive. Likewise, devastating effects from flooding and soil erosion (mud and rock slides) occurring with the rains after the drought would be significantly reduced. Denuded watersheds decrease the quantity and the quality of available water (except in the very short term).

ANIMAL PRODUCTION

The livestock population in the Puno Department was severely affected by the 1983 drought as estimated by INP. Table 9 presented a quantification of the population decrease due to the difference between the potential population and the actual final population. It shows a drastic decrease in cattle and sheep of about 22 percent, whereas alpacas showed a significantly smaller decrease of 7 percent.

More detailed information on birth rates, culling rates, mortality, live and carcass weight and prices are showed in Tables 13, 14, and 15 for cattle, sheep and alpacas, respectively. The general trend in culling and mortality is similar to that suggested by Table 9. A more interesting aspect of these tables is observed in the decrease in live weight/carcass weight for cattle and sheep and the change in the approximate dressing percentage (the ratio of carcass weight to live weight). The dressing percentage decreases significantly as the effects of the drought came more evident. This indicates that the animals body conditions deteriorated considerably. However, in the case of the alpaca, body weight decreased, but the dressing percentage remained fairly constant.

In terms of live animal, the nominal prices decreased, probably because of the poor condition and the high quantity supplied. However, the carcass prices remained relatively stable (Tables 13, 14, and 15).

The estimated decrease of animal population due to the drought shown in Tables 9, 13, 14, and 15 does not represent the total losses in animal production due to the drought. There is still a significant decrease in the potential production this year (1984) that is not included due to the failure to breed during the drought. Further losses in production due to the loss of potential weight gains or actual weight losses, decreased fleece production and increased susceptibility to disease are not included in these figures. Losses were primarily in young and old animals thus resulting in lower numbers available for replacements, or if more replacements are needed, fewer potential sale animals. The low plane of nutrition that animals encountered during the drought lowered their body condition and resistance to disease and parasitism. It would appear from the data in Tables 9, 13, 14, and 15 that cameloids were able to survive the drought better than cattle and sheep. Milk production decreased by 90 percent

TABLE 13. SUMMARY OF CATTLE PERFORMANCE AND RELATED DATA DURING THE 1983 DROUGHT

	QUARTER OF THE YEAR				
	1	2	3	4	TOTAL
INITIAL POPULATION	523500	454693	436933	422723	483000
NUMBER BORN	40500	30000	15000	11500	97000
CULLING	87780	19260	1000		117040
MORTALITY	11027	13500	15700	41163	81390
FINAL POPULATION	424693	421993	411933	381570	381570
LIVE WEIGHT (kg)	253	250	240	200	
CARCASS WEIGHT (kg)	126	112	96	74	
LIVE PRICE (S/kg)	725	800	500	400	
CARCASS PRICE (S/kg)	1500	1500	1400	1500	

Source: Comité Departamental de Coordinación Agraria, Informe No. 5, Puno, 1984
Ministerio de Agricultura, Informe de Evaluación
de la Región Agraria XXI, Puno, 1984.

TABLE 14. SUMMARY OF SHEEP PERFORMANCE AND RELATED DATA DURING THE 1983 DROUGHT

	QUARTER OF YEAR				
	1	2	3	4	TOTAL
INITIAL POPULATION	4717000	4207030	3953760	3859930	445000
NUMBER BORN	1267000	---	400500	667500	1335000
CULLING	293700	534000	400500	106800	1335000
MORTALITY	216270	120150	360450	504630	1201500
FINAL POPULATION	4207030	3552880	319243	3248500	3248500
LIVE WEIGHT (kg)	26	30	24	18	
CARCASS WEIGHT (kg)	11	13	10	5	
LIVE PRICE (S/kg)	635	650	600	600	
CARCASS PRICE (S/kg)	1500	1500	1440	1500	

Source: Comité Departamental de Coordinación Agraria, Informe No.5, Puno, 1984
Ministerio de Agricultura, Informe de Evaluación
de la Región Agraria XXI, Puno, 1984.

TABLE 15. SUMMARY OF ALPACA PERFORMANCE AND RELATED DATA DURING THE 1983 DROUGHT.

	QUARTER OF THE YEAR				
	1	2	3	4	TOTAL
INITIAL POPULATION	1898400	1837380	1606860	1369560	1356000
NUMBER BORN	542000	---	---	---	542400
CULLING	54200	216960	216960	54240	542400
MORTALITY	6780	13560	20340	27120	67800
FINAL POPULATION	1837380	1606860	1369560	1288200	1288200
LIVE WEIGHT (kg)	42	50	45	30	
CARCASS WEIGHT (kg)	22	27	22	14	
LIVE PRICE (S/kg)	386	400	385	385	
CARCASS PRICE (S/kg)	736	740	750	750	

Source: Comité Departamental de Coordinación Agraria, Informe No. 5, Puno, 1984
Ministerio de Agricultura, Informe de Evaluación de la Región Agraria XXI, Puno, 1984.

due to the drought and, because production dropped so low, even though some improved pastures were available, most producers chose not to attempt to milk their cows and just let the calves nurse in an attempt to save them.

Communities Around the Lake

In these communities, the drought impact was probably the greatest with little or no livestock production. Producers in these communities lost 60 to 80 percent of their sheep flocks, and up to 60 percent of their cattle. One producer commented also that he had 9 pigs and they all died. Further, those animals that survived failed to breed and did not produce offspring the next year. Also in these communities, the producers are still continuing to have death losses as a result of the drought even though forage is now available. Producers that are not adjacent to the lake purchased totora and llacho at highly inflated prices in an attempt to keep their livestock alive. When they sold their animals they did so at depressed prices, if they were able to sell them at all.

Communities Not Around the Lake

In general, livestock were almost as severely affected as in those communities around the lake. However, livestock losses were not quite as high, but mortality of the young animals was extremely high. Those animals that remained had low reproductive rates and suffered significant weight losses and decreased fiber production.

The data in Table 9 indicates that losses in alpaca were not as high as in sheep or cattle, but the data could be biased since the alpaca tend to be located in areas not as severely affected by the drought. However, in personal interviews in communities that produce both sheep and alpaca, we were told that losses were much greater in sheep than in alpacas. This indicates that the alpaca, an animal domesticated in the altiplano area where drought is a common phenomenon, is probably better adapted to withstand these conditions. The cameloids are capable of going 5 days without drinking, whereas sheep cannot go nearly this long. The main effect of the drought on alpaca was reduction in diameter of the wool fiber.

Large Operations and Associative Enterprises

These production units have not been as severely affected by the drought as the small communities for several reasons. They were well enough managed in general to have been able to sell surplus animals at the proper time. The range management pratices were better insuring more forage even during the drought. Most of the producers have developed cultivated and/or irrigated pastures to use during the drought to sustain the remaining animals. However, even in these operations the drought caused reduced reproductive rates, weight loss and decreased fleece production. In appendices 3,4 and 5, some general management strategies are formulated to cope with the drought from the perspective of both animal and range management.

ECONOMIC ASPECTS

An important factor in understanding the dynamics of the livestock productive system during the drought periods is the aggregate market characteristics. Livestock represent consumption and capital goods. Some people call it the poor people's bank or savings account because small producers use it in case of emergencies to obtain cash to pay for groceries, medicine, etc. This role is specially true in the case of sheep, alpacas and llamas. But the small producers respond to prices too. They always have the choice between liquidating animals for consumption or cash, and retention of animals for investment in future output, especially through the breeding stock.

In the case of regions with strong variations in weather patterns, another criterion enters into the producer decision-making process, that of weather and particularly rainfall. The influence of rainfall in the producers' decision comes through the availability of forage, which in the case of a drought, is the limiting production factor. That limits his stocking rate. The culling process in an emergency situation relates first to the sex and age of the livestock. It is expected that the producer would first sell the castrated males, then old females, and the last choice would be the young females because they represent the capital production factor. In general, this action was followed by most of the producers in Puno during the drought. The worst effects of the drought were suffered by the small producers, who in most cases were overstocked. When the drought came they had no pasture, even for the breeding animals. We observed cases where they sold or had death losses of 80 to 90 percent of their herds. It is common in this situation to have a very high quantity of animals supplied in the market, therefore, the market responds in terms of price decreases.

People referred to the very low prices that in some cases forced the producers to retain animals on the farm, increasing the mortality and the producers' eventual losses. An interesting phenomenon was noticed in the department of Puno relating to retail prices and live animal levels. In some cases, the per-head cattle price decreased from 300,000 to 50,000 soles during the worst part of the drought, when supply reached its maximum levels. But prices at the retail level showed an opposite trend, increasing during the drought. These facts present an apparent contradiction that can be cleared if two types of animals are considered, one being feeders and the other being finished animals. Each clearly has its own market structure. For feeders, the quantity supplied during the drought was very high and for finished animals the quantity supplied was low. The prices responded accordingly.

If it is taken into account that most of the marketed feeder animals were in the hands of community producers, it is then clearer why they were the most affected economically during the drought. Mechanisms should be put into place to assist the producers in retaining enough purchasing power to restock their herds in the post-drought period. Market intervention should be considered when the livestock supply surpasses certain levels and the prices decrease below a minimum level. A governmental intervention in the livestock market would be a solution to assure minimum prices. Of course, the intervention by itself would not solve the problem. The government would need to implement additional marketing practices, for example, encouraging processing and storaging of meat as well as reallocation of growing animals to better grazing lands.

INSTITUTIONAL ASPECTS

Government institutions involved in either high altitude animal production and/or native pasture management are shown in appendix table 1. Puno is a department depending heavily on livestock production, yet it appears that little support is given either for research or extension in these areas. The few people concerned with these topics lack communication among themselves, making their efforts less efficient.

On the other side, few resources have been placed into the understanding of the complex internal rationality of small producers found within communities. One of the main problems to appropriately assess this matter, is the lack of information at the micro level, i.e. farms. Behind the apparent contradiction of the diversified production of a small landholder, there is a very well developed set of strategies to cope with unpredictable weather and limited land resources. The only way to understand this complexity and delicate equilibrium is through the Agricultural Systems Approach. No government efforts have been made to date in that respect, although INIPA is now beginning a national program on that area.

Coordination among researchers, extensionists and funding agencies is not at a desirable level. However, it should be stated that we observed a positive effect of the drought in this respect. Government institutions like CORPUNO, INIPA, Ministry of Agriculture offices, and even UNTA, appear to be working more closely together as a result of the drought and subsequent recovery efforts.

In summary, one can conclude that, prior to the drought, all of the factors were in place for a disaster. The areas that were most affected by the drought were those closest to the lake, where overgrazing was the greatest or the animal numbers were the most out of balance with available forage. In contrast, the large producers, those least affected by the drought, had the resources, were not overstocked, and reduced animal numbers when the drought was apparent. The drought simply served as a catalyst to unbalance the system, resulting in high animal mortality and severe economic losses.

RECOMMENDATIONS

The primary impact of the drought was on the peasants in the small *Comunidades Campesinas*. Therefore, the recommendations for drought relief efforts and future planning are focused primarily toward these communities.

NATURAL PASTURE AND FORAGE MANAGEMENT

The major problem in the department of Puno is the tremendous inbalance between the number of livestock and the amount of forage available. In most communities, in addition to forage available from crops, the number of animals owned requires that natural pastures produce from 3 to 5 tons/hectare of forage per year in order to maintain these animals at a productive level. Most of the natural pastures produce no more than 0.5 to 1.5 tons/hectare during a normal year so animal diets are little above starvation levels without a drought.

Thus, even a minor drought which reduces available forage results in animal starvation. The problem is how to find ways to more nearly balance livestock numbers with forage.

BALANCING LIVESTOCK WITH FORAGE

1. Because livestock are used as a bank account and as a hedge against inflation, convincing producers to reduce animal numbers in order to produce more meat and fiber per animal, is probably not a realistic alternative. Yet reducing numbers to match the forage available is the best way to prevent starvation during drought.

   This, of course, does not preclude the need for drought planning. Producers still will need to reserve standing forage for dry periods, store forage in the form of hay or silage, reduce numbers early, etc., to be able to survive extended droughts without disastrous effects on their economy.

2. Through better management of the natural and cropped (e.g. barley and oats) pastures. This amounts to rotating the animals from location to location within a pasture allowing sufficient time for each grazed area to regrow. Otherwise, the plants are weak and produce little forage. Again the excessive number of animals kept per family makes this very difficult to implement. The community families are already doing about as much deferment and rotation as is feasible with the large number of animals they have. A program of community grazing management education would be needed to make any headway here.

3. Use of improved and/or introduced forages.

   Forage crops such as alfalfa plus *Dactylis glomerata* provide high forage production and high quality forage. Most communities apparently maintain a certain proportion of land fallow often up to 5 or 6 years to allow recovery of fertility. It would seem that seeding these areas to such forages would allow grazing by livestock as well as improved fertility as both grass and alfalfa roots are good soil building tools. Again some education is going to have to accompany the use of this practice as the temptation is going to be to overgraze these plots, tereby defeating the program. Also, all fallow plots would not be suitable for seeding to such forages.

   Although such forage crops could be used to replace land now being planted to such annual forages as barley and oats, the overall productivity is little different and because the cereal forages provide human food, easily stored grain, etc., we do not anticipate the replacement of barley and oats with pasture forages. At least, some comparative research needs to be done before suggesting that seeded permanent pastures replace these currently used annual forages.

ROTATION GRAZING

Rotation grazing is a basic principle of grazing management. Higher quality and greater production of forage can be produced by allowing it to rest during portions of the year. If fencing is not used, shepherds should be trained so they could regulate the grazing patterns of their herds.

FENCING

Fencing was mentioned by the more productive managers as a means to improve management. Fencing would allow a better rotation system of both native and cultivated pastures, ultimately improving their condition and providing more forage production. The forage produced could be managed to provide a higher quality product at critical periods of the year.

HAY/SILAGE

One of the best ways for producers, regardless of the size of their operation, to provide for a drought is to store feed. Production of "excess" forage from cultivated or from native pastures could be cut and stored as hay or silage. Some of the larger producers (both private and associative) are presently producing hay or silage and that enabled them to go through the drought of 1983 with less effect from the lack of rain. Hay could be stored either in bales (as some are presently doing) or in loose stacks that would require less capitalization.

ANIMAL PRODUCTION

The potential fertility and survivability of the livestock in the communities is fairly good. However females mated during the dry season or a drought have reduced fertility, and offspring born during dry season or a drought have increased mortality. Therefore, one important method of improving livestock efficiency is to confine, as best as possible, the parturition period to the rainy season. This will result in births when forage production is at or near its peak to maintain body condition and maximum milk production. In sheep, if feed is stored either as harvested forage or dry standing feed the best forage should be saved for use during the breeding season. This will help to increase the fertility rates.

During drought, the priority of using harvested or stored feed should be: (1) the parturition and lactation periods, and (2) the breeding period. In cameloids, and to a large extent in cattle, these two periods are at the same time of the year.

The alpaca and llama are unique in their reproductive patterns with late gestation, parturition, lactation and rebreeding all occurring at the same period. In order to optimize reproductive efficiency, nutrition and management during this critical physiological period needs to be carefully evaluated. The producer needs to save the best forage to secure the best possible nutritional resources for this critical period. In a drought, if supplemental feeds are to be used, this period (parturition, lactation and rebreeding) would be the most critical in terms of conception and embryo viability in the female and survivability and growth of the offspring.

In the communities near the lake, the lake products *totora* and *llacho* are commonly fed as a supplement and during the drought this was fed extensively to the livestock. Little information is available on the potential and actual productivity, nutritive value, and ecological and socio-economic implications of harvesting and feeding this resource to the livestock in the area. Research at the community level needs to be conducted on the best methods to use these lake products.

During a brief overview it is difficult to ascertain anything more than generalities about the health of the livestock in the communities. Two main and consistent observations were lack of proper nutrition, and parasitism. Parasitism is variable, depending on the location, types of forage, concentration of animals and wetness of grazing areas. In general, parasites compete for nutrients and deprive the animal of vital elements especially protein. Animals deprived of nutrients by parasitism are more susceptible to disease in addition to being unable to produce milk, meat, fiber or the ability to reproduce. Although parasite control programs may not give immediate effects when adequate feed is not available, they could allow the animals a better chance to recover some body condition and become more productive.

An immediate program could be to treat all ruminants in the communities with a product most efficacious for the parasites of that area. Vaccination programs may be more difficult as diseases differ from community to community, although the incidence of *Clostridium chavii* and *Septicum* was mentioned as a cause of disease in most of the cattle population in the Puno Department.

If a parasite control program is initiated, a simultaneous vaccination program for the most common diseases could be conducted. Along with any parasite or disease control program there must be a simultaneous educational component to educate the producer of the effects of parasites and the benefits (feed savings etc.) of their control.

In some of the larger enterprises in the Central Sierra, recommendations on the causes of morbidity and mortality are available. This type of diagnostic documentation is not available at the community level. Determination as to the major diseases affecting livestock in the communities could be an intermediate range program.

An agreement among UNTA, Colorado State University, and SR-CRSP will be supported by a World Bank loan to Microregion Juliaca-CORPUNO to conduct these type of field investigations in the Puno Department. This work should be directed toward communities and organized producers, providing methods of diagnosis, prevention, and control of prevalent diseases.

GOVERNMENT INTERVENTION

1. DURING DROUGHT PERIODS

In order to reduce the impact of the heavy decapitalization of livestock producers due to the steep drop in animal prices during the critical periods of the drought, it is proposed that the government intervene during the drought period through the following measures:

a. Intervention in the livestock market, principally at the level of livestock fairs, as just another participant among buyers in order to assure minimum prices for producers. This measure should be complemented with improvements in the area of slaughter, packing and marketing infrastructure which will be discussed later.

b. Implement work programs in the rural sector in order to improve local infrastructure and avoid the massive migration to urban centers using food as part of the salary.

c. Develop programs to assure the timely availibility of agricultural production inputs, particularily native varieties of appropriate seeds for the planting periods following the drought. These programs should be operating in time for the next planting season.

2. PREPARATION FOR FUTURE DROUGHTS

The following recommendations refer to Governmental actions to prepare for future droughts.

a. Improve marketing channels to increase the producer share in the final value of their animals. Some of the ways that this could be achieved would be through decentralizing, if necessary to the district level, the controlled slaughter of animals, and reducing of bureaucratic steps required to transport and slaughter livestock.

b. Improve the marketing infrastructure at the departamental level, especially concerning slaughter and packing facilities, and roads.

c. Provide for the processing of surplus meat, in the form of *charqui* and *chalona* for future marketing or distribution in programs such as "food for work".

d. Develop government programs for food storage at the regional level.

e. Improve the process for obtaining credit, to make credit more timely and accesible to agricultural producers, communities and associations of communities.

3. REDUCTION OF RISK

To reduce risk at the producer level during drought periods, it is recommended that:

a. Special caution should be used in the introduction of technological packages among small producers, particularily when they may increase risk when severe climatic conditions manifest themselves. In addition, traditional practices such as the diversification of crops, and varieties within crops, should be encouraged, as well as the use of different planting periods in dry land farming conditions.

b. Improvement and development of irrigation programs at the local level with special emphasis on low cost systems.

Irrigation in the Department of Puno can potentially be applied to about 200,000 hectares according to an oral communication from CORPUNO. Compared to third class range this provides the potential to increase animal numbers more than ten times. Advantages of irrigation to reduce or eliminate the bad consequences of drought are that forage production can be maintained at a relatively high level even though natural rainfall does not occur, and forage quality can be maintained at a high level. In other words, the normal season to season and year to year fluctuation can be largely eliminated. We cannot stress too strongly, however, that irrigation programs without extremely detailed prior planning are often disasters for the following reasons: salt accumulations more often than not occur from irrigation water or soils with too much salinity; high investments are made without the ability of the forage or other crops used being able to repay the cost; inadequate understanding of the management required to maintain stands of high cost forages or crops; diversion of water to more high value cash crops when the need may be more for livestock forage; inadequate water management know-how; lack of the technical knowledgeable to implement and manage a large irrigation undertakings.

This is not to say that irrigation should not be attempted. If it can be effectively used on third class range producing a half ton of forage or less, the potential to increase forage production to 6 or 7 tons/hectare is good. We doubt that much third class range can be irrigated, but if it can, the rewards can be great. However, for those communities with no communal land, where the average land owned is less than 2 hectares, and where only about 1.25 hectares of natural pasture is available, we suspect that relatively few of the families can benefit from irrigation. If so, the best use of the water would probably be to put it on the best land which is probably not on the native pastures.

Again we stress that the consequences can be terrible if irrigation water is applied to a family's best land and it gets so salted up that the land is ruined and produces nothing. Detailed planning is necessary before such projects are undertaken. The producers also must be made aware of the fact that irrigated perennial forages need a high degree of management to keep them producing at a high level. Thus, accompanying an irrigation program should be a training program to enable this new tool to be safely used.

Great caution should be exercised to avoid the loss of agricultural potential due to poor irrigation management.

c. Promote the expansion of cameloids in the herds of the altiplano because of their natural adaptation to the high andean environment.

Cameloids and native livestock are better adapted than European breeds, particularly to the highlands of southern Peru. They can go longer periods without water and make better use of the forages. The price of alpaca fiber is much greater than that for sheep wool, and llama fiber is intermediate.

Although alpaca meat is primarily eaten by the peasants, its nutritional quality is as great as that of sheep. Therefore, it seems that greater number of cameloids should be incorporated into one's herd while the number of sheep should be reduced.

d. Provide incentives to store forages for the normal annual dry period and surpluses for cases of emergency.

4. DROUGHT FORECASTING

Develop a probabilistic model to forecast extreme climatic conditions with the purpose of alerting contingency plans and programs.

5. AD-HOC COMMISSION

Create a high level commission with representatives of the agricultural sector, which, following pre-established criteria, will quickly activate emergency programs at the regional level.

INSTITUTIONAL ASPECTS

1. After evaluating the structure of the research, teaching and extension organizations in the department of Puno some questions arose as to whether the current allocation of manpower and resources is the best. The department of Puno consists of 7.24 million hectares of which, 64 percent is considered to be native pastures. Overgrazing due to poor native pasture management practices, is a serious problem. However there are no researchers or extension personnel at INIPA-CIPA XV in Puno working on

native pastures.

All research in the pasture area is devoted to cultivated pastures or crops, yet livestock primarily produced from native pastures is the leading agricultural product of Puno. At UNTA there is one profesional working in the native pasture area. If productivity is to be significantly increased and the effects of future droughts decreased the native patures of Puno, which account for 64% of all the department's area, need significant improvement. However, there is not enough manpower or resources devoted to this area. We believe that it is imperative that changes begin to be made at INIPA to put more trained man power and resources into the area of native pastures. Through educational and research programs would not only improve the well being of the peasant who occupy these area but would also help prevent the flooding that tends to occur after a drought.

This recommendation which perhaps goes beyond the department of Puno implies the development of a program to educate professionals in the range science area. The education needs to be both at the graduate and undergraduate level. More professionals need to be trained to fill the teaching, research, and extension roles, and more technical training needs to take place both at the level of community and of the larger producers.

2. In general, we support the community development programs of CORPUNO and believe that most of their resources should be directed toward the communities where the impact of the drought was the greatest because of past poor management practices and overstocking of their native pastures. However, we feel that care must be taken not to start small programs where 1) the animals will compete directly with the human population for common food stuffs 2) use of cultivated forages that may replace crops that are equally productive, more easily managed and can be used for either animal or human food and 3) development of small irrigation projects without proper planning to assure that salinity does not become a problem.

3. The drought has served to begin to strengthen the links and interactions between INIPA and UNTA. A continuation of these interactions should continue and they need to be stronger. With the small number of trained professionals in the animal and plant area and the tremendous amount of work to be done in Puno, both organizations must work co-operatively to more effectively develop technologies and transfer them to the ultimate user. More emphasis should be placed on developing appropriate technologies and

transfering these technologies to the peasant communities where they are badly needed. Programs that concentrate primarily on the cultivated pastures on a larger scale probably have little application to the peasant communities.

EXTENSION

In general, it was felt by the team that the "site visit" methodology tested in recent years by INIPA at the communities and small producers levels should be reviewed. In many instances, significant further research is required in order for extensionists to have a message appropriate to the needs, resources, and understanding of the producers. Furthermore, the situation of peasant communities is such that a permanent presence must be established in some communities, in order for lasting technology transfer to take place. Some alternative models to improve livestock production should be implemented as has been done in the case of crops through the "Proyecto de Investigacion de los Sistemas de Cultivos Andinos" (PISCA).

The importance of these kinds of projects is that they serve as visible demonstrations of some of the positive effects of technological improvements to an audience much larger than just the cooperating community. Furthermore, these sites present much needed opportunities for researchers to collect data on traditional methods prior to designing interventions.

SUGGESTED PROJECTS

1. COMMUNITY DEVELOPMENT IN PUNO

The community development project that has been begun by CORPUNO needs continuing support. The small projects developed by a community or groups of communities provide the peasants in the communities the opportunity to alleviate the effects of the drought and at the same time improve their well being. Such projects need to address the recommendations in this report, especially in the areas of: (1) forages and cultivated pastures, (2) irrigation, and (3) competition between humans and animal for a common feed resource. Actual budget: US$968,199. Duration: one year.

2. PASTURE AND FORAGE PROGRAM

This is a new program for INIPA - CIPA XV. Although the program has been budgeted, no work has begun. The project needs to be entirely re-evaluated and re-designed after carefully considering the recommendations in this report particularily in the following areas: (1) native range versus cultivated pastures on small plots, (2) use of cultivated forages versus annual forages and/or annual forages plus legumes, and (3) use of cultivated forages on fallow land. Data on economic feasibility needs to be collected in addition to the usual animal and plant response data. Co-operation with scientists in the SR-CRSP and UNTA will probably be necessary to accomplish this latter goal. Actual budget: US$1,042,145. Duration: one year.

3. FARMING SYSTEM ANALYSIS

Dynamic evaluation of the cropping and livestock activities in a sample of the communities most and least affected by the drought. This analysis will provide the basic information as to how the producers' strategies to cope with the drought worked. These communities could also be used for the demonstration and testing of appropriate technologies as they are developed. The expertise to conduct this type of work is already in place in Peru. The appropriate group to work on such a project includes: (1) Sociology and Economics components of the SR-CRSP, (2) Proyecto de Investigacion de los Sistemas de Cultivos Andinos (PISCA), (3) UNTA, and (4) INIPA - Programa Nacional de Sistemas de Produccion Andinos. This project would probably take a co-operative effort among researchers from all 4 groups and should be an interdisciplinary effort. Estimated cost: US$380,000 per year. Duration: two years.

4. LIVESTOCK DEVELOPMENT IN PUNO

A major livestock development effort in the Department of Puno needs to begin and should be targeted at the communities. This project should have two components: a development component and a research component.

The development program should be an interdisciplinary effort and should focus on: management of native pastures including a strong emphasis on grazing systems, along with the use of cultivated forages, combined with an animal health program that will work at the community level applying technologies already available.

The research program should be designed to support the development program but in addition should have a basic research component that includes as a minimum: (1) native pastures research, primarily but not exclusively directed toward grazing systems for communities; (2) research on improved forages and the best use of improved forage crops as a supplement to native range at the community level; (3) the value of *totora* and *llacho* forages from the lake in terms of the lake's present and potential productivity of these products, the nutritive value, the best method to use them, and the socio-economic factors related to their productivity; and (4) at Chuquibambilla and La Raya - UNTA, small units which are similar to the communities need to be used for research that can be later applied to the communities. These should include both cropping and livestock so that changes in the system can be carefully evaluated. Estimated cost: US$747,500 per year. Duration: four years.

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APPENDIX

APPENDIX TABLE 1.1 - Manpower Chart for Puno Department, Peru

NAME	PROFESSION	ACTIVITY	SPECIALITY
CIPA			
David A. Nuñez	Agronomist	Extension	Administration
Julio J. Lira	Agronomist	Extension	Administration
Gustavo Cuentas	Agronomist	Extension	Administration
Vicente Burgos	Agronomist	Extension	Administration
Humberto Serruto	Agronomist		Planing
Genaro Cachicatari	Agronomist		Planing
Gabriel Incacari	Agronomist		Planing
German Loza	Agronomist		Planing
Mauro Vallenas	Agronomist	Extension	Administration
Valeriano Huanca	Agronomist	Extension	Potatoes
Julio Castro	Agronomist	Extension	Potatoes
Javier Campos	Agronomist	Extension	General
Juan Ponce	Agronomist	Research	Cereals
Edmundo Vilca	Agronomist	Research	Cereals
Carlos Santos	Agronomist	Research	Potatoes
Julio Choque	Agronomist	Research	C. Forages
Roberto Valdivia	Agronomist	Research	Administration
Jesus Barbosa	Agronomist	Research	Quinua
Rosario Bravo	Agronomist	Research	Plant Pathology
Luis Abarca	Vet. Medicine	Extension	Livestock
Mauricio Mujica	Agronomist	Extension	Administration
Hugo Cabala	Agronomist	Extension	Cereals
Edwin Bolaños	Agronomist	Extension	Administration
Flavio Calsin	Agronomist	Extension	Administration
Carlos Aramayo	Agronomist	Extension	Administration
Jorge Ramirez	Agronomist	Extension	General
Farkin Perez	Agronomist	Extension	Horticulture
Agustin Aruquipa	Agronomist	Extension	General
Agustin Pacori	Agronomist	Extension	Potatoes
Eufracio Condori	Agronomist	Extension	Administration
Edwin Catacora	Anim.Scientist	Extension	Livestock
Juan Zapana	Agronomist	Extension	Cerelas
Victor Quiroz	Agronomist	Extension	Marketing
Natalio Cano	Agronomist	Extension	Administration
Juan Tupa	Agronomist	Extension	Administration
Jaime Arroyo	Agronomist	Extension	General
Jorge Zeballos	Agronomist	Extension	Administration
Juan Zamata	Agronomist	Extension	Administration
Alfonso Llanos	Agronomist	Extension	Administration
Roberto Samanez	Agronomist	Research	C. Forages
Raul Revilla	Vet. Medicine	Research	Livestock
Luis Mamani	Vet. Medicine	Research	Livestock
Hipolito Medina	Vet. Medicine	Extension	Livestock
Francisco Guzman	Vet. Medicine	Extension	Livestock
Cornelio Rodriguez	Vet. Medicine	Extension	Livestock
Adrian Calsin	Vet. Medicine	Extension	Livestock
Timoteo Arisaca		Extension	Livestock

NAME	PROFESSION	ACTIVITY	SPECIALITY
UNTA PUNO			
Alberto Placencia	Vet. Medicine	Teach + Research	Liv. Reprod.
Antonio Castro	Vet. Medicine	Teach + Research	Liv. Reprod.
Sebastian Perastegui	Vet. Medicine	Teach + Research	Liv. Nutrition
Alberto Lescano	Anim. Scientist	Teach + Research	Liv. Production
Victor Bustinza	Vet. Medicine	Teach + Research	Anim. Breeding
Enrique Calmet	Vet. Medicine	Teach + Research	Poultry
Martha Tapia	Vet. Medicine	Teach + Research	Fiber Technol.
Jose Durant	Vet. Medicine	Teach + Research	Public Health
Enrique Pacheco	Vet. Medicine	Teach + Research	Clinic Diagn.
Wilbert Davalos	Vet. Medicine	Teach + Research	Paras.+ Int. Disease
Edgar Apaza	Vet. Medicine	Teach + Research	Clin. Medicine
Ruben Zabaleta	Vet. Medicine	Teach + Research	Pharmacology
Ruben Chavez	Vet. Medicine	Teach + Research	Clin. Medicine
Edgar Avila	Vet. Medicine	Teach + Research	Clin. Medicine
Oscar Gomez	Engeenier	Teach + Research	Food. Technol.
Alcides Sanchez	Vet. Medicine	Teach + Research	Food Inspect.
Juan Astorga	Agronomist	Teach + Research	Range
UNTA CHUQUIBAMBILLA			
Benedicto Rojas	Vet. Medicine	Research	Adm. Liv. Product.
Rolando Alencastre	Vet. Medicine	Research	Liv. Product.
Teofilo Quispe	Vet. Medicine	Research	Liv. Product.
Santiago	Vet. Medicine	Research	Anim. Reprod.
Rolando Rojas	Vet. Medicine	Research	Anim. Reprod.
Rina Jaen	Vet. Medicine	Research	Anim. Reprod.
Hector Gonzales	Agronomist	Research	C. Forages
	Agronomist	Research	Crops
UNTA LA RAYA			
Guido Medina	Vet. Medicine	Research	Genetics
Guido Perez	Vet. Medicine	Research	Reproduction
Maximo Mole	Vet. Medicine	Research	Anim. Health
Uberto Olarte	Vet. Medicine	Research	Anim. Nutrition
Faustino Jawira	Vet. Medicine	Research	Anim. Mangmt.
Luis Condori	Vet. Medicine	Research	Fiber Tech.

APPENDIX TABLE 1.2 -Manpower in Puno Department by Specialities

SPECIALITY	I N I P A		U N T A	
	n	%	n	%
Administration	16	34.04	3	9.68
Planing	4	8.51	–	–
C. Forages	2	4.26	1	3.23
Range (N.Pasture)	–	–	1	3.23
Livestock	9	19.15	25	80.65
General Extension	4	8.51	–	–
Marketing	1	2.13	–	–
Horticulture	1	2.13	–	–
Crops	9	19.15	1	3.23
Plant Pathology	1	2.13	–	–
TOTAL	47	100.00	31	100.00

APPENDIX TABLE 1.3-Manpower in Puno Department by Activity

ACTIVITY	I N I P A		U N T A	
	n	%	n	%
Administration	2	4.26	3	9.68
Research	10	21.28	–	–
Extension	31	65.96	–	–
Teaching & Research	–	–	28	90.32
Planing	4	8.51	–	–
TOTAL	47	100.00	31	100.00

APPENDIX TABLE 2.1 Institutions and Locations Visited and People Interviewed

INSTITUTION	LOCATION	PEOPLE
1. United States Agency for International Development, US - AID	Lima	Mr. David Bathrick
	Lima	Mr. George Hill
	Lima	Mr. Michel Hurch
	Puno	Mr. Michel Feiser
	Lima	Dr. Adolfo Jurado
2. Instituto Nacional de Investigación y Promoción Agropecuaria, INIPA	Lima	Dr. Alfredo Montes
	Puno	Ing. David Nuñez
	Puno	Ing. Julio Lira
	Puno	Ing. Julio Choque
	Puno	Ing. Carlos Moscoso
	Puno	Ing. Bartolome Vargas
3. Instituto Nacional de Desarrollo, INADE	Lima	Ing. Eduardo Larrea
	Puno	Ing. Ciro Camacho
4. Corporación de Desarrollo de Puno, CORPUNO	Puno	Ing. Juan Carlos Málaga
5. Instituto Nacional de Planificación, INP	Puno	Ing. Hugo Rodriguez
	Puno	Lic. Jaime Villena
6. Universidad Técnica del Altiplano, UNTA	Puno	Dr. Victor Bustinza
7. Programa Investigación en Sistemas de Cultivos Andinos, PISCA	Puno	Dr. Mario Tapia
8. Colegio Adventista Titicaca 1/	Juliaca	
9. SAIS Yanarico 1/	Juliaca	
10. Frigorífico Cabanillas 1/	Cabanillas	
11. Centro Experimental Illpa 1/	Puno-Juliaca	
12. Comunidad Quenafaja 1/	Ilave	
13. Comunidad Amparani 1/	Ilave	
14. Pilcuyo 1/	Ilave	Sr. Luis Vargas (Promotor)
15. Instituto Veterinario de Investigación de Trópico y Altura, IVITA 2/	La Raya	Dr. Julio Sumar
		Dr. Nicanor Condorena
		Ing. Ramiro Farfán
		Ing. Juan Alpaca
16. Universidad Nacional Técnica del Altiplano, UNTA 2/	La Raya	Dr. Guido Perez
17. UNTA, Chuquibambilla 2/	Chuquib.	Dr. Benedicto Rojas
18. Comunidad Omasuyos Bajo	Ayaviri	
19. SAIS La Unión 2/	Asillo	
20. Hacienda San Antonio 2/	Ayaviri	Mr. Billy Prime

1/ Group I made these visits. It consisted of Dr. Dahl, Dr. Kimberling, Dr. Burfening Dr. Gutierrez and Mr. Jamtgaard.

2/ Group II made these visits. It consisted of Dr. Sosebee, Dr. Riera, Ing. Astorga and Dr. Alencastre.

APPENDIX 3

COMMON METHODS TO MEET DROUGHT CONTINGENCIES

1. Use a base herd of breeding animals that is 60 to 70 percent of what you would expect to be able to graze in an average year. Use other kinds of livestock to use the rangeland during an average to above average year. For example, use carry over mates or contrasted males to make the number of animals needed each year; during drought years cull the breeding animals and sell non breeding animals easily.

2. Cut excess forage for hay and store it for dry periods as well as dry years.

3. Purchase hay or animal feed during dry periods.

4. Move animals to rented or leased land or to land of relatives that have not been affected by drought.

5. Have land in different locations with the idea that if one area is badly hurt by drought, the other area(s) might not be so badly affected.

6. Use of irrigation from a permanent water source.

APPENDIX 4

MANAGEMENT STRATEGIES

All livestock operators face the problem of seasonal growth of grazeable forage. Thus, they must have available food for animals even though forage is not growing. The amount of forage depends on many factors.

Basically all livestock growers must do the following for high animal production on natural pastures :

1. Balance the amount of forage potentially available with the number of animals that are grazed thereon; i.e. don't overstock.

2. Use the kind of animal or mix of animals that can best use the natural forage - e.g. cattle and sheep, or sheep and llama, or sheep and alpaca; depending on the naturally occurring species.

3. Use the forage at the proper season. Some species of forage have more nutrition during the dry season than others, others are of little use during dormant season due to stemminess, low nutritional value, etc. Also, all animals have seasonal nutritional needs that have to be supplied by the natural pastures if not obtained otherwise, i.e. balance the season nutritional needs of the animals with the seasonal nutrients supplied by available forage.

4. Be sure the animals are properly distributed over the range areas. Because the areas of land owned by community members are so small, there is not likely to be an animal distribution problem.

Generally animals are grazed either continuously (i.e. the animals are allowed access to all parts of the pasture during the grazing season); or they are grazed rotationally (i.e. animals are provided access to only a portion of a range unit (pastures) for some designated period of time and then they are moved to unused portions of the range area or totally removed for designated periods).

Generally, with continuous grazing, plants leaves are kept grazed off and only a small amount of food manufacturing leaves are available to produce the forage necessary for grazing animals unless a low level of stocking is used that allows each plant a reasonable period of time to recuperate or regrow leaves after grazing. Commonly, forage grasses double their biomass each day up to 40 to 80 days during the growing season. For example, a pasture may produce at the rate of 10 kg/ha/day during the first 10 days after grazing or cutting; 20 kg/ha/day during the second 10 days; 40 kg/ha/day during the third 10 days; 80 kg/ha/day during the fourth 10 days; and 160 kg/ha/day during the fifth 10 days period.

However, if the animal numbers are such that each plant is regrazed even, 10 to 15 days, then the plants never have enough leaf surface to manufacture food to produce a high amount of biomass. Thus, stocking rates have to remain low because forage production is maintained at a low level. After a few years of heavy continuous grazing, only the plants that are unpalatable, that have thorns to protect the leaves, or that maintain a high proportion of their leaves near the ground so grazing animals cannot remove all of the leaves when grazing, remain on the range.

Thus if one grazes his pastures such that each plant is given 30 to 60 days deferment after grazing then if the conditions for growth occur, the potential number of animals grazed can be 2 to 4 times that of improperly managed pastures.

Also, it should be obvious that not all periods provide similar growing conditions. Some periods are dry and cold with no growth at all, other periods have moist soil with cold temperatures, and growth occurs but slowly, whereas, other periods have warm temperatures and enough soil moisture for rapid growth, consequently, optimum rest or deferment periods vary tremendously.

Ideally, then a person should place his animals on a given portion of a natural pasture and graze that portion only one to three days. The area used should, of course, have enough forage for the animals to last them the one to three day period. Then that grazed portion should not be regrazed until a significant volume of leaves have grown. This may mean that the animals will have to be totally removed from the natural pastures and fed or grazed on planted forage, etc. This rotation of use on pastures can be accomplished through fencing, tethering animals with ropes, herding, etc.

Where animals depend on natural pasture for forage during the dry cold period, one must defer or rest the pasture sufficiently during the growing portion of the year that enough dry forage is available for the animals to be grazed. Otherwise, stored forage will have to be used to allow the animals to survive this period of nongrowth.

Probably, the most critical period of the year for the health of the plant is the period just prior to the longest dormant season. Plants must store energy in their roots and stem bases to have energy to begin vigorous regrowth when growing conditions again occur. Otherwise regrowth will be little or some plants may even die during the dormant period. Thus, it is reasonable practice to defer natural pastures sufficiently before the dormancy or dry period to have a large amount of leaves for grazing during the dry period.

APPENDIX 5

RANGE MANAGEMENT

Many of the problems experienced during the drought of 1983 were caused by the operation of individuals and of communities at the marginal limit of productivity. Any abnormality in the weather conditions that reduced forage production tipped the scales and forced the operators over the brink.

Although there is only about 10 percent of the native pasture in Puno in first class condition, it is quite productive, averaging about 2000 kg/ha. The number of sheep units that can be supported on this rangeland is about 1,620,000, allowing 440 kg/forage/sheep units per year for maintenance and reproduction.

Second class native pastures constitute about 65 percent of the rangeland in Puno. The annual average maximum forage production on these rangelands is about 800 kg/ha. These pastures could carry 4,212,000 sheep units on a sustained basis. However, if half of these second class rangelands were allowed to improve to first class condition (through management over the next 10 to 20 years), an additional 3,159,000 sheep units could be supported on a sustained basis on Puno's native pastures.

Likewise, if only half of the third class rangelands were allowed to improve to second class condition, an additional 495,000 sheep units could be supported on a sustained basis.

Cultivated pastures (without irrigation) presently constitute about 2 percent of the land resources (127,577 ha) within Puno. The average production on these plots and fields is about 5,000 kg/ha. Since most of these fields are planted in annual crops, primarily oats and barley, they can be grazed completely or cut for hay/silage during the growing season. Their annual carrying capacity is higher than for native pastures (22.7 sheep units/ha). However, to achieve these high carrying capacities, one must manage these plots or fields during the growing season to allow the plants an opportunity to grow and produce at this level (5,000 kg/ha). During the drought, these fields and plots were no more productive than the native pastures; therefore, they could not support animals taken off the native pastures.

Irrigated cultivated pastures often consist of perennial species such as alfalfa/*Dactylis* or clover/ryegrass. Since these plants are perennial, they must be managed similarly to native pastures, or the stand of cultivated species will be lost in only a few years (as evidenced on our trip through the Department of Puno). While the carrying capacity of these irrigated pastures significantly exceeds that of native pastures, it does not equal that of dryland/cultivated annual plants. The pastures also require additional financial inputs from the cost of irrigation and the costs of seeds of perennial species that must be imported. If oats or barley are planted in irrigated, cultivated pastures, their annual carrying capacity, with proper mangement, can be increased to 31.8 sheep units/ha.

If the perennial, irrigated, cultivated pastures are fertilized, average production doubles that of the annual dryland cultivated pastures, but their carrying capacity (22.7) only equals that of the pastures planted under dryland conditions. However, if annual crops (oats and barley) are irrigated and fertilized, their annual carrying capacity would increase to 45.5 sheep units/ha.

There is a place for alfalfa/*Dactylis* or clover/ryegrass combinations in cultivated pastures of Puno, especially in the Puna. But they have severe limitations when considered for the high density population areas around Lake Titicaca (which also have high density of animals). Rather, annual species that require less financed inputs and can be used completely every year without reserving any growth for sustained yields in subsequent years are more productive (in terms of proper carrying capacities) than the perennial plants.

A note of caution, however, concerning cultivation and irrigation. Cultivated crops were no more productive during the drought than native pastures, unless they had irrigation. Although irrigation is highly promoted in the Department of Puno, there is a great deal of information that must be gathered before it can be recommended for the 200,000 ha that have been designated for potential irrigation. Availability of water during drought, access of communities to available water and sites (soils, species, climate) adapted to irrigation must be determined. Not all areas presently designated potentially irrigable, in reality, will respond to irrigation as proposed.