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INTERNATIONAL CONFERENCE ON THE ECONOMICS OF  
DRYLAND DEGRADATION AND REHABILITATION

- Canberra, Australia -  
( 10-14 March, 1986)

DEGRADATION AND REHABILITATION OF  
THE MEDITERRANEAN ARID ZONE  
OF CHILE.  
SOCIOECONOMICAL STUDY OF  
ONE CASE.

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J. GASTO, D. CONTRERAS AND F. COSIO\*

I. INTRODUCTION

Problem description

Natural resource degradation of the arid and semi-arid Mediterranean region of Chile is a continuous process that leads toward more acute stages of degradation. Desertification processes should be considered in a global context which includes, besides crops and animal husbandry, other dimensions of this problem among which should be pointed out aspects such as economics, labor, migration, attitudes toward risk and uncertainty, cultural, educational and political, all of which represent a very complex problem and difficult solution.

Because of this, the range group of Man and the Biosphere Program (MAB-3 Chile) decided upon a global approach in order to reach a better understanding and to state the possible solutions, starting from the supposition that quality of life and the possible solutions are, in some way, closely related with the degradation of the natural resources.

Contemporary man is often astonished by the ruins of cities, towns, and farms formerly occupied by successful human groups. Natural resource destruction is shown through the times to be associated with the downfall of the people and their culture. Natural resource degradation of ranches is also associated with the downfall of those who use and benefit from the land to produce their food and generate work sources.

Several historical documents present evidence of the stages of the natural resources and their contribution to the development of the peoples and their further destruction associated with the downfall of the natural

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resources. Those ecosystems around the Norte Chico\* region now show a desertification aspect, different from the one described in former documents. Man, and not the climate should be blamed for the birth of the desert in this area where previously there were fertile lands.

The method used in this study was based on the selection of two traditional ranch communities of the Norte Chico, with a historically trajectory known throughout a period of four centuries, where life quality and natural resource deterioration has been gradually increasing. For the purpose of this study these two ranches were considered as only one unit and analyzed in greater detail than any previous study. The information was gathered by eleven study groups which includes subjects such as sociology, technology and natural resources. This allows a clearer view of subjects unknown previously in the literature. An economic analysis is included among the subjects studied.

It was preferable to consider deeply and in detail two agricultural communities of the region instead of superficially analyzing all the region as has been traditional. The study includes space occupational analysis for which the elaboration of twenty maps of the farm developed on the scale of 10:10000 was required. The information presented in this work doesn't pretend to solve the problems, but to provide valuable information in order to improve the understanding and to be utilized by the studios, the authorities and general public in charge of the solution of this kind of problem.

#### Geographical location

The ranches considered as a case study are located in the Norte Chico region of Chile, which is characterized by its arid mediterranean climate. It corresponds to what Köppen calls abundant fog-covered steppe (BSn). Mean annual temperature is 15.3°C and mean annual precipitation is 185 mm. The case study is formed by two communities, Carquindaño and Yerba Loca, with 2823 ha and 3742 ha, respectively.

Geo-morphologically the ranch is formed by two main units, the coastal mountains and the marine terraces. The coastal mountains originated

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\* Geographical area located between the Atacama Desert (Norte Grande) and the mediterranean semi-arid part of central Chile.

during the Paleozoic, at the end of the Pliocene and the beginning of the Pleistocene, and is constituted of granitic rock. The marine terraces originated later, during the early Quaternary. The material forming these terraces originated in erosion sediment coming from the higher locations. There are also some creeks developed through water erosion in geological times and aluvial valleys beside the water courses.

#### Nature of problem

The economic problems of degradation and rehabilitation of natural resources in the mediterranean arid and semi-arid regions of Chile present certain peculiarities which make it different from other arid lands of the world. The study problem is essentially an agricultural problem related mostly with goat husbandry and cereal and spice crops under dryland conditions. In spite of being an agricultural problem related with natural resources, especially range and soil degradation and its consequence on the ecosystems productivity reduction, the problem is strongly related to the social and economical aspects of land use. This is common to other arid regions of the world.

The Norte Chico region of Chile presents, however, basic differences from other regions. One of these differences is centered in the presence of the Andes Mountains, located east of the study area where precipitation is abundant and representing a valuable watershed from where several highly productive valley and rivers are born. This allows dryland and irrigated lands to integrate and the use of runoff water in dryland areas. The closeness of the Andes range also stimulates movement of livestock and people from the occidental area with mediterranean climate and winter range growth toward the mountains with cold climate and summer range growth. This has been the main cause of the nomadic tradicion of the herders and other members of the families, together with Old World traditions introduced into the country through the Spanish settlers, circumstances which have continued for the last four centuries.

Large copper and saltpeter mining operations in the far north, located between 1000 and 1500 km from the study area, has been the traditional work source, giving a well-paid income. During favorable price periods for

mining products, migration to the mines and money sent to the communities is greatest. During unfavorable price periods, these people may return to their community. Because of this, the comuneros\* problem can't be analyzed independently of these mining operations.

There is also the small and medium sized mining operations, frequent in the region. The mining wealth of this area allows many comuneros to temporarily work in their own mines, as well as those of other owners and thus generate income which is later spent or invested in the ranch. The closeness of the sea also presents a different approach from the great deserts existing in the Old World. The Pacific Ocean nearby is rich in food and work sources and presents possibilities which still haven't been exploited.

As a young country, the fusing of two cultures and races, Europeans and Americans, four centuries ago, led to a different situation from the Old World where roots and customs are more solid than those of the Norte Chico.

Finally, the degree of degradation of the natural resources is less and less persistent since the intensive use of the resources covers only one or two centuries in comparison with several millennia in the Old World.

Alternate plans

There is a wide range of possible solutions which include both the solution itself as well as the different strategies to carry it out. An analysis of the two ranches studied is presented as well as the possible causes and mechanisms to solve it. Based on this analysis, the main categories of possible solutions are presented.

The solution to be given to this problem is not the concern of the authors of this study, upon which they do not pronounce judgement. The final decision must be taken by the comuneros to whom this problem directly affects and by the government officials who should take care of natural resource conservation and minimize government grants. The comuneros haven't

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\* Comuneros are the commoners or people who live and work ranches in a community style; this style is proper of the arid mediterranean part of Chile. A detailed description of the communities and comuneros is presented in the text.

been successful in resource conservation together with farming without government subsidy in order to maintain the standard of living similar to the rest of the population of the country. Government and comuneros should work together to reach a solution in the short and long term.

## II. BOUNDARIES OF ANALYSIS

The region of Coquimbo, which represents the largest proportion of the Norte Chico area, is located between 29° and 32°10' S.L. It covers an area of 39,647 square kilometers which represents 5.24% of the total area of the country. This region is divided into three provinces: Elqui, Limarí and Choapa. The province of Choapa is divided into four counties: Illapel, Salamanca, Los Vilos and Mincha, in which are located the ranches studied. There is a total of 162 communities in the region with a population of 75,000 persons in an area of about one million hectares (Figure 2-1).

Mincha county has a population of 11,361 persons of which a 42.9% are in a situation of extreme poverty and 39.3% live in rural conditions. The total population which lives in the study area are 299 persons and correspond to 2.6% of the total population of the county. Population density is 17.8 ha/person in Carquindaño and 26.7 ha/person in Yerba Loca.

The over-utilization of these ranches has meant a progressive reduction of productivity, simultaneously with range and ecosystem degradation. When reaching the advanced stages of degradation goats start being important. Presently they are the most important domestic herbivore in the region.

The land occupied by the agricultural communities is, in general, hills or grazing slopes, scarcely of agricultural value, owned in common by proprietors of small estates that form an adjacent nucleus similar to a small spread-out village. Because of this isolation, the communities in general lack roads and have little access to social, sanitary and technical help. The marketing of agricultural products is also difficult. In general, they have a subsistence system which doesn't allow integration within the region where they are located.

### Time scale

From a historical and anthropological view there are two periods clearly defined:

- i. prehispanic. It is characterized by the presence of the native population, of the "diaguita" culture, who only cultivated the valleys under irrigated conditions. The agricultural activities

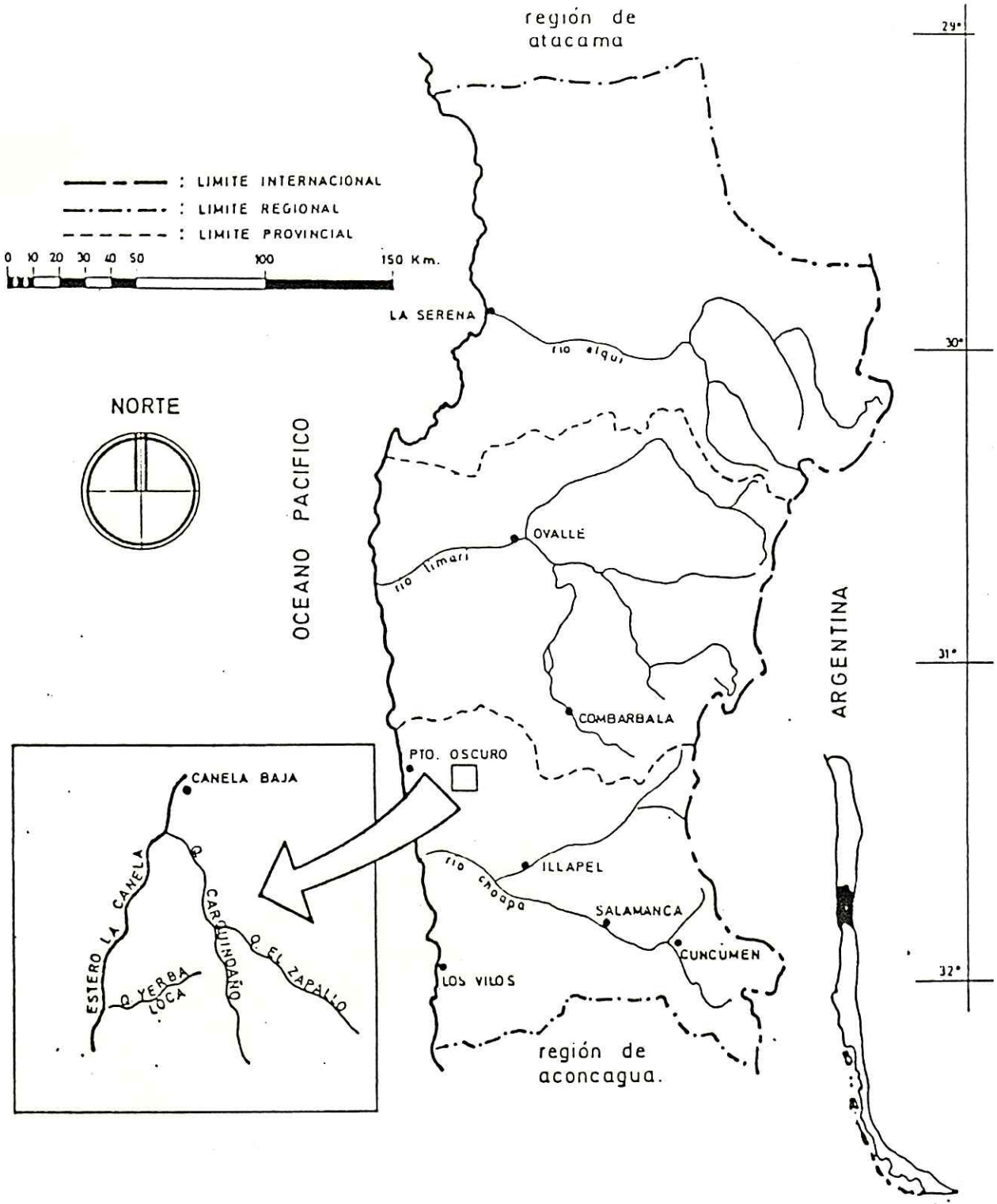


Figure 2-1. Coquimbo region and location of the study area.

were carried out using only the natural resources. With the late arrival of the "incas" in the fifteenth century, new methods of irrigated crops and livestock raising were introduced and mining activities were developed to produce gold, silver and copper.

- ii. hispanic. The European settlers introduced new plant and animal species and crop technology, especially those related with dryland agriculture and animal traccion. This caused intensification in the use of natural resources and oriented the regional economy toward livestock crops and mining. In this respect it should be pointed out that the production of tallow and other cattle by-products increased rapidly at the beginning of the seventeenth century together with large exports toward Peru. In the second half of the century the economy changed to crops and mining while livestock operations moved toward poorer lands.

From the year 1720 on, wheat exports to Peru started to decay and as a consequence, the mining increased which triggered a population growth in this area. This caused a larger pressure over the natural resources for the production of firewood, crops and livestock. At the end of the eighteenth century several mining smelters, using firewood in the process, were established.

The mining operations had the right through the mining laws to cut and destroy indiscriminately any type of vegetation in any place. Nothing was respected. Starting from the valleys the woodcutters and charcoal makers harvested slopes and hills and finally moved toward the Andes Mountains foothills. Simultaneously, cereal crops in the cleared soils increased intensively. This process characterized by more intensive cropping and firewood harvesting, simultaneously with range overgrazing, is continued up to the present.

The history of the land ownership of these two ranches is known in detail since the year 1553, when Don Pedro Valdivia, first governor of Chile passed away. In the year 1605, Alonso de Ramon was appointed governor and assigned in the name of the King of Spain land grants in Mincha county to Francisco de Aguirre and Cortés y Juan de Ahumada. Later, Aguirre exchanged

these lands to Pedro Cortes Monroy.

In the year 1679 the widow of Pedro Cortes Monroy, Doña Magdalena de Zavala gave to Pedro Cortes Monroy Peres the lands of the area around La Canela Valley and other lands located in Limarí. Don Diego established his home where presently is located the town of Canela Baja, where he lived with his wife, Ana de Castillo and had two children, Diego and Pedro. Through his will, Diego Cortes Monroy left in 1705, the property to his two sons, as well as a small farm to his sister, Baltazara. Later, in an agreement in 1739, both sons divided the lands and Diego kept the land located in the lower part, Canela Baja Ranch.

A year later Pedro Cortes Monroy del Castillo sold the lands denominated Yerba Loca and Carquindaño, to Bernardo Ibacache, leaving the rest of the land as an inheritance to his five children which formed the present community of Canela Baja.

According to the information available, Yerba Loca community kept the territory unchanged since the sale to Bernardo Ibacache until it was officially legalized as a community in 1969. Carquindaño and El Zapallo merged to form the community of Carquindaño.

When the Secretary of the Interior legalized the communities, he established the legal limits and gave the comuneros legal rights in each community. The decision was based on the ownership of estates inside the community, while these private estates were respected and maintained and thus coexist two ways of ownership, common land under dryland conditions and private estates, mainly under irrigation.

Presently the communities allow the people to rent estates, having or not having the right to use the common lands. It should also be pointed out that not all the comuneros live in the community, which doesn't mean that they lose their rights since they can continue using the grazing rights as well as temporary assigned estates for dryland farming which are called "lluvias", which allow to diversify and rotate their crops.

With respect to the "lluvias", they are assigned once and are inherited by the offspring which are worked for a period of 8-10 years, followed by a period of rest of 15-20 years. This is the reason why they are not totally

cultivated, only sections. Some comuneros own two or three "lluvias" which allow to diversify and rotate their crops.

The information presented in this study refers to the period 1983-1984. The economic information provided has been transformed into US\$ which at that time was equivalent to 75 Chilean pesos per dollar.

#### Economic dimension

It is difficult to make a detailed and precise economical analysis of the two farms since there is no available information for that purpose. Thus it was necessary to carry out the study and to make measurements both of productivity and area covered by each activity, especially crops and animal husbandry. The problem of getting reliable information is difficult since the fields are divided into very small plots. Milk productivity was determined through milk control of goat herds throughout the year which allows, through statistical information, calculation of the total productivity of the farm during the year.

Personal income was calculated for each one of the families in the community which include both the income generated on the ranch as well as that generated outside, such as government subsidized jobs offered to the community, retirement funds as well as government employees for education, forestry and health services.

In relation to capital investment, land value was calculated according to estimations of Internal Revenue Services. Construction values were determined after measuring the area covered by each building and the construction quality. Other sources of capital were also determined.

The economic results were determined for both communities, including gross margin, income and costs. The net income, family income, for each kind of activity and gross income were also determined.

In the study there is also included an estimation of the agricultural costs to rehabilitate the area; however, the social cost of this action is not considered. Also included is the relationship between ranch rehabilitation and total income, as well as the possibility to generate employment in the community. All of this is in the character of a hypothesis.

### Policy constraints

The management of the study area is based on legal regulations presently existing as well as custom and tradition of the population. Because this area has been declared an area of extreme poverty by the authorities, the government usually is involved through monetary assistance, work, education, health care and land management, as well as loans and technical assistance.

In Chile the communities are a way of land ownership included in the law 16,640 of the land reform, passed in July, 1967 which established that community land is that which belongs in common to all those persons that work personally on that land or to a cooperative forming a human and economical community. Each member contributes to the common labor and receives part of the benefits in relation to the nature and amount of work realized.

In December, 1967, the DFL 5 was passed and defined community as those rural lands belonging in common to scattered owners where the number of comuneros is larger than the productive carrying capacity of the farm and the family requirements.

The recent policy has included the legalization of land ownership and clarify their titles. At the same time the population income and the community development have received the benefits of employment programs from the government. The monetary income originating from this source represents a high percentage of the total community income.

The government backing also considers technical assistance, as well as loans for farming and forage shrub plantation programs to help livestock production and resource conservation. Finally, there is government financed health centers as well as rural schools.

### III. BIOPHYSICAL AND SOCIAL ELEMENTS

#### Ranch description

The two communities studied are located in the Norte Chico, Coquimbo region in Mincha county (Figure 3-1). Carquindaño covers an area of 2,823 ha and includes a population of 159 persons distributed in 32 families. Yerba Loca covers 3,742 ha and has a population of 140 persons in 29 families.

Both communities are located 200 km north of Santiago and 200 km south of La Serena, next to the Pan American Highway and 40 km west of Illapel. They are located in Mincha county between the parallels  $31^{\circ} 24'$  and  $31^{\circ} 31'$  S. and the meridians  $71^{\circ} 22'$  and  $71^{\circ} 30'$  W., and are adjacent.

In relation with the area covered, Carquindaño is located around the creeks of El Zapallo and Carquindaño Alto and Yerba Loca Community covers Carquindaño Bajo and Yerba Loca creeks as well as the surrounding Canela Baja Stream. The total surface is 6,565 ha. The relief is broken, represented by gentle slopes and mountain peaks. Several creeks cut the slopes and leave a few plateaus inbetween.

The agricultural communities are important forms of land ownership in Chile, due mainly to the high poverty and marginal conditions. This system is not well known and has a mixture of private property together with communitary use property in combination with the use of some private areas for long periods or "lluvias".

#### Biogeo-structure

The soils are predominantely of non-plowable land use capacity with strong restriction for its use. In the Table 3-1, it is indicated that the two most important classes VI and VII have 2302 ha and 2848, respectively, which represents 42.68% and 43.38% of the area. It should be pointed out the low proportion of irrigated soils which are only 0.00015% of the total area. The total plowable soils under dryland conditions are 88 ha which correspond to 1.35% of the total area. A good watershed management on the upper slopes could allow the use of irrigation or semi-irrigation with the winter runoff water which presently is not being used and this could be achieved through their storage in ponds or through infiltration underground.

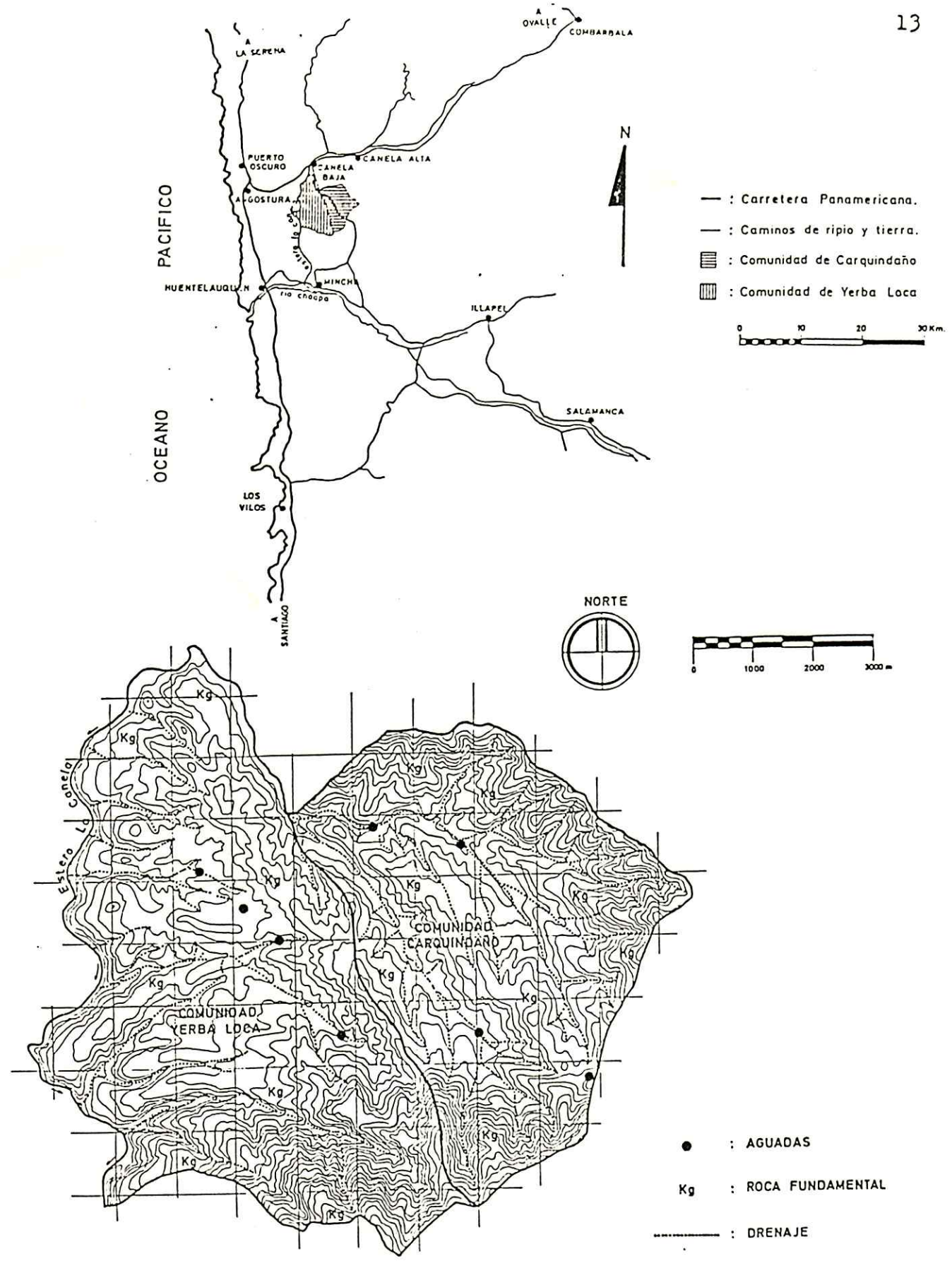


Figure 3-1. Topographic map of the study area.

Table 3-1. Land use capacity of the different soils of the communities. r, irrigated and s, dryland. Class I to IV are plowable and V to VIII are non-plowable.

| Class | Area |
|-------|------|
| Ir    | 0    |
| IIr   | 1    |
| IIIr  | 0    |
| IVr   | 0    |
| Is    | 0    |
| IIIs  | 88   |
| IIIIs | 0    |
| IVs   | 0    |
| V     | 298  |
| VI    | 2802 |
| VII   | 2848 |
| VIII  | 528  |

The possible multiple uses are crop production, rangelands for domestic livestock, wood production, watershed for water production, wildlife for hunting, outdoor recreation and urban and industrial uses (Table 3-2).

Table 3-2. Multiple potential use of the communities.

| Use              | Priority       |           |
|------------------|----------------|-----------|
|                  | Primary        | Secondary |
|                  | ----- ha ----- |           |
| Urban            | 9              | ---       |
| Agro-industrial  | 9              | ---       |
| Forage crops     | 88             | ---       |
| Pastoral         | 5939           | ---       |
| Fruit trees      | 88             | ---       |
| Annual crops     | 1              | 88        |
| Silviculture     | 2848           | 3072      |
| Water production | 546            | 2848      |
| Wildlife         | 528            | ---       |

The best way to use the land according to the multiple use is the simultaneous use for two or more purposes. The multiple use of land resources is a necessity originated from the lack of resources and population

growth. Multiple use is an answer in order to have larger resources of traditional and modern uses (Table 3-3 and 3-4).

Table 3-3. Primary use of land in the area studied.

| Use                    | Area          |                 |
|------------------------|---------------|-----------------|
|                        | Amount<br>ha  | Proportion<br>% |
| <u>Dryland-crops</u>   |               |                 |
| Wheat                  | 184.7         | 2.8             |
| Barley                 | 49.0          | 0.7             |
| Anis                   | 18.0          | 0.3             |
| Cumin                  | 0.5           | 0.0             |
| Anis-cumin             | 21.2          | 0.3             |
| Peas-horsebeans        | 4.7           | 0.1             |
| Potatoes               | 1.1           | 0.0             |
| Beans                  | 0.8           | 0.0             |
| Rye-grass pasture      | 0.9           | 0.0             |
| Fallow                 | 129.7         | 2.0             |
|                        | <u>410.6</u>  | <u>6.2</u>      |
| <u>Irrigated crops</u> |               |                 |
| Vegetables and corn    | 2.2           | 0.0             |
| Natural pasture        | 1.4           | 0.0             |
| Fallow                 | 1.7           | 0.0             |
|                        | <u>5.3</u>    | <u>0.1</u>      |
| <u>Rangelands</u>      |               |                 |
| Good condition         | 102.8         | 1.6             |
| Fair condition         | 1315.6        | 20.0            |
| Poor condition         | 4711.7        | 71.8            |
|                        | <u>6310.1</u> | <u>93.4</u>     |
| Other uses             | 19.0          | 0.3             |
| Total                  | 6565.0        | 100.0           |

Table 3-4. Actual land use of the study area

| Use                          | Area(ha) |
|------------------------------|----------|
| Deferred range               | 552.8    |
| Post-crop range              | 815.2    |
| Deteriorated disclimax range | 4947.5   |
| Pasture and mowing           | 0.5      |
| Crops                        | 423.1    |
| Vegetables                   | 4.1      |
| Peri-urban                   | 23.6     |
| Semi-natural fruit trees     | 12.0     |
| Forestry, planted            | 0.7      |
| Water production             | 0.2      |
| Firewood production          | 895.7    |
| Planted forage shrubs        | 236.1    |

One of the main problems which triggers desertification is the land overuse which is achieved mainly through the plowing and cultivation of non-plowable soils, together with overgrazing of the rangelands and the indiscriminate harvesting of firewood. As an initial action of land management and organization, land should be utilized according to its capacity. Some areas of the ranches are regularly underused. Any solution proposed should include using the resources according to their capacity.

The agricultural style applied to this farm is based on the ecosystem overuse. The soils are regularly plowed for cereal crops under dryland conditions without any restrictions according to their use capacity. Non-plowable soils are regularly plowed. Non-grazing lands are regularly grazed. Some areas should be improved as protection for watershed, however they are intensively overgrazed and their shrub cover harvested, leaving the soil uncovered.

The mechanism that triggers the soil and plant devastation is generated by the excessive demand and harvest by man. The final stage of this process is a desert generated by the action of man or agri deserti (Table 3-5).

Table 3-5. Desertification degree of the study area.

| Degree |  | Area   |
|--------|--|--------|
| Scale  | Denomination                             |        |
| 1      | Natural ecosystem                        | 0.0    |
| 2      | Modified faunistic composition           | 0.0    |
| 3      | Natural wildlife eliminated              | 0.0    |
| 4      | Natural vegetation selectively harvested | 3.8    |
| 5      | Devastated natural vegetation            | 728.7  |
| 6      | After growth                             | 0.0    |
| 7      | Thin vegetation cover                    | 643.8  |
| 8      | Bare                                     | 0.0    |
| 9      | Initial soil deterioration stages        | 0.0    |
| 10     | Moderate soil deterioration stage        | 321.5  |
| 11     | Intense soil deterioration stage         | 4120.1 |
| 12     | <u>Agri Deserti</u>                      | 747.1  |

Crop efficiency expressed on a yield basis is low, due mainly to ecosystem overexploitation and to the degradation process through overgrazing and cropping of non-plowable land which triggers the desertification process. The average yield of wheat is 400 kg/ha and barley, 180 kg/ha. In relation

to anise, productivity is 56 kg/ha and cumin, 41 kg/ha. The herd, especially goats and sheep, is not organized in a modern scheme to allow high productivity and efficiency. Each family group has an independent herd which is controlled by the owner separately from the rest of the herd, although usually utilizing the same area and rangelands (Table 3-6).

Table 3-6. Animal population and composition.

| Species | Number of heads | Equivalent animal units | Proportion |
|---------|-----------------|-------------------------|------------|
|         | N <sup>o</sup>  | AUY                     | %          |
| Goat    | 2821            | 541                     | 73.79      |
| Sheep   | 628             | 105                     | 14.37      |
| Horses  | 39              | 39                      | 5.32       |
| Donkeys | 62              | 31                      | 4.22       |
| Mules   | 26              | 13                      | 1.77       |
| Cattle  | 4               | 2                       | 0.03       |
| Pigs    | 10              | 2                       | 0.03       |
| Total   | 3590            | 732                     |            |

The organization of age, sex, race and species structure could lead toward a substantive improvement of the animal husbandry. Herd organization doesn't explicitly consider range conditions, or forage availability.

Decision making processes usually occur a posteriori and in a natural casual way. Herd organization is not contemplated with the necessary anticipation, nor is there a systematic organization to adjust the herd to the seasonal and annual changes in forage availability.

Production efficiency of kids is 0.13 heads/ha and 2.7 kg/ha. Production efficiency of lambs is 0.01 heads/ha and 0.56 kg/ha. Milk production is 34.9 kg/ha which is equivalent to 4.4 kg/ha of fresh cheese, these values being low in relation to the soil and climate potential. Wool production/ha is 0.19 kg and goat manure, 0.24 m<sup>3</sup>.

### Techno-structure

Technological structures presently existing in the farm are mainly housing, fences, corrals and storage sheds.

There is in the farms a total of 132.6 km of fences built of different materials and in several stages of maintenance and operation. There are no

fences bordering the property to allow separation from the neighboring ranches (Table 3-7), and thus livestock wanders from property to property and complicates the use and management of the range as well as forage conservation in the fields through deferment.

Table 3-7. Materials and fence length in the communities and maintenance state.

| Construction materials | State of conservation |            |            | Total      |
|------------------------|-----------------------|------------|------------|------------|
|                        | Good                  | Fair       | Poor       |            |
|                        | ----- km -----        |            |            |            |
| Wire                   | 26.8                  | 2.3        | 2.4        | 31.5       |
| Cactus                 | 27.1                  | 30.1       | 22.6       | 79.8       |
| Puya chilensis         | 0.0                   | 0.0        | 3.0        | 3.0        |
| Stone                  | 6.1                   | 0.0        | 2.8        | 8.9        |
| Adobe                  | 1.5                   | 0.5        | 0.0        | 2.0        |
| Wire and cactus        | 3.1                   | 0.0        | 0.0        | 1.0        |
| Stone and cactus       | 1.0                   | 0.0        | 0.0        | 1.0        |
| Branches               | 1.8                   | 0.0        | 0.2        | 2.0        |
| Others                 | <u>1.3</u>            | <u>0.0</u> | <u>0.0</u> | <u>1.3</u> |
| Total                  | 68.7                  | 32.9       | 31.0       | 132.6      |

In spite of the length of the fencing, which surpasses the needs, and has meant great investment and effort through the years, it doesn't present the minimum conditions for achieving good range and resource management and high productivity (Table 3-8).

Table 3-8. Number of paddocks and total area.

| Kind of paddock                   | Area           |               | Number   |
|-----------------------------------|----------------|---------------|----------|
|                                   | Total          | Mean          |          |
|                                   | ----- ha ----- |               |          |
| Manor house                       | 19.7           | 0.64          | 31       |
| Cultivated forage shrubs          | 236.1          | 118.05        | 2        |
| Dryland crops "lluvias"           | 427.0          | 5.77          | 74       |
| Abandoned dryland crops "lluvias" | -----          | -----         | 104      |
| Subtotal                          | 682            | 3.24          | 211      |
| Community rangelands              | <u>5882.2</u>  | <u>5882.2</u> | <u>1</u> |
| Total                             | 6565.0         | 30.97         | 212      |

It should be pointed out that in an area of 682.8 ha there is a total of 211 paddocks; while in the remaining 5882.2 ha there is only one paddock which is open toward the neighboring ranches. This is indicative that paddocks have been designed for crop protection and not for the ranch organization and the proper range use by livestock through management practices.

In relation to this, it is possible to improve the techno-structure, increase productivity and harmonize the use capacity and utilization of the different ecosystems. It is possible to improve this situation both in relation to the quality of organization as well as to divide the total area in paddocks of the proper size.

The fences to protect crops from livestock are usually in good condition. The same doesn't occur with fences for livestock management which usually are deteriorated or destroyed due mainly to the lack of interest because of the farm development style centered in small herds and herders which make unnecessary the fences.

The public road that crosses one of the farms as well as the lateral road, allows communication and transportation with the rest of the region throughout the year. There are many paths without clear destinations or objectives. For a modern organization of these ranches, it would be necessary to complete the roads with others according to the final design given the ranch (Table 3-9).

Table 3-9. Roads and paths in the community.

| Kinds of roads | Length(km) |
|----------------|------------|
| Gravel roads   | 24.2       |
| Main paths     | 81.0       |

The spreading of housing, storage sheds and working places of the comuneros along the valleys and piedmonts doesn't allow provision of the population with the minimum facilities of urban life such as: potable water, sewage system, green areas, street lighting, commerce and work centers which could be generated with a better concentration of population. Presently, it is difficult to think of changing the urban structure of the population in a short time. In longer term, in some decades, the develop-

ment could lead toward a village with the necessary facilities for country life. This would also liberate a larger area of the best soils presently being used for buildings.

Investments in buildings and housing are high, surpassing the farm needs which is shown in the porportion of capital being invested in these items and the area built (Table 3-10).

Table 3-10. Constructions in both communities.

| Kind of Construction                     | Comunity                   |            |         | Mean area  |           |
|--|----------------------------|------------|---------|------------|-----------|
|  | Carquindaño                | Yerba Loca | Total   | per person | per house |
| Number of houses and accessory buildings | 32                         | 29         | 61      | --         | --        |
|  | ----- m <sup>2</sup> ----- |            |         |            |           |
| Living rooms                             | 15.00                      | 0.00       | 15.00   | 0.05       | 0.24      |
| Dining rooms                             | 762.25                     | 662.40     | 1424.65 | 4.76       | 23.35     |
| Corridors                                | 3.50                       | 0.00       | 3.50    | 0.01       | 0.06      |
| Bed rooms                                | 973.26                     | 704.20     | 1677.46 | 5.61       | 27.50     |
| Kitchens                                 | 331.25                     | 331.00     | 662.25  | 2.21       | 10.85     |
| Rooms for worship                        | 0.00                       | 50.00      | 50.00   | 0.16       | 0.98      |
| Bathrooms                                | 20.25                      | 6.75       | 27.00   | 0.09       | 0.44      |
| Showers                                  | 2.25                       | 0.00       | 2.25    | 0.01       | 0.04      |
| Storage rooms                            | 619.36                     | 368.70     | 988.06  | 3.30       | 16.20     |
| Workshops                                | 129.75                     | 0.00       | 129.75  | 0.43       | 2.13      |
| Straw storage rooms                      | 400.00                     | 433.50     | 837.50  | 2.80       | 13.73     |
| Chicken houses                           | 58.00                      | 30.00      | 88.00   | 0.29       | 1.44      |
| Total                                    | 3318.87                    | 2586.55    | 5905.42 | 19.72      | 96.81     |
| Common buildings                         | 84.00                      | 90.00      | 174.00  | 0.58       | 2.85      |
| Schools                                  | 214.37                     | 0.00       | 214.37  | 0.71       | 3.51      |
| Chapels                                  | 36.00                      | 0.00       | 36.00   | 0.12       | 0.59      |
| Sport buildings                          | 32.00                      | 0.00       | 32.00   | 0.10       | 0.52      |
| Grand total                              | 3685.24                    | 2676.55    | 6361.79 | 1.51       | 104.29    |
| Number of persons                        | 159                        | 140        | 299     |            |           |

Techno-structure and development of other ranch items are insignificant in relation to the ranch needs, especially milking facilities, cheese making, crop equipment, transportation, irrigation, ponds and scales for livestock and products. Ranch information is nil.

### Socio-structure

Socio-structure could be divided into three items: labor, culture and social. The development of this area is closely related with population, culture and tradition since in this area of the country there has been little migration and outside cultural influences.

Growth and development has evolved toward a larger independence from the urban centers in the valleys and coastal regions. Presently it has been transformed into a center of consumption of the manufactured products from the industrial areas, while being dependent on the commercial banking and administration activities of those areas. Labor is mainly invested in activities related with population self-consumption. In a minor degree crop production, fruit trees and mining is destined for consumption in other regions.

Migration to other regions with better job possibilities has been traditional. It has been demonstrated that population density presented by the census during the last century hasn't changed. This strategy has allowed adjustment of the carrying capacity of the ecosystem in spite of the high birth rate. There is also seasonal migration to other areas.

Labor organization has been limited and has shown, in general, low efficiency. The nomadism of the herders and sometimes part of the family, toward the Andes Mountains during the summer is another characteristic of labor. Cultural activities are limited and related mainly with regional traditions. Educational levels of the population are low in spite of the fact that most of the population has some primary school education. The preservation of customs and traditions has allowed the population to successfully survive in the difficult regional environment.

A special effort should be made to achieve a better administration of the community, giving a cooperative structure which obviously is very difficult. Industrial activity related with milk technology could stimulate a community action to develop cooperative work and administration which could end in an efficient ranch. To reach this goal, it is necessary to improve the social structure of the population through industry and range management.

The lack of a centralized administrative and information system is one of the main reasons of the lack of efficiency of this ranch. Administrative decisions are taken individually, often damaging the ranching operations and without the benefits of a modern ranch organization and a larger scale economy.

Some areas of the ranch are owned in common, even when the administration and benefits are private. Other areas are owned in common and the administration is also in common even when the benefits are private. This situation generates conflict of interests among the comuneros and the community and affects the optimization of resource management and productivity. Private property structure also doesn't allow having a modern and efficient ranching operation mainly because of the spacial distribution of the properties in the area (Table 3-11).

Table 3-11. Population structure.

| Kind     | Number |
|----------|--------|
| Families | 61     |
| Men      | 157    |
| Women    | 142    |
| Total    | 299    |

It is difficult to change production activities and organization of this community without modifying the cultural restrictions. The natural culture of the population would not allow organization of a highly efficient ranch without affecting their values and customs. Their present culture would not allow an efficient ranching operation and would require specialized educational programs.

## IV ECONOMIC ANALYSIS

Capital resourcesRanch Capital

In this study the farm capital is divided into five items: land, construction, fences, milking and reproducing livestock, and agricultural implements and tools.

Land value was calculated based on the Internal Revenue information service. This is usually smaller than the commercial value (Table 4-1).

Table 4-1. Land price value according to Internal Revenue appraisalment.

| Item                           | US\$     |
|--------------------------------|----------|
| Per hectare                    | 3.43     |
| Total area of both communities | 21936.99 |

In relation to the constructions, all of the housing facilities were considered as well as family storage sheds and barns. Also included are the school, chapel, sports facilities and social center of the community (Table 4-2).

Table 4-2. Construction values.

| Kind of construction |          | Total  | Value per | Total value |
|----------------------|----------|--------|-----------|-------------|
| Material             | Quality  |        | sq. m.    |             |
|                      |          |        | US\$/sq.m | US\$        |
| Adobe                | Standard | 874.5  | 68.28     | 59710.85    |
| Adobe                | Fair     | 293.0  | 48.75     | 14282.77    |
| Adobe                | Poor     | 5026.3 | 39.12     | 196656.54   |
| Wood                 | Standard | 150.0  | 87.79     | 13168.00    |
| Wood                 | Poor     | 18.0   | 50.72     | 912.96      |
| Total                |          |        |           | 284731.12   |

The length of fences built was calculated through planimetric studies of the community. A value of the different kinds of fences was calculated as well as their state of deterioration. There is a total of 132.6 km (Table 4-3).

Table 4-3. Fence value.

| Kind   | Length | Value    |
|--------|--------|----------|
|        | km     |          |
| Wire   | 31.5   | 23919.00 |
| Cactus | 79.8   | 58156.56 |
| Stone  | 8.9    | 3168.07  |
| Others | 12.4   | 3498.72  |
| Total  | 132.6  | 88742.33 |

Of the total value of livestock, it was only considered those animals which lose price through time such as milking goats and reproducers, leaving aside the livestock that is sold during the season. Livestock included under this item are goats (100% are for milking and reproduction), adult male goats (100% are for reproduction), female kids (20% of the females), sheep (100% are for reproduction), rams (100% are for reproduction), and lambs (20% are females)(Table 4-4).

Table 4-4. Milking and reproduction livestock value.

| Species       | Unit value | Number | Total value |
|---------------|------------|--------|-------------|
|               | US\$/head  | heads  | US\$        |
| Goats         |            |        |             |
| Adult females | 16.00      | 2736   | 43776.00    |
| Adult males   | 66.67      | 48     | 3200.00     |
| Female kids   | 9.33       | 4      | 37.33       |
| Male kids     | 4.00       | 175    | 700.00      |
| Sheep         |            |        |             |
| Ewes          | 20.00      | 603    | 12100.00    |
| Rams          | 93.33      | 23     | 2164.67     |
| Lambs         | 5.33       | 25     | 133.33      |
| Total         |            |        | 62093.33    |

The value of tools and working implements was made based on the estimation of the average amount belonging to each family to be used for agricultural activities. The total value is US\$3579.48. The total farm capital of both ranches is US\$461,083.25 (Table 4-5). 61.75% of the total capital is invested on constructions.

Table 4-5. Total ranch capital.

| Item          | Amount US\$      | %     |
|---------------|------------------|-------|
| Land          | 21936.99         | 4.76  |
| Constructions | 284731.12        | 61.75 |
| Fences        | 88742.33         | 19.25 |
| Livestock     | 62093.33         | 13.47 |
| Tools         | <u>3579.48</u>   | 7.76  |
| Total         | <u>461083.25</u> |       |

#### Working Capital

In relation to this, the working capital of the ranches is divided into livestock inventory and seed value.

Livestock inventory only included those animals sold during the season, and include the males plus 30% of the females born during the season. Horses, mules and donkeys are also included under these items since they are used for labor in the production process (Table 4-6).

Table 4-6. Livestock value considered as operation capital.

| Species         | Value/unit<br>US\$ | Livestock          |            | Total value<br>US\$ |
|-----------------|--------------------|--------------------|------------|---------------------|
|                 |                    | Total              | Considered |                     |
|                 |                    | ----- Number ----- |            |                     |
| Goats           |                    |                    |            |                     |
| Male kids       | 4.00               | 1748               | 1573       | 6292.00             |
| Female kids     | 9.33               | 37                 | 33         | 308.00              |
| Sheep           |                    |                    |            |                     |
| Lambs           | 5.33               | 249                | 224        | 1194.67             |
| Horses          | 200.00             | 39                 | 39         | 7800.00             |
| Mules & donkeys | 53.33              | <u>82</u>          | <u>82</u>  | <u>4373.33</u>      |
| Total           |                    | 2155               | 1951       | 19968.00            |

The seeds used in the four main crops are also included (Table 4-7).

Table 4-7. Seed used during one agricultural season.

| Crop   | Seed  | Area  | Total Seed |
|--------|-------|-------|------------|
|        | kg/ha | ha    | kg         |
| Wheat  | 50.0  | 184.7 | 9235.0     |
| Barley | 50.0  | 49.0  | 2450.0     |
| Anis   | 5.6   | 28.6  | 160.2      |
| Cumin  | 4.1   | 11.1  | 45.5       |

It should be pointed out that the livestock is the most important item in working capital, since the comuneros only own small areas of private land. They increase the use of common areas since livestock is raised without direct expenses and very little work.

To summarize this information, Table 4-8 presents the total working capital of the case study. Capital investment in livestock is 89.01% in Carquindaño and 91.2% in Yerba Loca.

Finally, Table 4-9 shows the total capital of both communities. The information shows that 95.4% is ranch capital and 4.6% is working capital. This is indicative of a low level of activity.

Table 4-8. Working capital.

| Item      | Capital         | Proportion |
|-----------|-----------------|------------|
|           | US\$            | %          |
| Livestock | 19968.00        | 89.9       |
| Seeds     | 2241.05         | 10.1       |
| Total     | <u>22209.05</u> |            |

Table 4-9. Ranch and working capital of the communities studied.

| Item                     | Capital   |            |
|--------------------------|-----------|------------|
|                          | Amount    | Proportion |
|                          | US\$      | %          |
| <u>Ranch capital</u>     |           |            |
| Land                     | 21936.99  | 4.54       |
| Constructions            | 284731.12 | 58.91      |
| Fences                   | 88742.33  | 18.36      |
| Livestock                | 62093.33  | 12.85      |
| Tools & implements       | 3579.48   | 0.74       |
| Total                    | 461083.25 | 95.40      |
| <u>Operation capital</u> |           |            |
| Livestock                | 19968.00  | 4.13       |
| Seeds                    | 2241.05   | 0.47       |
| Total                    | 22209.30  | 4.60       |
| <u>Total capital</u>     | 483292.30 | 100.00     |
| <u>Proportion</u>        |           |            |
| Ranch capital            | 461083.25 | 95.40      |
| Working capital          | 22209.05  | 4.60       |

### Economic results

#### Gross margin per item

The main productive items in crops are wheat, barley, anise and cumin and in relation with livestock are goats and sheep. To determine the gross margin, the following formula was used:

$$\text{Gross margin} = \text{gross income} - \text{variable costs}$$

To determine the gross margin of crops, the four main crops were considered: wheat, barley, anise and cumin. On the other hand it is known that the comuneros seed in their estates vegetables such as potatoes, corn, onions, garlic, beans, garbanzos, lentils, tomatoes, squash, melon, watermelon, peas and horsebeans; also some fruit trees such as pears, peaches and figs. These crops were not included in the calculations since they are mainly for self-consumption and lacking information such as yield and surfaces and also for being amounts probably insignificant. Table 4-10 presents information related with the gross income of the five main crops. Variable cost of each crop includes only seeds. Animal

labor is included among the fixed costs since they can't be related to any specific crop and should be included in the total cost.

Table 4-10. Gross income from main crops.

| Crop      | Mean yield | Cultivated area | Price per unit | Gross income |
|-----------|------------|-----------------|----------------|--------------|
|           | kg/ha      | ha              | US\$/kg        | US\$         |
| Wheat     | 400.0      | 187.7           | 0.1467         | 10835.73     |
| Barley    | 180.0      | 49.0            | 0.1333         | 1176.00      |
| Anis      | 56.3       | 28.6            | 0.4000         | 644.00       |
| Cumin     | 41.0       | 11.1            | 0.1480         | 182.00       |
| Coriander | 34.0       | 1.0             | 3.0667         | 104.27       |
| Total     |            |                 |                | 12942.00     |

The variable costs of the four main crops is included in Table 4-11. However, it is important to consider the small size of the cropping operation which allows every family to have enough labor to fulfill their needs. On the other hand, it should be pointed out that the crop technology is very low using only goat manure produced locally. Table 4-12 shows gross margin which only considers cost of seeds.

Table 4-11. Variable costs of main crops.

| Crop   | Seed value |
|--------|------------|
|        | US\$       |
| Wheat  | 1354.47    |
| Barley | 490.00     |
| Anis   | 251.29     |
| Cumin  | 145.29     |
| Total  | 2241.05    |

Table 4-12. Gross margin of main crops.

| Crop      | Gross income | Variable cost | Gross margin |
|-----------|--------------|---------------|--------------|
| Wheat     | 10835.73     | 1354.47       | 9481.26      |
| Barley    | 1176.00      | 490.00        | 686.00       |
| Anis      | 644.00       | 251.29        | 392.71       |
| Cumin     | 182.00       | 145.29        | 36.71        |
| Coriander | 104.27       | -----         | 104.27       |
| Total     | 12942.00     | 2241.05       | 10700.95     |

### Animal Gross Margin

The main income from animal husbandry is from milk production, manure, births and cheese yield. The average yield per goat in the herd and the number of milking days were calculated to estimate the monthly milk production (Table 4-13). The gross income from cheese production is equivalent to the gross margin. Variable costs were not calculated because there is not reliable available information; it is known however that the feed comes only from natural range and labor used in milking operations and cheese manufacturing is that of the family group.

Table 4-13. Milk and cheese production values.

| Variable                           | Month    |          |         |          | Total   |
|------------------------------------|----------|----------|---------|----------|---------|
|                                    | November | December | January | February |         |
| Number of days                     | 30       | 31       | 31      | 38       | 120     |
| Mean grams/day<br>per goat in herd | 560      | 290      | 170     | 110      | ---     |
| Milk kg/month                      | 45965    | 24597    | 14418   | 8427     | 93407   |
| Cheese kg/month                    | 8150     | 3732     | 2060    | 1206     | 15153   |
| Total cheese value (US\$)          | 3260.00  | 1492.80  | 826.00  | 482.40   | 6061.20 |

An important source of expenses of some comuneros is the herd movement to summer ranges in the Andes Mountains. The trip lasts between 15-20 days, moving 6-10 km/day. Some comuneros who can't go to the mountains send their animals with others and for this arrangement, they pay half of the kids plus US\$.40 of grazing fees per goat. The cost of going to summer range was not included in this study since there is no reliable information in this respect nor of the weight gain of the animals.

In order to calculate the gross income from livestock sales, it was considered that 50% of the kids and lambs were males and thus are sold (Table 4-14). The total animal income, which includes manure, animal skins, wool and milk produced during the months of the year not included in the calculations presented in the table, is US\$ 23906.67 (Table 4-15).

Table 4-14. Live weight production value.

| Products sold | Number of heads | Value US\$ |
|---------------|-----------------|------------|
| Lambs         | 125             | 666.67     |
| Kids          | 874             | 3496.00    |
| Total         | 999             | 4162.67    |

Table 4-15. Wool production value.

| Item                       | Amount |
|----------------------------|--------|
| Number of sheared sheep    | 628    |
| Total wool production (kg) | 1256   |
| Total value (US\$)         | 669.87 |

#### Fixed Costs

To determine the fixed costs, all the expenses which can't be assigned to particular items were considered. This includes land taxes, horse and mule maintenance and fence maintenance.

The comuneros pay a total of US\$25.69 every three months which corresponds to US\$102.77 per year. This amount is divided into equal parts among all the comuneros. They also have to pay a certain amount in proportion to the "lluvia" area and the number of animals, as well as the equivalent of one firewood unit per family. Each family pays in total between US\$.26 and US\$1.33 per quarter. In this study only the land taxes were considered.

For feeding horses and mules, rangeland forage, wheat straw, grain and barley straw and grain which is cultivated for that purpose and, occasionally, alfalfa hay is used. Of all these items, only two have a monetary expense and these are alfalfa at US\$2.67 per bale and barley, at US\$0.53/kg. Wheat and barley straw are by-products and have no commercial value. Five percent of the diet is alfalfa, 10% barley, and the remaining 85% are range grasses and straw. In feeding a horse, US\$0.39/day are spent and US\$0.28/day for a mule (Table 4-16). Fence maintenance requires 5% of the capital invested (Table 4-17).

Table 4-16. Feeding expenses of working animals: horses, donkeys and mules.

| King of animal    | Number | Annual expenses | Total    |
|-------------------|--------|-----------------|----------|
|                   |        | per head        | expenses |
|                   |        | US\$            | US\$     |
| Horses            | 39     |                 | 5542.16  |
| Donkeys and mules | 88     |                 | 9807.31  |
| Total             | 127    |                 | 15349.47 |

Table 4-17. Total cost.

| Item              | Amount         |
|-------------------|----------------|
|                   | US\$           |
| Land taxes        | 102.77         |
| Animal feeding    | 15319.48       |
| Fence maintenance | <u>4437.12</u> |
| Total             | 19889.36       |

#### Net Income

Net income was calculated discounting the fixed costs from the gross margin. The crop contribution to the total net income is larger than the one originated from livestock (Table 4-18). This difference is larger in Carquindaño than in Yerba Loca since it has a larger cropping area and yields.

Table 4-18. Net income.

| Item         | Amount          |
|--------------|-----------------|
|              | US\$            |
| Gross margin |                 |
| Crops        | 10700.95        |
| Livestock    | <u>23906.67</u> |
| Total        | 34607.62        |
| Fixed cost   | 19889.36        |
| Net income   | <u>14718.26</u> |

#### Family Income

In these communities there are several types of activities which generate different amounts of income (Table 4-19). The smallest income are those of small farming-ranching operations which only receive an annual family rent of US\$420.60 which corresponds to US\$52.57/person/year, while the retired people receive US\$576.00/family which is equivalent to US\$288.00/person.

Table 4-19. Family income according to activity-type.

| Activity-type                                   | Family income | Income/person |
|---|---------------|---------------|
|   | US\$          | US\$          |
| Big operation livestock-cropping                | 2569.92       | 285.55        |
| Small operation livestock-cropping              | 420.61        | 52.58         |
| Livestock operation                             | 794.18        | 397.09        |
| Large crop operation                            | 2574.53       | 643.63        |
| Medium-sized crop operation                     | 1690.67       | 281.78        |
| Retired   | 576.00        | 288.00        |
| Average income in study area generated in ranch | 577.83        | 177.88        |
| External support                                | <u>531.41</u> | <u>108.42</u> |
| Total   | 1109.24       | 266.30        |

#### Total Income

The total community income could be divided into two main groups: income generated internally in the ranch and income generated outside the ranch (Table 4-20). 52.09% is internal income while 47.91% is external, mainly through government help of subsidized employment, public employee salaries in the area of education and forestry and through retirement funds. From this information it is clear that the ranches are directly supported by the state with approximately half of their income. If the indirect sources of government support are considered, the internally generated income percentage would be very small.

Table 4-20. Total income generated in the ranch and from external sources.

| Item             | Amount          | %            |
|------------------|-----------------|--------------|
| Internal income  |                 |              |
| Dryland crops    | 10700.95        | 15.81        |
| Livestock        | 23906.67        | 35.33        |
| Forestry         | <u>640.00</u>   | <u>0.01</u>  |
| Total            | 35247.62        | 52.09        |
| External income  |                 |              |
| Education        | 1920.00         | 2.84         |
| Forestry         | 1536.00         | 2.27         |
| Subsidized labor | 16960.00        | 25.07        |
| Retirement funds | <u>12000.00</u> | <u>17.73</u> |
| Total            | 32416.00        | 47.91        |
| Total ranch      | 67663.62        | 100.00       |

### Commercial value of property

It is difficult to determine with precision what the commercial value of the property is since it constantly changes according to the condition of the property market. A mechanism for calculating could be the Internal Revenue Service evaluation. If this is the case, the value of the land would be US\$21936.63. Since the official evaluation is usually less than the commercial value, it could be considered that the property value would be at least that amount. Possibly, it could be twice or thrice that value. In the latter case, the commercial value would be US\$65809.88.

Another way to calculate the commercial value of the land in livestock ranches, is to determine the carrying capacity in animal units and to assign a value to each animal unit. The stocking rate at the moment of the study was 732 animal units/year of which 73.79% were goats, and 0.03, cattle. Estimations made by specialists indicate, that considering the range conditions and the degree of desertification of this ecosystem, the real carrying capacity is no more than half of the present one, that is, only 366 animal units/year. Due to the kind of range and the degree of deterioration, as well as the seasonal growth and the annual variation in precipitation and range growth, the ranch would be only adequate for small ruminants, or for seasonal cattle grazing, all of which reduces the commercial value of the animal unit.

The commercial value of the animal unit/year usually fluctuates between US\$1000/animal unit in fields adequate for fattening cattle and US\$250/animal unit in fields for raising cattle, but can also be above or below these values. Since these ranches are deteriorated and in conditions for carrying mostly goats, the commercial value would be close to the lower limit or possibly much less than that. In this case the commercial value of the ranches would be not larger than US\$91,500. Commercial transactions of land of this quality show that the values are much smaller than the two estimates indicated previously.

It is possible to calculate the commercial value of the ranches in other ways which aren't indicated in this study. It is interesting to compare

the US\$395,410.44, the amount determined from the calculations of the ranch capital made previously, considering the land value plus construction and fences. This indicates a great difference between the commercial land value and the investments made, especially those referring to the excessive surface with constructions in relation to a modern ranch operation. At the same time fences are poorly designed and due to the materials used in their construction, such as stones, adobe and branches, they cannot, in general, be moved to other places without losing a great deal of their value.

From an economic point of view it is not convenient to forget these amounts related with property values, in order to be able to establish comparison parameters to show the magnitude of the problem.

### Job opportunities

The amount of work generated by the community under the present conditions, based on the supposition that the total income received by the community permits employment and generates living conditions for all the population is 52.09%, since of the present employment, the remaining comes from government aid. In this way, the ranch could maintain 32 families from a total of 61 that live at present on the ranch, and 156 persons of the total of 299. The average population income is US\$233.45/year but from that amount only US\$125.03 comes from internal ranch income and the rest, from government aid.

Under present conditions, if US\$500/person would be acceptable as income produced within the community, the total population should be reduced to 70 persons instead of the 299 which presently reside there.

It is possible to calculate the population carrying capacity and the amount of jobs that the ranch could produce, starting from several suppositions and mechanisms. Under any circumstances in relation to the general ecological conditions in this region and the standard of living of the population of the country, it could be considered that there are excessive population and employment needs in relation to the ranch possibilities. Under any circumstances, the need to move part of the population to other areas in order to reduce the population density should be considered.

## V. POLICIES, PLANS AND ALTERNATIVE STRATEGIES

### Possible solutions

There are four main groups of solutions.

- a) Decolonization. The meaning and effects of decolonization of the area and its subsequent natural ecosystemic transformation is analyzed as a possible way to restore the ecosystem and to rehabilitate after desertification.
- b) Maintenance of the goat-dryfarming system. The effect of maintaining the present state of the ranch without applying further solutions is compared with other options.
- c) Increasing input to the goat-dryfarming system. It consists in the input increases through monetary subsidization from external sources in order to improve the present state of the community, and
- d) Community ranching operations. This option analyzes the possibility of solving the community problem through the development of a well-structured and modern ranching operation administered by the comuneros.

The objective of this study obviously is not to solve the problems of this community but to provide information, analyze and discuss several possible solutions. The chosen solutions and the way to be applied is a problem of the comuneros and it depends on their culture, organizative capacity, community spirit, savings, willingness to sacrifice, future perspective, economic possibilities, perseverance and others not considered in this work.

It is also a political problem related with the local, regional and national authorities upon which the authors do not pronounce judgement. In relation to these problems, education, culture, government aid, job options, economic and financial aid, agricultural extension, technological structure and many others should be considered.

Under any circumstances, it is necessary to make decisions, even when the decision could be to continue as it is. The problem is difficult and basic. It is even possible that it could not have an ideal solution. Thus,

it is required to select a solution-type and gradually impliment the action for eventual solving of the problem, which may happen over a long period, of several decades (Table 5-1).

### Decolonization

Because of the high degree of desertification it is often thought that a possible solution would be to decolonize the whole area. It is supposed that this option would trigger a ecological secondary succession which would eventually regenerate the original vegetation and fauna.

To decolonize the area would have the advantage of rehabilitating the ranches without direct expenses. The lack of human action through crops, livestock and social activities would allow a rapid recovery of the ecosystem. The lack of human control and ecosystem management would eventually reach a stage different from the optimum for humans characterized mainly by a dense shrubby cover characterized by low antropic value.

The larger cost would be of social nature since it would force establishment of the population in another area. This option is not very convenient since, besides not producing direct benefit, it implies a high cost which affects 299 persons and 61 families.

Under the present economic situation, the money needed to create a new job, as well as the economic cost to establish a family in a new area, indicate that the possibility of applying this solution is insignificant and could be considered as utopic.

### Maintenance of the goat-dryfarming system

This option from a point of view of investment and risk is the most comforable and convenient. It would not create new expenses or investments. The present community system doesn't create problems or tensions that cause trouble among people or activities. The communities could continue operating in the future as in the present. This is the option applied by all the governments in the country during the last 50 years whatever their political leanings. There are, however, cronical degradation problems related with range overgrazing, plowing of non-plowable soils and indiscriminate harvesting of firewood which causes increased deterioration of the ranches. Primary and secondary ecosystem productivity is constantly being reduced. As a consequence

Table 5-1. Ranch organization options and gross income estimations for the options.

| Item                | Decolonization option | Present system options |                       | Adicional external funds option |                       | Modern Ranch operation option |
|---------------------|-----------------------|------------------------|-----------------------|---------------------------------|-----------------------|-------------------------------|
|                     |                       | Present                | Eventual Agri deserti | Present                         | Eventual Agri deserti |                               |
| Crops               |                       |                        |                       |                                 |                       |                               |
| Dryland             | 0                     | 10700.95               | 0                     | 10700.95                        | 0                     | 0.00                          |
| Semi-irrigation     | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 0.00                          |
| Fruit trees         | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 26666.67                      |
| Annuals             | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 13200.00                      |
| Livestock           | 0                     | 23906.67               | 0                     | 23906.67                        | 0                     | 80000.00                      |
| Agro-industry       | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 240000.00                     |
| Forestry            | 0                     | 640.00                 | 0                     | 640.00                          | 0                     | 0.00                          |
| Mining              | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 0.00                          |
| Services            | 0                     | 0.00                   | 0                     | 0.00                            | 0                     | 66666.67                      |
| External income     |                       |                        |                       |                                 |                       |                               |
| Education           | 0                     | 1920.00                | 0                     | 1920.00                         | 0                     | 6666.67                       |
| Forestry            | 0                     | 1536.00                | 0                     | 1536.00                         | 0                     | 0.00                          |
| Subsidized salaries | 0                     | 16960.00               | 0                     | 16960.00                        | 0                     | 0.00                          |
| Retirement funds    | 0                     | 12000.00               | 0                     | 12000.00                        | 0                     | 12000.00                      |
| Donations           | 0                     | 0.00                   | 0                     | High(?)                         | 0                     | 0.00                          |
| Total               | 0                     | 67663.62               | 0                     | High(?)                         | 0                     | 445200.00                     |

of the degradation process and the lowering of productivity, the human carrying capacity is reduced, which is shown in the low gross income and in the capacity to generate productive jobs. This triggers a migratory process toward other centers, remaining mainly older people and children. This fact can be demonstrated through the abundance of abandoned housing and private estates.

The persistence of this process will eventually lead to a stage of agri deserti which would also mean the decolonization of the area. It is only a problem of time. The main difference is that, with this solution, the final stage is agri deserti instead of climax and that the process is endogenous and gradual instead of exogeneous and abrupt.

Since the gross product of the community is less than the expenses, it requires some external inputs such as employment support, retirement funds, money originated from mining and external support from relatives who live in urban and mining centers. The annual cost of this solution is US\$32,416 coming from external support, being equivalent to 47.91% of the total income.

#### Increasing input to the goat-dryfarming system

This option is based on the increase of external inputs to the system through government sources in order to improve the standard of living of the population but without changing the internal structure of the ranch and the social and technological activities. Among the main actions to be applied to increase the employment support are loans and aid for dryland crops, subsidized buying power for goat cheese and any other action to increase the income.

This kind of action would improve the activities of the community and generate a passing goodwill which would remain as much as the external inputs remain. Since the ranching operation is based on overuse and degradation of the natural resources, such an increase of inputs would accelerate the process.

The cost of this solution would depend on the amount of inputs and the benefit would only be social. There are few possibilities of improving community structure which could lead to a permanent development.

### Community ranching operations

From an agricultural point of view it is the best solution since it optimizes soil conservation and the use of the natural resources according to their capacity. The technology to be implemented on the ranch would be according to the productive process requirements. Monetary investments should be directed toward those activities of high rentability.

The first stage should be to generate a livestock organization on the ranch as well as for the complimentary crops and firewood production. It is also required the development of a centralized organization to coordinate activities and efforts according to the community objectives.

The population should be laborally, socially and culturally organized in order to adjust to the requirements of the ranching operations with the improvement of the standard of living of the comuneros. To improve the standard of living and incorporate services such as drinking water, electricity, sewage and others, an urban organization should be organized according to the population needs, economic possibilities, ranch resources and the requirements of a modern village.

To increase employment it is necessary to develop agro-industrial technology and transform production into goods with larger values.

The possible solutions are many and should be applied after the main decisions are taken. The following stages should be considered:

- a) To develop a centralized organization, to improve as time goes on and according to ranching operation requirements,
- b) To organize laborally, socially and culturally,
- c) To generate crop, forestry and animal organization, compatible with the restrictions of the natural resources,
- d) To implement an urban organization compatible with the operation and the resources, and
- e) To develop an agro-industrial structure.

The timing to complete this development could be instantaneous in a period of one to three years to long range of 30-70 years. It is possible that it could eventually be solved in not less than this period.

## VI. POLICY IMPLICATIONS

Preparatory activities for development

Since this is a complex and difficult problem it is not possible to pretend to solve it by applying actions on a whim, nor in an incompatible sequence not according to reality. Probabilities are high for failure thus careful planning of activities is needed to solve the whole problem, and this should include the final stages of the ranch as well as the steps and circumstances to apply this plan. Preparatory activities and the steps should be as follows:

- 1) To decide among the possible solutions, the most convenient according to the interest and possibilities of the comuneros and that of the regional community that should cooperate in the global solution of this problem,
- 2) To specify in detail and precision each one of the elements of the solution in order to plan the actions,
- 3) Plan the sequence and circumstances of the actions to carry out the solution,
- 4) Train the comuneros or their groups in those activities required to optimize the chosen solution among which should be emphasized:
  - Education and training of the comunero in activities such as herding, crops, shrub management for firewood production, topography, natural resource conservation practice, soil movement, management and administration of water reserves, as well as other activities to improve the ranch,
  - To prepare the comuneros in those activities of administration, accounting, ranch organization and work organization required to be successful,
  - Education in commercial activities, especially in those aspects related to buying and selling products and cooperative organization,
  - Training of people in technological activities according to the degree of ranch development, especially in relation to milk,

cheese and meat technology as well as agro-industrial and small industries according to the requirements of the chosen options,  
- To prepare some of the comuneros in activities related with the organization of information systems and ranch control.

- 5) To develop regional and local centers of information of easy access for the comuneros where it would be possible to find specific information required to carry out the solution, which should include local libraries and documentation centers, developed at the county level or county districts, local teams of honorable advisors, highly qualified and trained to cooperate with the comuneros in the selection and application of the plan and publish extension bulletins, related with the specific ranch problems of the area,
- 6) To establish the techno-structure in each county or county-district, to compliment the ranch solution in a more global dimension. As an example, the following could be mentioned: milk and cheese industry on a larger scale which could integrate the production of several ranches in the area, meat industry to make a better use of animal products, watershed management of surface and subterranean water over an area that includes several ranches through the building of a network of channels and dams, efficient organization of banking and financial activities to optimize local money administration and incorporate the ranch into a efficient monetary system,
- 7) Since this is a complex problem, it is required an analogous model to allow the comuneros from the same natural region to observe and to be trained in the kinds of solutions to be applied in their own community; it is necessary then to establish a first stage in the development plan, a demonstrative ranch in each eco-region. In this way, the population can observe and repeat what they have observed and then apply the solution from the demonstrative ranch toward their own, according to their own interests, abilities, idiosyncrasies and creativity.

- 8) To carry on ad hoc research and experimentation programs in subjects related with the real problems of the community and not in subjects related with the researchers' whims carried on out of place or utopic experiments. Among the required studies, it should be mentioned ecological successions, utilization of rain-water runoff, range condition, range carrying capacity, fencing, and rangeland organization, soil management, styles of agriculture, silvo-pastoral system, agro-pastoral system and others, and
- 9) The success of the solution is due mainly to the capacity to select the right alternatives and to carry out the solution. Since this is not an intellectual or university subject, it should be carried out in conjunction by the comuneros and the regional and municipal authorities. It should be carefully applied since there is a high probability for failure. During the recent years, as well as during the last decades, there hasn't been the remotest possibility of reaching an optimum solution. All the governments, of all tendencies, have failed in giving a solution to this problem. This is not a political problem. It is possible that if things are well done and all the necessary activities are completed, it would be possible, in a long term, to solve this problem. It is a difficult task but not impossible.

#### Comparison of the many options

Traditionally the most convenient option has been to let the problem solve itself. Authorities have not directly participated in the community operations with the exception of a gradual increase in the aid through employment, health care and education, electricity and public road work. No punitive action has been taken in order to improve the sanitary conditions of the cheese making or to improve soil conservation. This solution is the cheapest one in capital investment and population tranquility but it is the most expensive in operation costs through government aid, which gradually will have to be increased. Emigration to other regions will also continue.

The indiscriminate increase in government monetary aid would not solve the problem ever but would create a temporary well-being. It would accelerate the desertification process and as in the previous case, would eventually lead to a agri deserti with the difference of a shorter time period. Public expenses could be large.

Decolonizing the area would represent a low ranch investment but high external costs through furnishing employment and living conditions in other areas. It would also mean resource wasting since the area presently occupied by the community if properly managed could be productive and produce jobs and goods for many people. Obviously it is not the ideal solution.

The solution given to this problem should be considered as one of the primary and essential activities to revert the desertification process and thus improve the natural resource conditions, especially range conditions. Any chosen option should include ranch improvement and its transformation into an operation that, besides resource conservation, would allow maintenance of high production levels. For that, it is necessary to organize all the scattered herds into only one, well-structured and efficient. It is also necessary to organize the space in paddocks to manage and utilize properly the range to increase productivity through range condition improvement. This would allow increasing milk production by approximately seven times to 244 liters/ha, which has been considered as possible by specialists.

The material costs to carry out this transformation is mainly moving fences and building some new ones according to the plan in the original study. In this transformation the main cost is time since range condition improvement through good utilization and management has been estimated between 5-20 years according to the degradation degree. It is not possible to think in artificial reseeding because of the low precipitation and the experimental results in this area. The required investment to solve these problems is not high money-wise, but it is in time, organization and administrative capacities to carry it out.

Another dimension of this option is social and this is very complicated. To organize the group in this community to successfully carry out a modern and efficient ranch operation is difficult and possibly surpasses the human group capacity who presently form the community. In this respect the

cooperation of sociologists and anthropologists are necessary to organize the population into a group to be successful and carry out his ranch operation.

Since population density outnumbered the carrying capacity of the ranch, simultaneously with a good organization of work and income per person, it is necessary to reduce the ranch population. This has a high cost and should be calculated as an external cost to the ranch. It hasn't been possible to calculate in money the magnitude of the social costs but possibly it outnumbered many times the agricultural costs to improve the ranch.

Whatever solution is taken, the preparatory costs to carry it out should come from regional or national sources. This cost could also be large.

## CONCLUDING REMARKS

The analysis of the many studies carried out for this project shows that this is a highly complex problem of great magnitude. It is difficult to find in the area of agricultural research and agriculture in general a more difficult problem than this. It shouldn't be surprising that in spite of this age-old problem, it hasn't been solved in the past.

This problem can't be solved in a casual way through the application of partial solutions to only some components of the ecosystem or to some of the sub-problems of the total. Also required is a high refinement and precision to be successful in this task. It also lacks part of the information necessary for a complete solution of this problem.

The socio-structural constraints implicitly given to the solution trigger larger technological and natural resource management complications which at the same time create economic complications of difficult solution. None of the specific problems analyzed in this study is difficult to solve, but the whole is very difficult. The agricultural problem could be easily solved, even when it requires some time, but the interaction with the social aspects and the way that both interact and conflict, make this global problem extremely complicated. Even when the solution is difficult, it should be considered as possible. The basic problem is to determine what price must be paid, if there is the willingness to pay to solve this problem and who pays it, and simultaneously to determine the rewards and who shall reap those rewards.

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