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GRAZING ECOSYSTEM AND THEIR SOCIAL-ANTHROPOLOGICAL ORGANIZATION IN CHILE

BY

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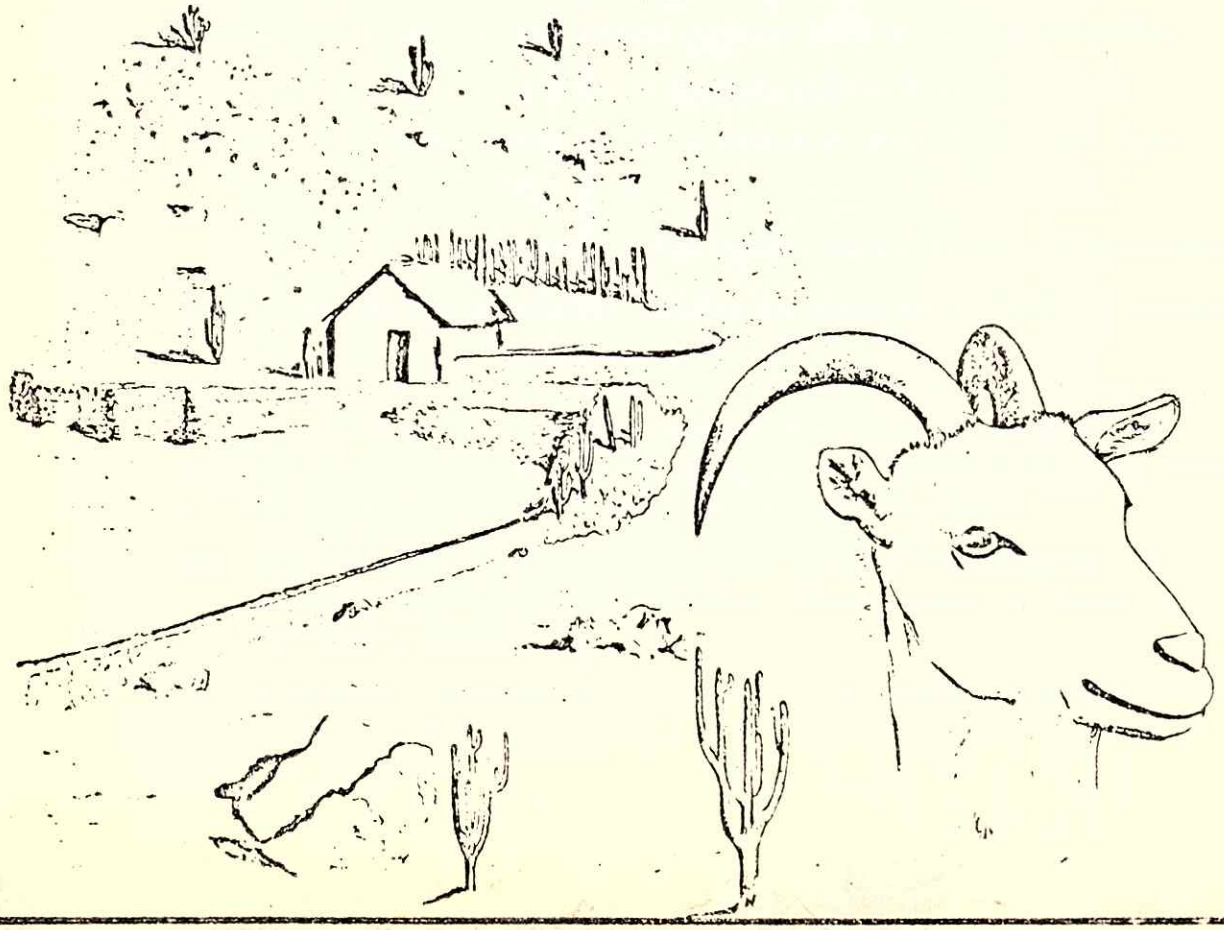

Grazing Ecosystems and Socio-Anthropological Organization in Chile -Incorporating a Number of Interdisciplinary Studies on Pastoral Ecosystem of Chile's Arid Lands. (1)

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Arid Zones of Chile

The national continental territory has an area of 75,662.634 ha, from which the 51% correspond to desert zone, 31.8%; arid zone, 9.6% and semi-arid zone, 9.7%. The arid zone is administratively included in the IVth Region, Coquimbo, and geographically in the sector usually known as Norte Chico that is located between 29° SL and 32° SL. It is a natural region involving ecological entities with very peculiar abiotic and biotic characteristics. The arid zone is located in the region of transversal valleys distinguished by the presence of a series of hill, ranges with relative height which born in the Andes Range and extend to the coast, interrupted by the intermediate central depression, developing exorreical basins and valleys where agriculture under irrigation conditions is performed (Rodríguez, M. 1959-1960).

The climate having a mediterranean arid tendency and dominated by the Southeast Pacific anticyclone as well as evidently

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influenced by the Humboldt cold stream, is characterized by the presence of winter-type precipitations concentrated in a short period -June, August- with a dry period that can oscilate between nine and eleven months.

Average precipitation is 200 mm and it reaches higher values in the southern limit with 260 mm and in height sectors. This parameter is important and is characterized by the great variability and spatial distribution. Although in the last decades it has been observed a decrease of precipitations and a displacement in its seasonal distribution, it is not effective that is a tendency to a greater aridity, since it implies to disregard the cyclical character of precipitations and the amplitude of the wave projected in the time (Hayek, 1977).

Average annual values reached by rains in northern and southern limits are 100 mm and 260 mm respectively, even though the coast is characterized by presenting dense fogs during a great part of the year which means a considerable decrease of the hydrical shortage; this is reflected through a greater covering of vegetation and the presence of more developed shrubs, including trees characteristical of semi-arid and sub-humid mediterranean climates.

The water problem in the arid zone is an offer and demand problem; the former very reduced, the latter very high, although it cannot be considered independently from other climatical parameters. The effects of long droughts have been drastic and with incidence in diverse aspects of the socio-economical development of human settlements located in the arid zone.

Soils are derivate from granitic materials, volcanic and sedimentary, medium to light textures being dominant, as well as compact, with small organic matter, and stone-shaped materials in a high proportion existing in its surface. In general, soils reflect the influence of medium and man through the impact produced by harvest of fire-wood, cultivations and overgrazing. According to Peralta (1977) they would correspond to the soils with a strong erosion, degradation of vegetation due to felling of trees, seeding, overgrazing and hardening in 434,000 ha approximately.

Regarding to the natural vegetation, arid zone is characterized by the presence of vast shruby formations with several dominant floristic species that characterize it. The following dominant vegetal formation can be distinguished: i) coastal shrubs with Happlopappus foliosus, Bahia ambrosoides, Baccharis concava, Adesmia arborea; ii) bushy land by Colliguaya odorifera, Flourensia thurifera, Proustia pungens; iii) Cactaceous formations with Trichocereus chilensis, T. coquimbensis associated with Bromeliaceous like Puya chilensis ; iv) Annual natural grassland, mainly composed by Erodium cicutarium, Erodium moschatum, Pectocaria dimorpha, Plantago tumida, Vulpia dertonensis and Medicago polimorpha; v)Post-cultivation bushy land composed by Haplopappus angustifolia, Haplopappus glutinosus, Gutierrezia resinosa and Cassia coquimbensis.

In ravine bottoms, protected basins and medium altitude slopes zones. Vestiges of exclerophile wood species, Lithraea caustica, Quillaja saponaria, Schinus mollis, appear in creek bottoms.

From the 2,000,000 ha that arid zone has, a little more than 900,000 constitute the "Comunidades Agrícolas", whose land tenancy system is unique in the country. This system was generated with the arrival of spaniard colonizers in the XVIth and XVIIth countries. It is a kind of typical communitary property that constitutes a social-anthropological-economical-ecological and juridical complex. It forms a social organization of little farmers-stockers, joined by cognation and friendship ties around a common property with undivided territorial extension and fundamentally in dry land condition; they are owners of little sectors in river banks, ravines and permanent watering-sities. They self-govern through a Junta de Comuneros with a President , Secretary and Treasurer; the Junta fits to the law for its operation and administration and decides trascendental subjects such as the utlization of lands for cultivation, advance of agricultural frontiers, number of animals and other competent subjects.

The number of agricultural communities in the arid zone is estimated in 162. They dispose of 7% of the cultivated area, 60% of permanent grasslands and 27% of soils clasified as without use. The population is estimated in 75,000 people equivalent to 55% of the rural population of the IVth Region. The family group is constituted by an average of 5.3 persons and the available figures indicate that 55% of comuneros is formed by adults being 56 or more years old; 0.6% by people under 25 years old and 44% by people between 15 and 26 years old (IREN-CORFO, 1977).

Global incomes of comuneros come from : 51.6% farm operation; 19% salary activities; 11.9% retirement salaries; 6.9% government social programs; 4.9% supports from no-resident relatives.

It is of interest to point out the fact that the comunero family group is closely tied to goat raising by participating in the inherent works and benefits. On this respect, in the arid zone there are 840.000 heads of goats. The racial composition is characterized and composed by 79% of spaniards naturalized race; 18% Anglo-Nubian; 1.5% Saanen and 1.2% Angora.

Agricultural Communities have 85% of goats in the arid zone, with open grazing management; that is, without vigilance, nor control of goat daily or seasonal itinerary. This species is the most adapted to the browsing and it uses efficiently this kind of vegetation. Goats are not responsible of retrogradation process but man, who induces to the overuse of resources through his decisions. Several studies -Gastó and Contreras (1977), Valdés, J. (1983)-, indicate that deterioration of renewable natural resources has been due to the action of man over the medium through:

i) indiscriminate and sustained felling of tree and shrubby vegetation to obtain fuel for mineral foundries, fire-wood for domestic use; ii) plowing of land for cultivation, mainly of cereals and aromatic species like anise, cumin and marjoram, in those sectors vulnerable to the erosion due to its structure, lack or organic matter, lack of protection and excesive slope and, iii) inadequate management of goats, specially in the adjustment of stocking rate free grazing without daily control and use of the resources during critical periods for vegetation, mainly the shrubby one and the prairie. The latter constitutes a source of sustenance for goats, specially for lactino does. In critical periods, lack of forage, shortage of drinking water and high temperatures, obligate to the comuneros to reduce the flocks or to move it to high-mountains ecosystems, where they remains between 4-5 months. Those comuneros having flocks of more than 50 heads move their goats to the Andes Range, running over 300 km as an

average, at a rate of 20 km per a day, trip that it takes about 15 to 20 days.

From a historical-anthropological point of view, two well differenced periods can be distinguished:
i) pre-spaniard, characterized by the presence of natural inhabitants correspondent to the "diaguitas" culture, who cultivated only the valleys under irrigation conditions. Their agricultural and live-stock activities were developed without major problems using natural resources. With the "Incas" arrival, new methods were introduced in the irrigation agriculture, cattle-raising and, specially, in mining that attracted attention by gold, cooper and silver. ii) spaniard, when the colonizer introduced new vegetal and animal species and new cultivation technics, specially the practice of dry-land agriculture. This caused an intensification in the use of natural resources, giving to the region economy a cattle-agricultural-mining orientation; connotation fat, cordwains and grease production increased rapidly at the beginning of XVIIth century with an appreciable exportation magnitude to Peru. In the second half of XVIIth century, economy turns to an agricultural-mining type, with livestock moving to poorer places causing practically the disappearance of cattle and began the importance of goats.

In 1720 the great boom of wheat exportation to Peru began to decrease; therefore mining production revitalized, growing the population in an accelerated way. To supply basic foods to this increasing population asking for major contributions, natural resources were more pressed, expanding agricultural frontiers to fragile and marginal areas. It is of interest to note that at the end of XVIIIth century, numerous mineral foundries utilizing thousands of tons of fire-wood to process then.

were established. It is calculated that a furnace used, per year, 6.300 tons of fire-wood coming from trees and shrubs that constituted the natural plant communities. It is of special relevance the fact that by the rights given to miners through Mining Ordinances, they could destroy and cut with no discrimination any kind of vegetation. Nothing was respected; from the valleys and the adjacent interflows, woodmen and coal-men kept on pressing heights, hills and, finally, the first range counterforts (Bahre, C., 1979). Along with this felling or cutting, many places were used to cultivate cereals increasing the discharge of the ecosystem in a drastic way. It is observed in Figure 1 that in the intesive grazing stage it is also produced the cutting or felling mainly of litre (Lithraea caustica), Quillay (Quillaja saponaria); quebracho, Cassia coquimbensis ; Cassia closiana; paihuen (Adesmia arborea); molle, (Shinus molle); huingan, (Schinus poligamus); hawthorn, (Acacia caven); boldo (Peumus boldus); carbonillo (Cordia decandra); crob-tree (Prosopis chilensis); chañar (Geoffroea decorticans). With this a thin, sulky heath was produced, having a low palatability and a low nutritive value, species as bailahuen (Haplopappus bailahuen); romerillo (Baccharis linearis); guaucho (Baccharis concava); cardon (Puya chilensis); chamicilla, (Bahia ambrosoides). Another way of degradation was the combined strategy of cultivation and grazing in any of the successive stages mentioned above.

The clearing is total along with soil cultivation (fallow) and cereal seeding for many years. The periodicity of cultivation in a same place about 10-12 years which, along with the lack of protection and low organic matter, produced the decapitation of the upper soil layer with the consequent reduction of yields, which induced to the abandonment of the sectors. These, land were incorporated as grazing lands for goats for periods not inferior than 30 years.

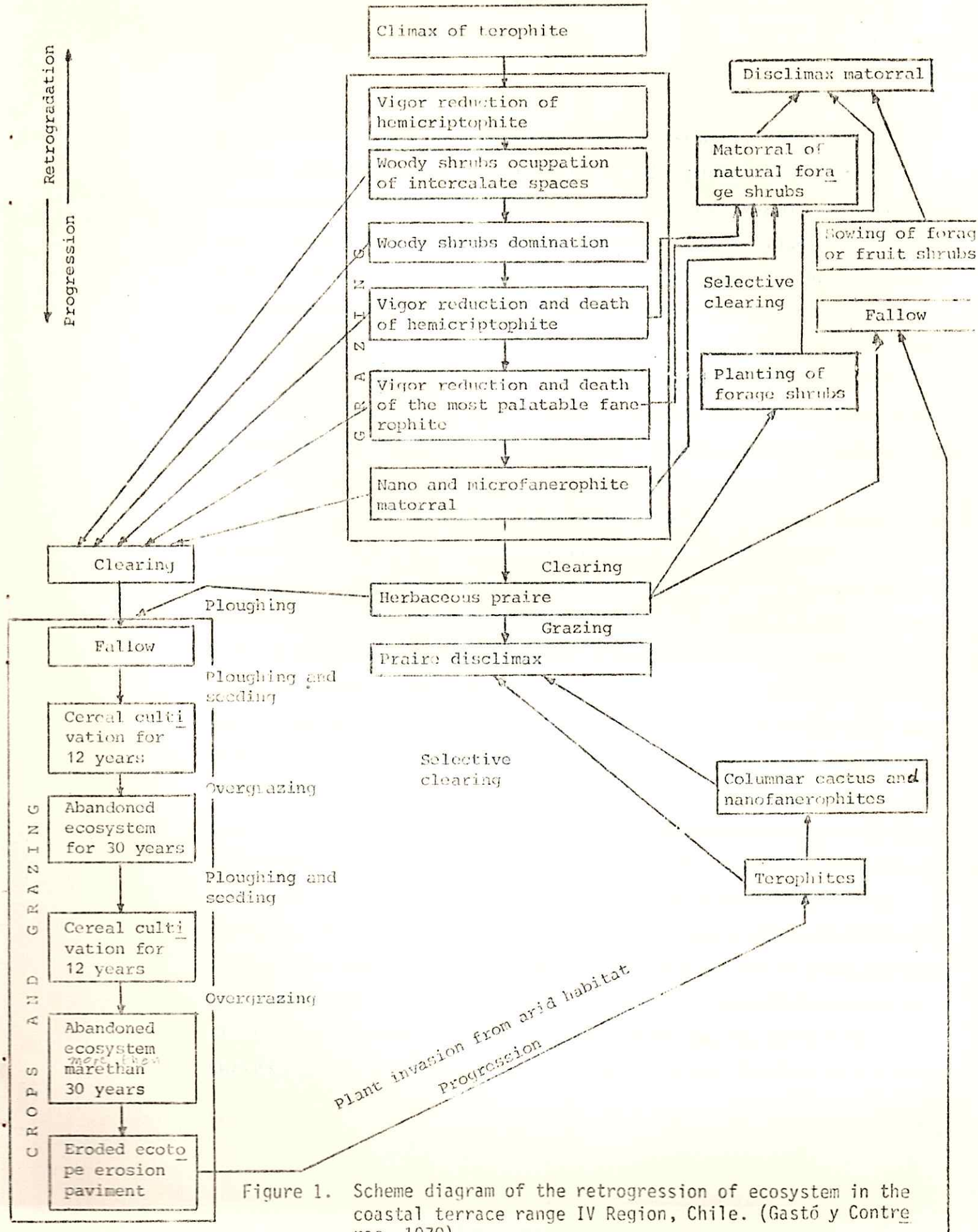

Figure 1. Scheme diagram of the retrogression of ecosystem in the coastal terrace range IV Region, Chile. (Gastó y Contreras, 1979).

Due to overgrazing and overstocking rate these ecosystems finish in an eroded ecotopo and in abandonment (Gastó and Contreras, 1979). The above described stage was the determinative one in the starting of desertification processes in the arid zone of Chile. Along with this fact, the climatic and cyclical changes, and severe and periodical drought contributed to the process acceleration.

Today, surviving conditions presented by the human settlements have caused an emigration to other attraction center such as the copper and nitrate enterprises of Antofagasta and Tarapaca.

In relation to studies and investigations carried out around the problem of desertification in the arid zone of Chile , it is of interest to note that, with occasion of the United Nations International Conference on Desertification effectuated in Nairobi, 1977, the Government of Chile had the responsability of presenting a case study. This study was carried out under the auspices and support of UNESCO-MAB that coordinated the activities with the collaboration of FAO, OMM and BID , within the Project PNUD-RLA/74/018.

The Instituto de Investigaciones Agropecuarias (INIA, 1977) performed as a connection and coordination agent at a national level. The selected place covered precisely an area of 160,000 ha occupied, in its great part, by Agriculture Communities. An information on the actual state of the ecosystems is presented, whose plant communities show diverse states of retrogradation with sequential schemes of process, vegetation and cultivation sensibility charts, attractivity to harvest biomass, sustainer capacity, condition and tendency of grasslands

of the studied sector. Aspects of human settlement that cover diverse subjects are analized, such as land tenency, situation of comuneros, social structure, health and social aspects during pre-spaniard, spaniard XIXth and XXth centuries periods, concluding that the actual state of renewal natural resources is reflected in the precarious socio-economical situation of population, emigration and low life standards.

With the support of UNESCO-MAB a work was made in order to put in action the Study of Case carried out in 1977 in the IVth Region, Coquimbo (Bonilla, S.; F. Squella et al, 1983). All the antecedents written after that date, are analized, carrying out a land recognition of selected place to verify possible changes in the involved systems. It is noted that in Chile, the Nairobi Conference helped to create conscience on prevention and fight against desertification and development of arid zones; thus, several institutions have joined efforts to generate technologies, to implement re-forestation programs for degraded areas, control of dunes (CONAF, 1984) and the creation of the Centro de Estudios Zonas Aridas by the Universidad de Chile in La Serena city. As a general summary above referred study indicates that, in spite of the efforts realized by government institutions in social, technical and economical support, the degradation process of natural resources is present and active, although sectorized, in the great part of the ecosystems described for the place studied in 1977. The effects are dramatic in those units offering a major attractivity for cultivation and cattle-raising in spite of the precarious state and low productivity of resources. It is emphasized that into the interior bushy land the man's intense and sustained pressure on the already degraded natural resources is shown in its most dramatic way.

The man of arid zone, main subject of the environment, lacks of an intellectual development; the population involved in forestry-agricultural-cattle activities survives with increasing difficulties at the same time it becomes more dependent of other income sources such as government social programs.

Another study, actually in developing, is the one related with UNESCO's Man and Biosphere Program (MAB) in grazing lands area (MAB-3) [1] entitled "Study of grazing ecosystems of the arid zone of Chile and its socio-anthropological organization". The interest zone comprises the arid zone inserted in the IVth Region, Coquimbo, with a diversity of situations and complexity of problems. Considering the territorial size and the detected ecological regions, three contrasted sites were chosen.

The location of sites was elected under a combination of ecological and socio-economical criteria. The first criterion allowed to obtain a representativity in all related to climate, vegetation, soil, geomorphology and general management of systems. The socio-economical criterion considered the distribution, size and representativity of human settlements. The situations considered were: i) coastal sector, with ocean influence located in smooth hills of the Coastal Range, with no water contribution from other river basins, with an average precipitation of 200 mm and a median of 185 mm, the use of the agro-grazing resource; corresponded to the location of Canela Baja, Comuna of Mincha, the election of Agricultural Communities, known as Carquindaño and Yerba Loca (31° 36'S and 71° 30'W); ii) pre-cordillera sector, corresponding

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1) Project financed by UNESCO-MAB ROSTLAC CONTRACT N° 48182

to a piedmont, with clear and dry height climate, with a relative humidity less than 50%, with an average annual precipitation of 261.9 mm and a median of 294.3 mm; use of the agricultural-mining resource, with a low incidence of goat raising it has an irrigated sector regulated by the function of the hydrographical basin of river Pama through the Valle Hermoso creek. The study corresponds to the Community of Alvarez de Valle Hermoso, Comuna of Combarbalá (31° 15'S; 71° W); and; iii) the third sector has not been studied yet.

The project centralizes its attention in man as a unit and in community as a set that supposes a complex of ethical, social and biological influences and interactions, where the former, associated to goats, constitutes the key. These shephered societies are responsible of the deterioration of renewable natural resources and, therefore, of the diverse desertification states presented by ecosystems involved in this study. In grazing ecosystems, man must be considered as the dominant biotic element, given the projection of impact exerted through domestic stock and harvest of diverse ecosystem components. This focusing tends, necessarily, as a main objective, to improve life quality, to procure welfare and to promote the conservation and adequate management of renewable natural resources in fragile media, such arid zones. In these media, pastoral population, when expanding, occupies vulnerable and fragile sites in which productive potential is progresively reduced by over-use.

The project objectives are : i) to carry-out a socio-economical diagnostic in order to know life level and problems generated by using natural resources in three sites of the arid zone of Chile and ii)

to deliver natural resources management alternatives to benefit of man, as well as to stop and revert desertification process.

Twenty teacher-investigators pertaining to four Universities and two government research and development institutions participated in the work through nine sub-projects. Methodological aspects and work plans on site were discussed in general technical meetings, and in affined groups when the subject was more specific and interrelated. The coordination kept informed about activities, supporting actions leading to promote the project's normal and integrated development.

Achievements . The more important aspects of the studies realized in the first site, located in coastal and pre-range sectors are summarized.

Coastal Sector . Carquindaño and Yerba Loca Agriculture Communities

1. Social anthropology. In an area of 6,500 ha live 64 families, whose housings are located in a dispersed way along ravines and close to hydrical resources.

Total number of inhabitants in both Communities reachers up to 299 persons. Table 1.

Table 1. Total number of inhabitants differenced by sex in Communities of Carquindaño and Yerba Loca, October 1982.

Community	Men	Women	Total
Carquindaño	81	78	159
Yerba Loca	76	64	140
TOTAL	157	142	299

Marriages within the Community are performed, inevitably, between persons having some relationship grade. It is important to notice that the phenomenon of woman migration to urban centers has influenced in sex equilibrium. Thus, it is observed that man tends to look for his couple out of the Community or remains single, specially in the Community of Yerba Loca. The major quantity of people in both Communities is between 30-39 years old. From population distribution it is observed that birth-rate has decreased and that there exists female emigration, since more women than men are born. However, between 10 and 19 years old it begin to increase men by woman rate. Illetiracy is present in indivuals preferably over forty years old. The organization of the Community is represented by a Directory formed by seven comuneros generally having more solvency and economical resources. Comuneros maintain solidary relations, but they also show individualism when it treats of increasing capital in lands and animals. Communitary organizations tends to maintain the equilibrium of population by turning out those elements with no rights according to the Law which gave its organization. Subsistence economy implies to maximize available resources, both for self-consumption and for interchange (Castro, M. 1983).

Structure and dinamics of housing. The housing is the expression of a level of perception of medium by the comunero. Its forms reflect the quotidian and the familiar, accentuating the residence function. Its external and internal spaces are simple since they respond to basic needs. Houses are located near the hydrical resource an oriented by wind factor. There exist 92 habitations, from which only 5 are of sporadic use, with a total of 6,361 m^2, resulting an average of 89.19 m^2

per habitation and of 18.47 m^2 per inhabitant. The average of persons per family is 4.96 inhabitants and 4.82 inhabitants for the Communities of Carquindaño and Yerba Loca, respectively. Population density reaches to 5.65 and 3.73 inhabitants per km^2, respectively. The surface occupied by habitations, in the two Communities, reaches to 0.007% of the total surface.

Vegetation

By means of studies of vegetation, it is possible to deduce various factors of the environment; plants are one of the ecosystem components that better intergrate abiotic and biotic factors. Through the cartography of land occupation (vegetal formation, dominant species and artificilization grade), the sector was characterized by a map 1:10,000 scale; also, a sub-structure map was prepared and herbs production was evaluated. From the global analysis of the cartographed sector, it is deduced that 46% of the surface is occupied by herbal communities; shrub land occupies 40% of the area, divided into low-shrub woody formations of 31%;low woody formations of 8%. Less important, though not negligible, are areas of scare vegetation representing 14.1% of the surface; degraded and cultivated areas reach 13.3% and they constitute the most characteristic types of space occupation.

In relation to coverage, 53% of the surface presents coverage of less than 25%. With regard to the types of coverage observed in both communities, it can be noted that Yerba Loca presents 57% of the coverage, whilst Carquindaño presents 43%. (Table 2)

Table 2 Importance of main vegetal formations expressed in percentage of total surface of the Communities of Carquidaño and Yerba Loca

Vegetal Formation	Community		
	Carquindaño	Yerba Loca	Total
	..... %		
Herbs	17.3	28.9	46.2
Low-woody	3.4	4.6	8.0
Low-woody-herbs	12.8	18.7	31.5
High-woody-low-woody herbs	----	0.2	0.2
High woody	0.01	----	0.01
Succulent	0.25	0.45	0.70
Plowed sector	1.3	1.2	2.5
Sector with no vegetal coverage	7.8	3.0	10.8
Urbanized sector	-----	0.1	0.1
%	43.0	57.0	
Surface (ha)	2.823,0	3.742,0	6.565.0

In general, they correspond to grazing lands, the plant layer of which has been damaged by overgrazing and by indiscriminate and continous harvest of fire-wood for fuel. To a lesser degree there are coverages ranging between 25-50% of which 28.8 correspond to herbal formations (16.7%) and low woody-herbs (9.6%). Coverages over 50% occupy 19% of the area, corresponding to sectors of difficult access, influenced by clouds.

Prairies mainly characterize the peripherial sectors of human settlements and of easy access; these sectors are overgrazed and

degraded. In this respect, Carquindaño presents the major proportion of degraded sectors in relation to Yerba Loca, 7.8% and 3.0% respectively in determined values; in absolute values Carquindaño presents 18.1% of its surface with degraded areas and Yerba Loca only 5.2%. (Table 3)

Table 3 Percentage distribution of plant cover by type of coverage in the Communities of Carquindaño and Yerba Loca (Caviedes et al, 1983)

Community	Category of Coverage					Total
	0-10%	10-25%	25-50%	50-75%	75-100%	
	..... %					
Carquindaño	9.3	17.1	9.0	7.2	0.4	43
Yerba Loca	4.4	22.4	19.8	9.5	0.9	57
	13.7	39.5	28.8	16.7	1.3	100

Plowed or cultivated areas or sectors are almost equal in both Communities (Table 2)

In relation to dominant species, it can be noted that from a total of 92 dominant species found in the territory of both Communities, the most frecuent are :

Herbs : Koeleria phleoides, Vulpia dertonensia, Gamochaeta oligantha, Pectocarya dimorpha, Lastarriaea chilensis, Medicago polymorpha, Erodium cicutarium, Erodium moschatum y Lotus subpinnatus.

Low woody: Gutierrezia resinosa, Flourensia thurifera, Lepechinia salviae, Muehlenbeckia hastulata, Eupatorium salvia, Senecio bahioides. Adesmia microphylla and Bahia ambrosioides.

Considering that the herbal formations occupy almost 50% of the studied territory, in the same way the herbal species are the most widely distributed; amongst these, Koeleria phleoides and Vulpia dertonensis constitute the base of both the prairies and of the low woody herbal formations. When conditions of humidity become more favourable, these species are replaced by Erodium moschatum and Medicago polymorpha, especially in slopes facing south exposure; under these conditions they constitute pure herbal formations or associate with Senecio bahioides, Senecio benaventianus or Eupatorium salvia. In over-grazed conditions Gamochaeta oligantha, Lastariaea chilensis and Pectocarya dimorpha dominate.

With respect to low woody species, Gutierrezia resinosa and Muehlenbeckia hastulata are two species that, separately are characterized by being dominant in low woody herbal formations of post-cultivation of different ages, generally occupying flat lands or with low or medium slopes. The first one is chiefly in Carquindaño and grows on granitic soils, whilst M. hastulata dominates in Yerba Loca. Flourensia thurifera constitutes an important plant communities, typically in the sunniest position as in the case of North and North-East exposures. It also appears associated with Bahia ambrosioides; in both cases it constitutes formations which herbal strata has a low coverage. F. thurifera concentrates preferabily on high slopes and the summit of Guanaco hill. Bahia ambrosioides also grows in the middle and high sectors of the same hill, extending to the west to occupy the slopes of Pangue hill, especially in medium and low positions exposed to the west. In these conditions it associates with Fuchsia lycioides and Adesmia microphylla, especially in conditions of southern exposure.

Finally, it is important to note the presence of Puya chilensis in wide areas, preferably in lands having low to medium slopes.

Use of Land

In relation to the use of land in both Communities, grazing lands are of exceptional importance and represent 93.4% of the total studied area (Table 4). Most of them are in a bad condition, considering both the species that compose them and plant covering; there are only 102.8 ha of grazing land in a good condition, located chiefly in the Community of Yerba Loca.

Lands dedicated to dry-land cultivation reach a total of 410.6 ha., representing 6.2% of the whole of the area . Crops of major importance are wheat, barley, anise and cumin. These two last are generally sown in surfaces of less than 0.5 ha., the two crops being in most cases in the same small area, thus preventing the separation of both in individual cartographical units, in view of the scale used in this study. In general, a very large area is dedicated to dry-land cultivation in the Community of Carquindaño.

Crops under irrigated conditions hardly reach a total of 5.3 ha., being carried out in margins of ravines with temporary draining. Main crops in irrigated land are potatoes, beans and greens.

Under the classification of " Other uses" are included those sectors that surround houses, recreational areas and small areas with trees.

Table 4 Distribution of use of land in Communities of Carquindaño and Yerba Loca, September 1982 (Caviedes et al, 1983)

Use of Land	Community					
	Carquindaño		Yerba Loca		Total	
Dry-land cultivations	ha	%	ha	%	ha	%
Wheat	104,0	3,7	80,7	2,2	184,7	2,8
Barley	33,6	1,2	15,4	0,4	49,0	0,7
Anise	13,8	0,5	4,2	0,1	18,0	0,3
Cumin	-----	---	0,5	0,0	0,5	0,0
Anise-cumin	21,2	0,8	-----	---	21,2	0,3
Peas-Broad beans	4,7	0,2	-----	---	4,7	0,1
Potatoes	-----	---	1,1	0,0	1,1	0,0
Beans	-----	---	0,8	0,0	0,8	0,0
Ballica prairie	-----	---	0,9	0,0	0,9	0,0
Fallow	77,0	2,7	52,7	1,4	129,7	2,0
	254,3	9.0	156,3	4,2	410,6	6,2
Irrigation cultivations						
Vegetables	0,8	0,0	1,4	0,0	2,2	0,0
Natural Prairie	-----	---	1,4	0,0	1,4	0,0
Fallow	1,0	0,0	0,7	0,0	1,7	0,0
	1,8	0,0	3,5	0,0	5,3	0,0
Grazing lands						
Good condition	22,4	0,8	80,4	2,1	102,8	1,6
Fair condition	383,3	13,6	932,3	24,9	1.315,6	20.0
Bad condition	2.153,9	76,3	2.557,8	68,3	4.711,7	71,8
	2.559,6	90,7	3.570,5	95,3	6.130,1	93,4
Other uses	7,3	0,2	11,7	0,3	19,0	0,3
TOTAL	2.823,0	100,0	3.742,0	100,0	6.565,0	100,0

High Woody : Fuchsia lycioides

Succulent : Puya chilensis, Trichocereus chilensis

Site : The sites which compose the two Communities were recognized and described and a systemogenic hypothesis was stated for each one of them.

The site is defined as a unit that has homogeneous enronmental characteristics which give it a particular biotic potential. Those units can be repeated in a property, thus the concept of "site" allows the classification of the elements of landscape which are presented separately in a hieriarcical level higher than the present one.

The dynamics of vegetation have two main forces: ecological succesion and antrophic action. The succession always has a progressive trend to climax; the antrophic action may also have a trend inverse to the succession, constituting the retrogradation of the ecosystem. Retrogradation has, as a consequence, a separation from the state of ecosystem in relation to its climax. Retrogradation becomes a degradation of the resource only when the magnitude of retrogradation exceeds the limits of stability and resilience of the ecosystem.

It was determined that vegetation is in a degraded state and that its recovery is possible if ecological succesion is considered as an ecosystemic operator (Fleismann et al, 1983)

In the identification and description of sites the following variables were considered: Physiographical formation, physiographical situation, exposure, slope, geomorphological type, nature of generating material, superficial rockiness, superficial stoniness and microrelief. A profile of soil was described in each site, determining depth, stratification, colour, texture, structure, biological activity and pH.

In each site the vegetational states chiefly represented currently and the most relevant ones in respect to their successional position, were described. Each one of these states was characterized by determining plant coverage and botanical composition per biological type; in the herbareous strata the phytomass of total species was estimated; in the woody strata the number of units per plant species and their phytovolume per hectare was estimated.

The results obtained allow the establishment of 12 sites that occupy an approximate area of 6.565.3 ha (Table 5)

Table 5 Area expressed in hectare of twelve sites determined in the Communities of Carquindaño and Yerba Loca (Fleischmann et al, 1983)

Sites	Area in ha
Flatland of marine terraces	298.0
Slope of marine terrace with North exposure	310.7
Slope of marine terrace with South exposure	217.0
Highness of slope with North exposure	1.433.3
Highness of slope with South exposure	511.2
Low part of slope with rocky North exposure	373.2
Low part of slope with rocky,summit	158.7
Low part of slope with rocky South exposure	371.7
Middle slope (hillrocks)	2.803.0
Ravine bottom/Alluvial terrace/Piedmont	88.5
Total	6.565.3

For each one of these sites a systemogenic hypothesis is stated where ecological succession and antrophic action are considered. The main antrophic operations are plowing and fallowing in the case of agriculture, grazing; the residue of cattle exploitation and the clearing and harvesting of fire-wood to obtain fuel. The intensity of these actions determines the present state of resources. The main effects on the resource by anthropogenic over use can be grouped in: loss of vegetative elements in woody and herbal stratum; loss of physical structure of soil and its natural chemical fertility properties, low sustaining capacity of ranges resources and decrease of general productive capacity of the system. The slopes of a site of marine terrace with North exposure are presented as an illustrative example.

Slope of marine terrace with North exposure

In slopes of marine terraces with North exposure, the species that currently dominate in the most advanced vegetative states are the nanophanerophytes Heliotropium stenophyllum and Verbena sp with the succulent Trichocereus chilensis. These plant communities have been grazed for many years and it is not know if they were cleared and cultivated in the past.

The dominant vegetation of these advanced states is presented in alternate patches of two types: a clear heath of Heliotropium stenophyllum with sparse Trichocereus chilensis and a clear heath of Verbena sp. with sparse Trichocereus chilensis. In these sloping sectors a high population of multi-aged cactaceae develops and possibly the community goes in progression.

As secondary species of the heath there are camephytes of the genera Chuquiraga and Chorizanthe and the succulent Opuntia obata. There are also specimens of the succulent Puya chilensis present and the nanophanerophytes Cassia coquimbensis and Proustia cuneifolia, growing as species of third order.

In the herbal stratum the therophytes, such as Avena barbata, Vulpia dertonensis, Medicago hispida and Koeleria phleoides and the hemicriptophyte Cardionema ramosissima dominate. In micro-environment protected from grazing by thorny plants, there grow the hemicriptophytes Nasella chilensis and Nasella pubiflora, Melica sp., Dioscorea humifusa and the therophytes Trisetobromus hirtus, Avena barbata and Vulpia dertonensis, reaching a high degree of development.

In prairies subjected to a major grazing intensity the terophytes Koeleria phleoides, Gamochaeta oligantha, Plantago tumida, Plantago spidula, Adesmia tenella, Erodium cicutarium and the hemicriptophyte Cardionema ramosissima dominate. In sectors more overgrazed and with indexes of erosion Koeleria phleoides, Lastarriaea chilensis and Eringium coquimbanun grow.

When the vegetation of these slopes is cleared and later is left without plow the soil, being subjected to a certain grade of grazing, the colonization of Cassia coquimbensis behind the prairie of therophytes start. In more advanced stages of this sequence, in sectors rather inaccessible for livestock there develops a community dominated by Cassia coquimbensis in low woody stratum and as the hemicriptophyte Stipa plumosa in herbal stratum. Besides, the nanophanerophytes

Adesmia arborea and Proustia cuneifolia and the camephyte Chorizanthe sp. grow as subordinate.

In some sectors of slope the original vegetation has been felled for the installation of "rains" for crop purposes. Successive annual dry-land cultivation are carried out and then abandoned when soil has lost its natural fertility or presents a high degree of laminar and gully erosion and therefore is present with a high precentage of superficial stoniness.

When the practice of cultivation is abandoned, but these sectors are still excluded by a fence of Trichocereus therophytes of the genera Raphanus, Brassica, Rapistrum and other therophytes as Madia sativa and Helenium aromaticum already present increase. Also plants of Cassia coquimbensis and Muehlenbeckia hastulata are present.

In excluded post-cultivation sectors of three or more years old, a prairie dominated by the native therophyte Gamochaeta oligantha with isolated specimens of Nasella pubiflora dominates. In the shrubby stratus of nanophanerophytes, like Muehlenbeckia hastulata is a dominating coverage, Cassia coquimbensis grows subordinated but with a great number of small plant as invaders.

Arid environment with high indexes of erosion are colonized by Cassia coquimbensis, Opuntia obata and the herbs Homalocarpus dichotomus, Erodium cicutarium and Nasella pubiflora.

Slopes of terrace with Southern exposure

The plant community at present with great development in the succession is a dense or slightly dense heath dominated by nanophanerophytes Senecio cf. benaventianum and Eupatorium salvia . Also, growing isolated specimens of the microphanerophytes Lobelia salicifolia and Schinus latifolius, types of two to four meters high. In clear or slightly dense herbal stratum the naturalized mediterranean therophytes like Vulpia dertonensis , Avena barbata, Koeleria phleoides, Trisetobromus hirtus and Erodium moschatum dominate.

In the sectors of slopes with minor gradient and with less stony outcrops, original vegetation was cleared, fences were built and subsequently dry-land crops as Triticum aestivum, Cuminum cyminum, Hordeum vulgare, Lathyrus sativus and others were cultivated.

The area of cultivated soil are abondoned when fertility is lost. In the first stages of post-cultivation a community of cruciferae therophytes and then a prairie of naturalized and native therophytes and then a prairie of naturalized and native terophytes develop. After three or more years of post-cultivation without grazing, a prairie of therophytes with plants of Atriplex repanda (of about 40 cm height appears,) an abundant sprouting of the camephyte Atriplex semibaccata.

With continous grazing in cleared slopes and apparently post-cultivated, progress is made towards a livestock disclimax represented by the prairie with dominance of naturalized terophytes and isolated specimens or in small groups of Schinus latifolius. These species behave as invaders when they eliminate the residues of woody

vegetation and reach the size of a tree of 3 to 6 m. height. Other micro-phanerophyte that grows in this successional stage is Maitenus boaria , although it occupies more frequently the low part of the slope, alluvial terraces and upper edge of ravine bottoms.

The present range condition is variable and it depends mainly on the soil fertility level at which soil has remained after the abandonment of the practice of cultivations, evolution post-cultivation plant community and the range management practice used.

When the prairie is overgrazed the importance of hemi-criptophytes with low nutritive value increases, such as Dichondra repens and Cardionema ramosissima and at the same time the nanophanerophyte Cestrum parqui invades.

Livestock Production

It is of interest for the the study to consider in detail the animal factor due to the incidence it has in the function of the system itself and the effects on the global development of both communities. Goats and sheep are important factors due to the fact that they constitute the main source of sustenance of 52% of the natural population in arid zones and contribute 42% of the value of the agricultural-livestock production.

Animal population reaches 732.88 AU for both Communities. A detail of animal composition per species can be observed in Table 6.

Table 6 Animal population in AU and composition per species in the Agricultural Communities of Carquindaño and Yerba Loca, during October 1983 (Cossio et al, 1983)

Livestock	Commnunity		Total
	Carquindaño	Yerba Loca	
	..... AU.....		
Goats	313.50	227.01	540.83
Ovine	83 51	21.84	105.35
Equine	24.00	15.00	39.00
Donkey	17.00	14.00	31.00
Mule	10.00	3.00	13.00
Bovine	2.00	-----	2.00
Porcine	0.80	1.20	2.00
T O T A L	450.83	282.05	732.88

In both Communities most of the livestock mass is formed by goats, which represent 69.6% and 79.9% for Carquindaño and Yerba Loca, respectively. In relation to the stratification of population on the basis of number of goats that each family has, it is observed that 43.8% do not have goats; the most frequent herds are those ranging between 51-100 heads with 82.1% representing 24 families (Table 7)

In relation to sheep, 34 families do not exploit this species in both Communities; Carquindaño has a major precentage (18.5%) than Yerba Loca (7.7%); the most frequent herds range between 1-25 sheep representing 15 families. Transport and work animals (horses, asses, mules) represent 11.3% in both Communities. This signifies a

Table 7 Stratification of population based on number of goats of each family in the Communities of Carquindaño and Yerba Loca (Alvarez and Valdés, 1983)

Number of goats	Carquindaño		Yerba Loca		Total	
	Families	%	Families	%	Families	%
0	9	30.0	4	13.8	13	43.8
1 - 50	7	23.3	3	10.3	10	33.6
51 - 100	6	20.0	18	62.1	24	81.1
101- 150	3	10.0	2	6.9	5	16.9
151- 200	1	3.3	1	3.4	2	6.7
201- 250	1	3.3	-	----	1	3.3
251- 300	1	3.3	1	3.4	1	6.7
301- 350	1	3.3	-	----	1	3.3
501- 550	1	3.3	-	----	1	3.3

critical situation for the residents who need elements for transportation and for preparation of soil, because the animals have to be fed with forage purchased by the Community, in form of alfalfa hay through direct purchasing or through barter of products produced by the family. Finally, the contribution of cattle and pork to the total does not exceed 0.7% and 0.4% in each one of the Agricultural Communities, respectively; the porcine are fed with the whey obtained from the manufacture of goat milk cheese.

With respect to the stock rate it is observed that both Communities present an over rate greater than the average of the Region 0.063 AU/ha (IREN-CORFO 1977). On the other hand, it is observed that

grazing lands that have been overgrazed are in an advanced degradation state. Cossio et al (1983) suggests that these ecosystems cannot support stock rate greater than 0.04% AU/ha/year and 0.06 AU/ha/year, resulting in a total stocking rate of 90.6 AU/ha/year and 214.23 AU/ha/year for both Communities. This means that each family should have, as an average, 4.6 AU/year and 8.5 AU/year respectively; but at present they maintain 20.4 AU/year and 11.4 AU/year which is producing and accelerating the desertification processes. This situation is important by the fact that 100% of the families are not willing to reduce the animal stock rate; and they wish to increase it by holding the females, selling they only the males and respects. However, a variation of animal population is observed due to the removing of livestock to Andes highland ecosystems, known as "veranadas" at the end of november coinciding with the beginning of the critical period. The livestock have to walk 300 km at a rate of 20 km/day and at an altitude that varies from 200 to 3.500 m.a.s.l. On this route vegetation changes from coastal sub-desertical matorral to the andean shrubby steppe (Figure 2). According to vegetational state and the physiographical conditions, the "veranada" of Cuncumén was divided into four sectors located from 1.500 to 3.500 m.a.s.l. Between 1.500 and 2.000 m.a.s.l. correspond the sectors where heath species dominate, with a prevalence of the association Ephedra andina Poepp., Colliguaya odorifera Mol. and Kagenekia angustifolia Don. In sectors having South exposure; in the herbal stratum Vulpia sp. and Avena sp.; are present other species that can be found are Adesmia sp., Baccharis linearis, B. pingraea and perennial grasses species as Nassella chilensis and Stipa sp.

Between 2.000-2.500 m.a.s.l. correspond sectors with pronounced slopes and meadows where herds are established during

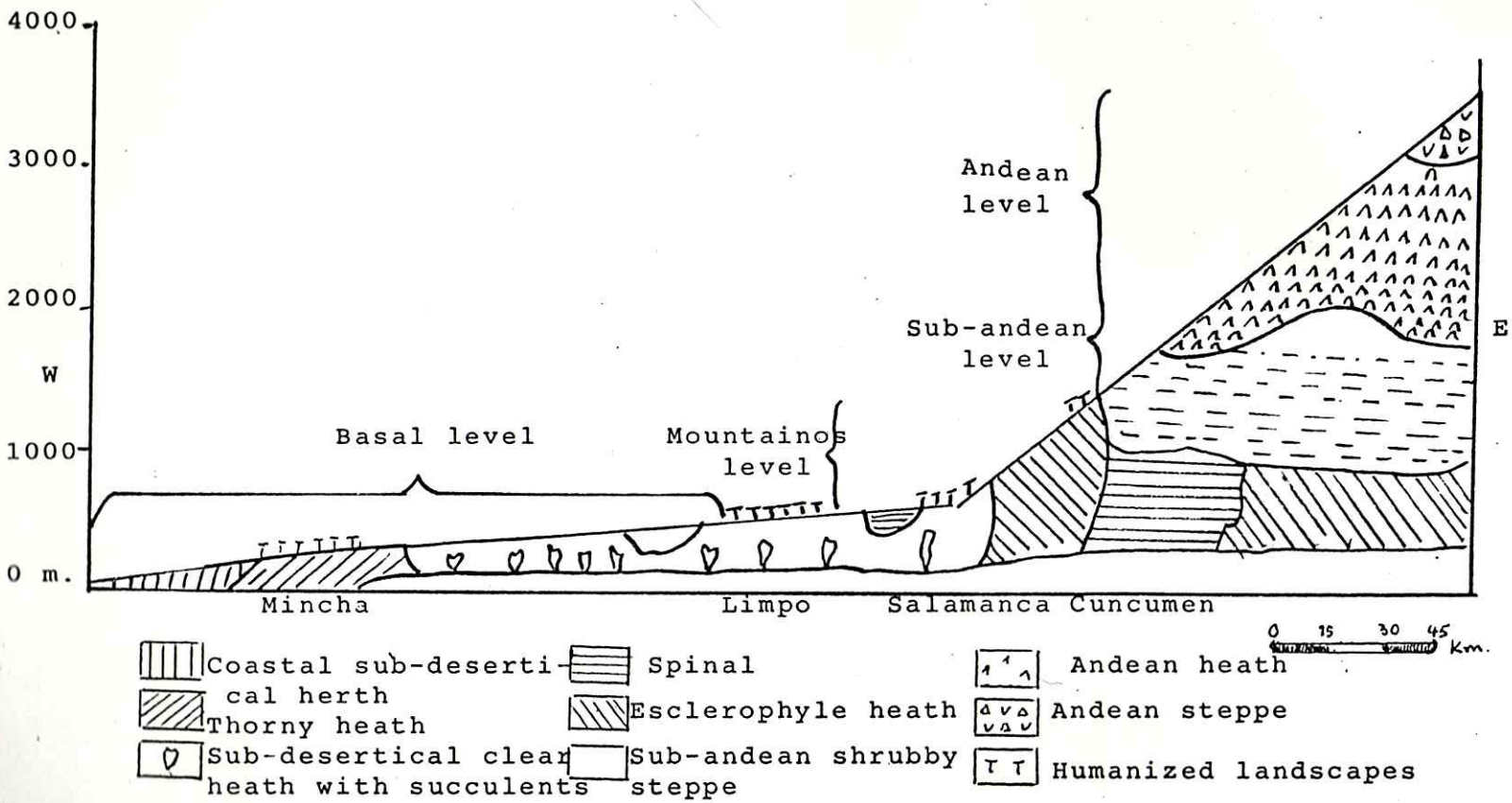

Figure 2. Phytogeographical profile at 31°50' South.
Quintanilla (1981).

summer time. Vegetation consists mainly of Avellanita bustillosii Phil and Haplopappus arbustoides Remy with a stratum dominated by Stipa pogonanthera Desv. and isolated population of Verbena scoparia (Sch.) Mol together with a herbaceous stratum composed by Acaena splendens and Mutisia ilicifolia; Solidago chilensis; Gamochaeta stachydifolia ; Phelum alpinum.

The sector located between 3.000 and 3.500 m.a.s.l. corresponds to lands physionomically diversified such as: i) ravine bottom, where draining of water is permanent during ice-melting, existing dominant species as Trifolium megalanthum Hook; Calceolaria biflora Lam; Cardamine decumbens Barn and Ranunculus peduncularis; in the zone near to edge of water Juncus balticus wild develops associated with Calandrina ferruginosa, C. affinis, Phacelia magallanica and Oxalis sp. ii) sector of mid and high slopes, where the filling of vegetation has been carried out to obtain fire-wood; a community of herbs can be found dominated by grasses as Festuca acanthophylla Dev., as dominant, and others plants located among rocky outcrops such as Deschampsia setacea , D. cordilleranum, Danthonia picta, Bromus sp. and Astragalus sp.; some shrubby species grow isolaledly such as Berberis empetrifolia Lam. and Tetraglochin alatun.

The last sector is located between 3.000 and 3.500 m.a.s.l. and is characterized by steep summits with rocky outcrops, great stoniness and presence of snow. Plant communities are small and they can only be observed in the edge of water where Patosia clandestina dominates which associates with Heleocharis. In slopes and flat sectors with great stoniness Hordeum comusum Presl. and H. comusum var. humilis are to be found in

rity of cheese. Salting is done when curding is put into the mould in a very uneven manner. Maturity is carry out doors. Milk presents a varied fat content which has an incidence in the yield of cheese that ranges between 5.95 and 6.98 liters per kilogram of cheese. Man with his family group accompanies the livestock throughout the season, creating a close relationship between man, the animal and the mountains.

Summarizing owing to nomadism, a seasonal variation in stock rate is produced. (Table 8)

Table 8 Seasonal variation of stock rate in the Communities of Carquindaño and Yerba Loca, expressed in animal units. (AU)

Season	Community	
	Carquindaño	Yerba Loca
Winter	459.45	283.29
Spring	450.83	284.05
Summer	393.31	277.59
Autumn	423.21	259.20
Annual average	431.82	276.03

In Carquindaño, de most important variation is present during summer due, precisely, to the moving of livestock to the mountains. However, in Yerba Loca this variation is more important in spring time due to the selling of kids goat and lambs. According to this variation, the annual average is 431.82 AU and 276.03 AU for Carquindaño and Yerba Loca, respectively; this determines a stocking rate of 0.16 AU/ha and 0.07 AU/ha for both Communities, considering only the grazing area.

the form of clumps of low density. In the high summits isolated vegetational strata is present close to the line of permanent snows, such as Nassauria lagascae, Viola sp. and Cajophora coronata.

Observations recorded by Cossio et al (1983) indicate that in the first and second sector, the yield of the range is 7.422 and 1.367 kg/ha of dry matter. With respect to management of livestock, this is located in a sector previously determined called "postura" , where it remains throughout the season by means of a continuous and uncontrolled grazing.

The herds or "piños" range between 50 and 100 goats; 64% in milk, with a daily average yield of 400-500 grs of fluid milk/goat/milking and 300 grs of milk/goat/mass with a daily yield of 8 liters of milk per kilogram of cheese. Milking is done early which makes it necessary to round up the herds about 2-3 hours before, since it grazes and sleeps in high slope sectors.

The manufacture of cheese is carried out under deplorable conditions of cleanliness and with archaic methods. The milk of the day before and the one of the milking day are mixed, with a previous filtration in order to eliminate macro-particles (hair, excrement, soil); the coagulant ("lonco") is the rennet contained in the abomasum of kids goat, it is preserved in a plastic bottle throughout the season. Between 0.15 and 0.25 lts of coagulant ("lonco") are added to each 10 kg of milk, preserving it for 30 to 60 minutes. The scattering or stripping of curding is made by hand, which produces a grain, uneven in size, that contains a large quantity of retained whey, which produces undesirable fermentations after matu-

According to the foregoing, it is concluded that the Community of Carquindaño has an overstock rate of 0.11 AU/ha and Yerba Loca one slightly reasonable of 0.07 AU/ha. This confirms that the use of grazing is accelerating the desertification processes; it reflected in the low production of milk/goat/year, figure that corresponds to observed in other ecosystem for goats in the arid zone. Cheese production shows a close relation with milk production; thus yield is 6.6 kg/ha and 3.1 kg/ha of cheese in Carquindaño and Yerba Loca, respectively. The difference is mainly due to the population of goats that both Communities have.

With respect to meat production the net yield of the carcass is 10.4 kg from a kid goat with a live-weight of 26.1 kg. Other parameters can be observed in Table 9.

Table 9. Parameters of evaluation of a kids goat carcass observed in the Community of Yerba Loca (Cossio et al. 1983)

Live-weight (kg)	26.1
Net yield (kg)	10.4
Carcass yield (%)	39.8
Range of carcasses (cm)	57
Weight of digestive tract (kg)	8.60
Weight of viscera (kg)	0.97
Weight of head (kg)	1.24
Weight of testicles (gr.)	0.255
Weight of blood (kg.)	1.02
Weight of leather (kg.)	2.6

According to past data it is observed that the yield of the carcass compared with other animal species, is extremely low (39.8%) due to the high content of the digestive tract (32.9%) in the total weight.

At present, kids goats are sold with a live-weight of 20 kg.

From the economic point o view, 3.1% and 6.9% of the families of both Communities belong to the cattle group; these groups are not dedicated to agriculture; they are composed of few people, insufficient to dedicate to agriculture; to this group belong old people that are not fit to work. Farmers reach 18.7% of the population of Carquindaño and 6.9% in Yerba Loca.

The manure of goats is important because of the profit made in cultivated sectors, specially under irrigated land. Observations reported in 1982, yields of 284.7 kg of fresh manure per goat/mass were obtained; this manure contains 61.9% of dry matter. It is estimated that the production of manure per animal is approximately 4% of its live-weight and that only 12% is constituted by solids adequate for the production of biogas (methane). The total contents of nitrogen reaches, in average, 2.3% of the dry matter of the excrements with 30% of total available nitrogen.

Animal health. In this aspect it is of interest to note that animal health is the least studied in the arid zone. Thus, many pathologies affecting livestock in general, and the goats particulary, are not yet known. The study centered its attention on those problems of health most relevant such as brucellosis, mastitis, parasitism and intoxications, and the sanitary quality of goat milk for cheese production.

In both Communities 14 flocks were sampling obtained 198 samples and using two serumlogic tests which indicated: i) 9.1% of

clinical mastitis; 3.3% of warts and papilloma, being greatest in Carquindaño; ii) the serumlogic tests indicated the absence of brucellosis; iii) quality of cheese indicates that in all examined samples there were Coliformes bacilli in excessive amount, which reveals a low hygienic level of handling. The same occurs with environmental and housing conditions. The presence of positive Staphilococcus coagulasa in fresh cheese samples indicates the risk of intoxication for consumers.

Economic study. In the specific case of studied Communities, the system of land tenancy is not really of joint ownership at all. The community system only works for grazing lands where there is freedom for animal grazing in an extensive way; the sectors where "lluvias" are cultivated are asigned to each resident, who must fence it, and its use is limited by the natural soil fertility; when is exhausted, the enclosures are withdrawn and the sectors are incorporated to grazing lands; the profit of cultivation sectors and livestock, is private. From the analysis made by Alvarez M. and M. Valdés (1983) it can be concluded: in the capital of assets in both Communities a great incidence of the value of construction is noted, with 64.83% and 57.69%. Table 10.

In the case of the working capital, livestock-raising predominates. This is due to the fact that the residents, owing to the small sector that they cultivate, expand in grazing lands, where it is relatively easy and convenient to raise livestock without direct expenses or problems (Table 11)

Table 10

Capital in assets estimated for the Comunities of Carquindaño and Yerba Loca (Alvarez M. y M. Valdés, 1983).

Community	Capital in assets											
	Land		Constructions		Enclosures		Cattle		Tools		Total	
	$	% *	$	%	$	%	$	%	$	%	$	% **
Carquindaño	852.719	4.34	12.733.699	64.83	2.905.511	14.79	3.006.700	15.30	140.832	0.71	19.699.461	95.22
Yerba Loca	792.555	5.30	8.621.135	57.69	3.750.164	25.09	1.650.300	16.04	127.629	0.85	14.941.783	95.64

\# Percentage over the total of Capital in Assets
\## Percentage over the whole Capital.

Table 11 Working capital calculated for the Communities of Carquindaño and Yerba Loca, october 1982 (Alvarez M. and M. Valdés, 1983)

Community	Working Capital					
	Cattle		Seed		Total	
	$	%	$	%*	$	% **
Carquindaño	876.500	89.01	108.196	10.98	984.696	4.77
Yerba Loca	621.100	91.20	59.883	8.79	690.983	4.36

* Percentage over the total of working capital

** Percentage over the whole capital

It is possible to appreciate the high incidence of the Capital in Assets on the Total Capital, which would indicate a low activity level in both Communities.

With respect to the use of human resources, the results of the census indicate the percentage of population economically active, being figures obtained over 50% (Table 12) involving both sexes.

Table 12 Distribution of active and inactive population in the Communities of Carquidaño and Yerba Loca, october 1982 (Alvarez M. and M Valdés, 1983)

Community	Sex	Active population		Inactive population	
		N°	%	N°	%
Carquindaño	Female	42	26.4	36	22.6
	Male	60	37.7	21	13.2
Yerba Loca	Female	34	25.2	25	18.5
	Male	46	34.1	30	22.2

The majority of female population of more than 15 years old is involved in carrying out agricultural-livestock activities (sowing, weeding, mowing, milking, preparation of cheese) besides house-keeping. Only 4% and 3.7% of the populations of Carquindaño and Yerba Loca, respectively, carry out other jobs (mining, forging, cooking). Scholars represent the greatest percentage of inactive population, followed by children less than 5 years old. It is necessary to notice that 59.49% and 75.9% of the families in both Communities have, as a main economic activity, agriculture and goat raising.

With respect to the net income, the results are shown in Table 13 , where it is observed that the contribution of cultivations to the Total Net Income of both Communities is significantly grater than that of livestock-raising; this difference becomes greater in the Community of Carquindaño due to the fact that there is a greatest cultivated are good and greater than those of Yerba Loca.

Table 13 Net income of the Communities Carquindaño and Yerba Loca, in 1982 (Alvarez M. and M. Valdés, 1983)

Community	Gross Margin		Fixed Costs	Net Income
	Cultivations	Livestock		
	----------	$	----------	
Carquindaño	2.140.216	478.180	857.575	1.760.820
Yerba Loca	843.835	338.850	634.125	548.560

In relation to Family Income per activity, it is appreciated that the family group Agriculture-livestock presents a greater income obtaining from cropping activities. (Table 14)

Table 14 Family Income per activity in the Community of Carquindaño, october 1982 (Alvarez M. and M. Valdés, 1983)

Type of Activity		Family Income	Income per capita
		----------$----------	
Farmer livestock-raiser	big	192.744	21.416
	medium	221.352	24.594
	small	31.545	3.943
Livestock-raiser		59.563	29.781
Farmer	big	193.090	48.272
Farmer	medium	126.800	21.133
Tenant farmer		43.200	21.600

Due to the size of exploitations, small Capital of Exploitation and nil technical assistance, residents need an extra-predial income to survive. Hence, they have the income proceeding from government social programs, pensions, support from realtives located in urban centers, etc. However, the residents must apply to other income sources such as mining, and extra-predial activities.

All the analyses carried out in both Communities agree with the results of other studies, which conclude that the economies of these human settlements are sustained by a simple economy of subsistence, with very little signs of increase in net family incomes. They live and exploit the resources more by tradition than for obtaining an economic profit. The migration of young people is of special relevance, forming a cacuum in the work-force and for the future.

Agriculture.

It is the second most important activity. The area dedicated to cultivation is 257.3 ha in Carquindaño and 159.8 in Yerba Loca respectively. They correspond 9.1% and 4.27% of the total area of each community. The cultivation of wheat is performed in a priority way since it supplies an important part of the family feeding around the year and from it are obtained flour, "mote" and other subproducts as straw and bran. Most of the wheat production is destined to the supply of the familiar nucleus; the excedents, in a relatively small amount, in most of cases, are destined to selling or exchanging for other products.

In Table 15 the area of both Communities dedicated to cultivations, can be observed where there can be found wheat, anise (Pimpinella anisum, L), cumin (Cominum cyminum, L) and coriander (Coriandrium sativum). In the irrigated sectors there exits "huertas", orchards; there are crops as greens, corn, potatoes, tomatoes and fruit trees; alfalfa is cultivated in small proportions.

Table 15 Distribution of cultivated area under dry-land and irrigation condition in the Communities of Carquindaño and Yerba Loca.

Cultivation	Carquindaño	Yerba Loca
	ha	
Fallow	77.1	53.4
Wheat	104.0	80.7
Barley	33.6	15.4
Anise and cumin	21.2	0.5
Anise	13.8	4.2
Vetches/field beans	5.5	0.8
Maize	1.3	2.5
Eucaliptus forest	0.8	---
Prairies	----	2.3
	257.3	159.8

It was estimated that in most of the soils dedicated to dry-land cultivation, only 50 to 60% is effectively croppes and productive. Thus, the actually productive are would be 150 ha and 100 ha for Carquindaño and Yerba Loca, respectively.

The second crop is barley, which is generally seed in depleted and degraded soils, with low fertility, obtaining low grain yields. The grain is used mainly to feed horse and mules. It does not constitute a contribution to the family income.

The crop in dry-land conditions, such as anise, cumin and coriander are made in small areas due to the lack of workmanship and the fact that they try to diversify their production and assure an income in cash. Thus, almost the totality of production is destined to selling or to exchange. Other less relevant crop correspond to those carried out under irrigate conditions in ravines. There are small areas dedicated to vetches, beans, tomatoes, corn, for family consumption.

It is of interest to note that an important area of the sectors dedicated to crops has to be prepared the year before, leaving soil uncovered and with no protection. It is estimated that the area reaches 30% of the total area dedicated to farm crops.

The sequence of cultivation is practically continous. Within the sectors called "lluvias" there is a little rotation which includes weed crops, mainly anise and cumin. The consecutive cultivation may reach up to 8 years, period enough to exhaust natural soil fertility and cause erosion processes. The sector is abandoned and returned to the Community by the resident, who takesout the fences . These sectors

constitute grazing lands that are "common field" for all the members of the Community. The recovery of herbal vegetation is very slow through ecological succession. Non controlled grazing due to the lack of herders, causes overgrazing and erosive processes.

Some parameters in wheat cultivation were observed, having found differences with a slight superiority in Carquindaño (Table 16)

Table 16 Morphological characteristics, density of plants per m^2, wheat straw and seed yield in the Communities of Carquindaño and Yerba Loca, october, 1982 (Cossio et al , 1983).

	Carquindaño	Yerba Loca
N° plants/m^2	54.9	52.5
N° bunches/m^2	120.5	83.4
N° bunches/plant	2.2	1.6
Total N° spikes/m^2	121.6	94.1
N° spikes/plant	2.2	1.79
Straw yield (kg/ha)	3.190	1.500
Seed yield (kg/ha)	240	870

However, in flat lands there can be obtained yields of 1.800 kg/ha, corresponding to soils with high fertility and water retention.

The yields of barley range between 600-700 kg/ha due to the fact that this crop is established in poor and degraded soils.

Semi-extensive crops are carry-out in hillsides or in

"family orchards". These cultivations receive more attention than cereals. They need more labor and due to this they are located close to human settlements. These crops need good soils and prefer warm mediterranean climates, established on North exposure slope. Miss dense dews and rains damage plants during blooming and fructification period.

The seed rate used in anise and cumin ranges between 20-22 kg/ha, amount that is very superior to the usual ones in other regions.

The yields of crops will vary according to the precipitation distribution, incidence of plagues and diseases and techniques of harvest. In Table 17 some parameters considered in an evaluation made in the studied Communities are shown.

Table 17 Height of plants, number and average seed yield in anise, cumin and coriander.

	Anise	Cumin	Coriander
Average height of plant (cm)	34.8	15.0	39.6
Number of plants/m^2	3.5	2.0	2.0
Yield kg/ha	56.3	41.0	34.0

With respect to fruit-trees, they are lacking but important. The most abundant is the pear-tree (Pyrus comunis) that grows and produces in almost natural conditions with no management, producing a fruit with good taste and texture. Exccedents are used to feed goats. Besides, there are quinces (Cydonia oblonga) that are consumed fresh. Another important fruit-tree is fig-tree (Ficus carica), that can be found

in each orchards.

In general, it can be concluded that in both Communities an agriculture of subsistence is developed, based mainly on cultivations of cereals and other weeded crops such as anise, cumin and coriander. These cultivations are made under extensive or semi-extensive conditions in hillsides with extreme slope; low yields per unit of area reached, causing severe damage to soil by consecutive cultivation. Part of the production is dedicated to Family consumption and the rest is transacted with no defined marketing channels.

The re-location of crops according to the slope, the adoption of certain cultivation practices and management, are feasible through pilot areas. Long rotation and medium rotations are proposed which include mainly, the prairie.

Hydrography

The Communities under study are over granitic rocks of jurassic to cretaceous age. There are no old quaterny sediments that might constitute hydric accumulators. The problem presented by the scenery is the high soil run-off due to the loss of protection, in such amount that there does not exist infiltration.

The highly eroded hydrographic basins without any vegetation have variable static levels and volumes. (Table 18)

Table 18 Geomorphological and hydric characteristics of four basins in Carquindaño and Yerba Loca Community (Rozas, E. 1983)

Ravine	Volume lt/sec	Static level m
El Zapallo	0.25 - 1.00	2.0 - 5.0
Carquindaño	0.5 - 2.0	2.0 - 5.0
Yerba Loca	1.0 -10.0	5.0 -15.0
Honda	1.0 -10.0	5.0 -15.0

Geomorphological and hydric characteristics indicate that the basin does not have external contributions. Thus, it is necessary to increase the harvest of rain-water through all the known techniques, location of crops according to the slop gradient and to include the prairie in rotations.

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