# 7

# SOUTH AMERICA

**Juan M. Gastó**

*Facultad de Agronomía*
*Universidad Católica de Chile*
*Santiago, Chile*

**Alfredo Olivares E.**

*Facultad de Ciencias Agrarias y Forestales*
*Universidad de Chile*
*Santiago, Chile*

**Rolando H. Braun W.**

*CONICET*
*Instituto Argentino de Investigaciones de las Zonas Aridas (IADIZA)*
*Mendoza, Argentina*



## I. INTRODUCTION

The objective of this chapter is to present a synthesis of recent advances and research related to plants in the arid and semiarid environments of South America. Because of the extent of the subject, it has not been possible to present an exhaustive and integral paper. To accomplish this work, which includes diverse regions and countries, it was necessary to ask for the cooperation of some of the most outstanding researchers on the continent. Even so, some regions or countries are not included in detail.

The study has been divided into three parts. First, a brief description of the main natural regions is included, giving a general view of the problems and limitations of each one. Then, a synthesis of the recent advances in each of the regions, as well as the general problem of desertification, is presented. The last part is related to the needs and recommendations for future research, according to the interpretation of the authors.

## II. PHYSIOGRAPHY

The regions described here experience arid or semiarid conditions during part of the year or season (Figs. 1 and 2). In some regions, the total precipitation may be high, but the combined effect of temperature, soil, and water balance produces the dry environment that characterizes arid regions.

### 1. DESERT

The South American desert is located on the Pacific coast between 2 and 30°S. The climate is warm and dry, with extreme temperature ranges between day and night, and different seasons. The desert belt is located next to the ocean, and because of the cold Humboldt Current, and air pressure, often has dense fog, which concentrates on leaf surfaces. This moisture stimulates the growth of vegetation, which under certain circumstances is profuse and corresponds to the coastal fog or Lomas desert. The total annual precipitation in the north approaches 100 mm and gradually diminishes toward the south; in Arica and Iquique, Chile, the annual mean is near 0 mm. Further south, it gradually increases, and at 30°S it barely surpasses 30 mm.

The central part of the belt experiences a very low relative humidity, high luminosity, and a minimum of cloudy days, which produce an environment with an almost absolute lack of vegetation. In the ecotone with the high Andean region, 2800 m above sea level toward the east, annual precipitation surpasses 5–10 mm, allowing the growth of ephemeral vegetation and open shrublands.

Next to the Andes, where there is a larger amount of precipitation, extra water comes from canyons, underground rivers, summer surface runoff, and other sources. These sources cause oases, transversal valleys of the desert, salt flats, and pampas; underground water is present at less than 20 m depth. The vegetation and fauna are characteristic of the environment.

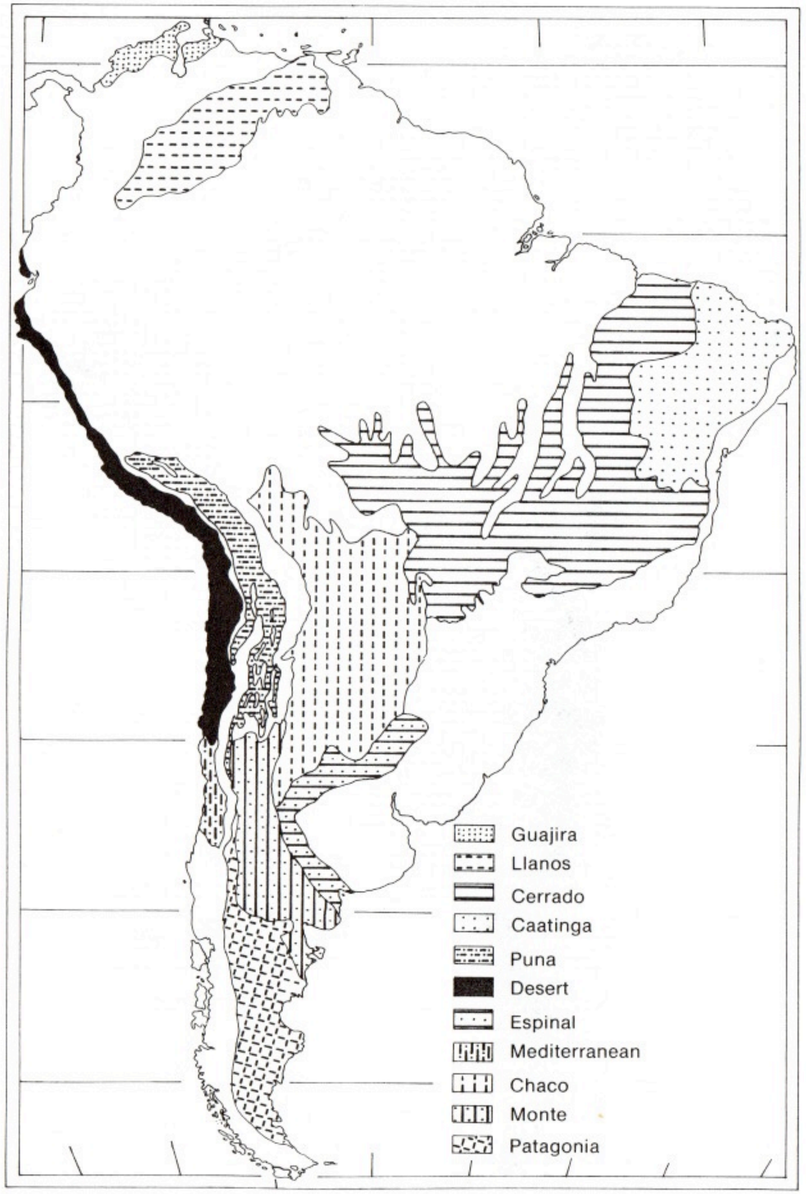


**Fig. 1.** Natural regions of South America, according to Cabrera and Willink (1973). The regions included, during part of the year or year-round, present arid or semiarid conditions.

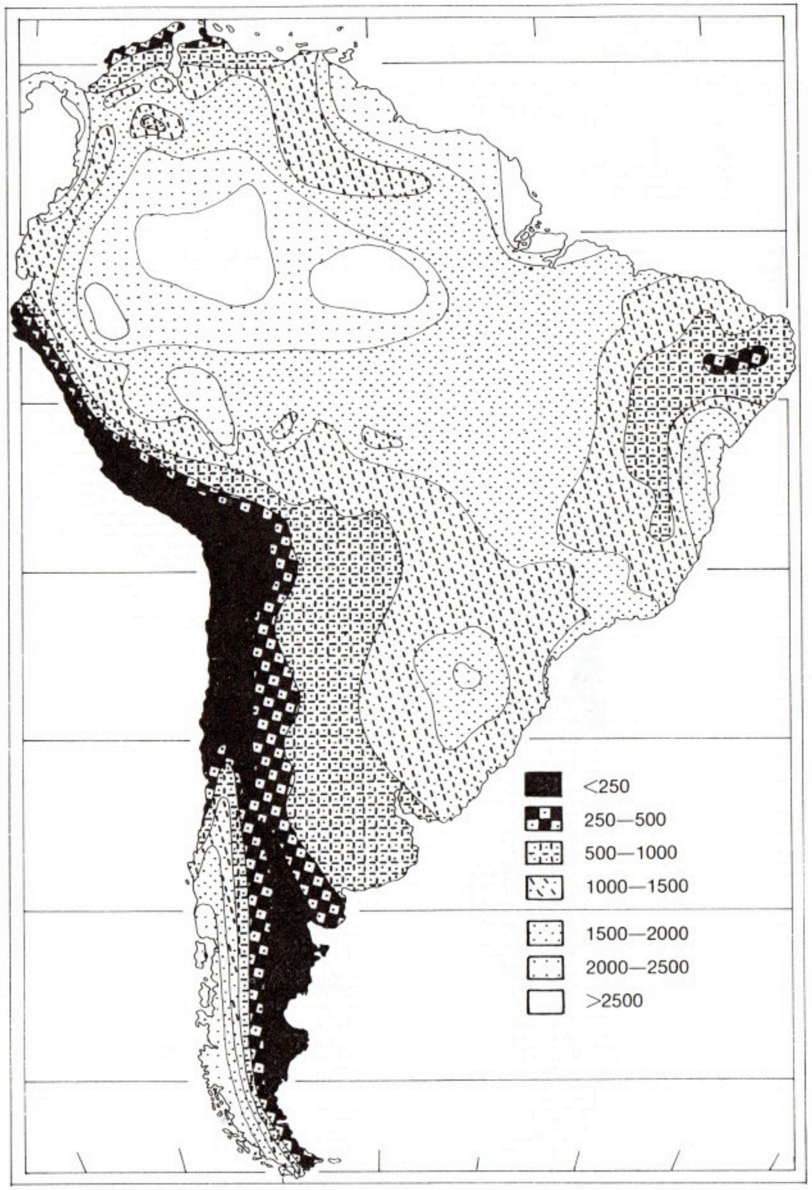


**Fig. 2.** Total annual precipitation (mm) in South America.



## 2. PUNA

The Puna is a flat highland located between the Andes and the Cordillera Réal; its altitude ranges from 3200 to 4200 m above sea level. The climate is cold and dry and presents a strong thermic variability between day and night, and between seasons. Mean annual temperature is 9°C. The precipitation is higher in the north, registering up to 800 mm per year and gradually diminishing to 50 mm toward the south. The rainy season occurs during summer, thus ephemeral summer plants are abundant. The remainder of the vegetation corresponds to a steppe whose main vegetation consists of perennial grasses interspersed with low shrubs.

## 3. PATAGONIA

A temperate–cold climate with strong westerly winds during a great part of the year is the most characteristic trait of this region. Frost, occurring most of the year, and snow, falling during the winter months, gives the area an inhospitable environment. Mean temperature reaches 30°C in the north and 5°C in the south, and precipitation fluctuates between 100 and 200 mm. The physiography corresponds to flatland interspersed with valleys, sierras, and highlands. Soils, in general, are stony and sandy, though with a high range of variability according to the position in the relief. The vegetation is a low shrubby steppe, with grasses interspersed with low shrubs. In the low meadows, grasses predominate over other life forms.

## 4. MONTE

The monte vegetation corresponds to an open chaparral whose height gets smaller toward the west. The location of this region—between the Andes, chaco, pampean forest and dunes, and Patagonia—produces a wide variety of ecotones. The climate changes from the north, where the average temperature is warmer, to the south. The regional mean is 13–15°C. Precipitation is scarce, ranging from 100 to 250 mm per year. The region has a low carrying capacity, from $\frac{1}{10}$ to $\frac{1}{70}$ animal units per year per hectare, with extensive livestock use. Forage is produced by some herbaceous plants as well as shrubs.

## 5. CHACO

The predominant vegetation is xerophytic and deciduous, with Cactaceae and Bromeliaceae, and a Gramineae stratum. In addition, there are palm trees and savanna, as well as halophytic, shrubby steppes in localized areas (Cabrera and Willink, 1973). In the eastern part of this area, precipitation is abundant throughout the year, while in the west only the summer season is rainy, with an annual average precipitation between 500 and 1200 mm. Mean temperature is between

20 and 23°C. Adverse environmental conditions are related to the low carrying capacity of the range for livestock, which only reaches $\frac{1}{20}$ to $\frac{1}{33}$ animal units per year per hectare in the north, and $\frac{1}{10}$ in the south.

#### 6. PAMPEAN FOREST AND DUNES

This is a xerophytic open forest, with trees (5–8 m tall) dominated by the endemic legume calden (*Prosopis caldenia*), and associated woody species such as *P. nigra* and *Condalia microphylla*. The pampean forest region forms a belt oriented from northwest to southeast, approximately between the 450 and 600 mm isohyets in the central part of Argentina (Ragonese and Cano, 1971). Annual mean temperature ranges from 15 to 20°C. There exists a certain floristic affinity with the chaco. Edaphic communities with rhizomatous species are frequent on dunes, and there are bushes of fleshy Chenopodiaceae on salty soils (Cabrera and Willink, 1973). Native grassland has great importance. Its carrying capacity ranges between $\frac{1}{10}$ and $\frac{1}{2}$ animal units per year per hectare.

#### 7. MEDITERRANEAN

In the more favorable habitats exposed to the south, the vegetation is dominated by trees, while on northern exposures, or in shallower soils, it is shrubby. Vegetation and stratification are complex, with horizons of pterophytes, geophytes, and phanerophytes at different heights, as well as hemicryptophytes and lianas; all give a high stability to the system.

The climate, as in other Mediterranean regions of the world, is characterized by long summer droughts alternated with a short winter rainy season, which, in the most favorable environments, starts at the end of fall and ends in the middle of spring. In the north, annual precipitation is only 20–25 mm, or even less, whereas toward the south, it increases up to 1400 mm and even 2000 mm. The mean temperature, on the other hand, is higher in the north, reaching 16°C, with a mean of 12°C near the coast and 8°C near the Andes. The average temperature range is high, and nights are cool. The minimum temperature during the coldest months usually does not reach below 0°C. During summer, the maximum temperatures are usually between 32 and 35°C (Di Castri and Mooney, 1973).

The physiographic traits of this zone are hills and terraces cut by transversal canyons and creeks, which carry the winter surface runoff. In winter, the land is covered by annual plants, which dominate the lower strata and ripen and dry during spring. On the other hand, woody species start growing and flowering in spring and stay active during summer. Most species are evergreen.

#### 8. LLANOS

The llanos are located at the extreme north of South America in Venezuela and Colombia. The climate consists of a dry season alternated with an extremely wet



season (Cabrera and Willink, 1973). The llanos are characterized by their flatness and are covered by a continuous stratum of Gramineae interspersed with isolated shrubs and trees. During the rainy season, the soil surface is covered in many places by thin, heavy layers of water that reduce the growth rate. During the dry season, the growth rate is kept to a minimum by a water deficit.

#### 9. GUAJIRA

This region is located in the coastal area of northern Colombia and Venezuela, next to the Caribbean Sea. The precipitation concentrates mainly during October and November, when the annual mean reaches only 400 mm. Mean temperature is 28°C (Cabrera and Willink, 1973). Vegetation is dominated by columnar Cactaceae and dwarf shrubs.

#### 10. CERRADO

The cerrado is located in a highland where elevations vary from 500 to 1000 m above sea level. This region covers 200 million ha. Mean precipitation is between 1200 and 2000 mm per year, with a dry season from May to October, and a mean temperature between 21 and 25°C. The vegetation corresponds to open forests of low height, occasionally reaching 8–12 m; shrubby and herbaceous strata develop under them. A high proportion of this region is savanna dominated by a continuous stratum of perennial grasses interspersed with shrubs and small trees (Cabrera and Willink, 1973).

#### 11. CAATINGA

Caatinga is characterized by a shortage of precipitation, averaging between 400 and 700 mm, with high annual variability. In wet years, the surface runoff is lost, while during dry years there is a shortage of water and the seasonal growth is reduced to a minimum. The aridity problem is magnified by high temperatures, with a mean of 27°C. Plant cover is heterogeneous. Trees and shrubs inhabit the best environments and are mixed with open areas dominated by spiny shrubs. A high proportion of the predominant species lose their leaves during the dry season from May to September.

## III. PLANT RESOURCES

### A. Phytoecological Studies and Management

#### 1. DESERT

Because of the lack of precipitation for long sequences of years and the low relative humidity, few vegetation studies have been conducted in the desert region. Researchers have centered their attention in those areas—oases, valleys, and salt flats—that, due to special circumstances, receive water inputs from other systems, such as surface or subterranean runoff or where the input comes as fog.

Acosta-Solís (1970) described the vegetation and flora of arid lands and lands marginated by drought in Ecuador; these are located in the coastal and inter-Andean region. Ecological conditions and the proposed management were discussed.

In the coastal fog desert, the problems differ according to the area. In the northern savanna, where *Prosopis* and herbaceous plants dominate, the main problem arises from the indiscriminate cutting of *Prosopis* and *Acacia,* which causes eolian erosion. This promotes the advance of sand dunes, which in turn increases the process of desertification and modifies the microclimate (Kummerow, 1966). On the other hand, indiscriminate grazing by goats reduces the importance of herbaceous vegetation, which in turn affects the natural regeneration of shrubby and arboreal vegetation. All of this causes a rupture of the organic-matter cycle, and reduces the potential productivity (MAB-3, 1977).

In the lomas of the coastal region of Peru and Chile, there is a problem of overgrazing, especially of the herbaceous forage plants, which are seasonal and thus are not protected from being consumed by grazing. The lomas vegetation grows mainly during winter on the slopes facing the sea, which are exposed to the south or southwest (Aguilar, 1970; MAB-3, 1977; López Ocaña, 1978). Castaño *et al.* (1978) studied the lomas of the Peruvian coast using a system approach in order to find a methodology to develop and evaluate the natural resource management of the regions in Lachay and Iguanil. This is one of the few integrated studies that has tried to solve the problem with multiple objectives.

The shrubby and herbaceous vegetation of the lomas survives as a result of fog, which increases in intensity from July to October. The process has been carefully studied by several authors who have even quantified the water influx (Kummerow, 1966; Hajek and Saiz, 1976). When vegetation is destroyed, the plant surface, which intercepts the fog, is reduced; this, in turn, causes a reduction or loss of water income to the soil and plants, triggering the desertification process. Because of this cycle, a natural recovery of vegetation does not exist.

The most outstanding section of this phytogeographical unit is the Pampa del Tamrugal in Chile, which is characterized by the presence of a natural open forest dominated by several species of *Prosopis* (Contreras and Gastó, 1978). The density of *P. tamarugo* ranges from 20 to 30 plants per hectare (Pisano, 1966). Since the early 1970s several studies have been done to increase the knowledge necessary to improve man-made irrigation of primary and secondary production, as well as to increase the area planted (Cadahia, 1970). Because of the lack of precipitation and its association with natural forests, this region has received much attention. Several studies analyzing water relations and balance have been conducted in order to state formally a hypothesis leading to the establishment of a cause-and-effect relationship to explain the presence of this association (Botti, 1970; Sudzuki, *et al.*, 1973; Sudzuki, 1975).



The plant community is characterized by its high proportion of support and fruit tissues. A high percentage of the digestible protein is localized in the foliage, even though the highest percentage of digestible energy is located mostly in the fruit (González and Haart, 1960; Lanino, 1966; Muñoz, 1972). Abundant forage that is palatable to sheep, goats, and cattle is produced with 12% crude protein, 30% fiber, and 1.9% ether extract. Litter productivity may reach 74 kg per tree, and that of fruits, 8.2 kg per tree. The carrying capacity of the forest is related to age, reaching up to 10 sheep per hectare per year on a 16-year-old plantation (Elgueta and Calderón, 1970; Elgueta, 1971; Contreras and Gastó, 1978; Lanino, 1966). Under certain circumstances, 30-year-old trees have produced as much as 3.4 kg/m$^2$ of dry matter, 50% of which is litter, and the rest fruit. Livestock mainly consumes the ground litter, which, because of the dryness of the air and lack of precipitation, is preserved in good condition for many years. Occasionally, they consume the foliage and fruit on the lower branches (Muñoz, 1972; Klein, 1970; Contreras and Gastó, 1978).

The natural trophic chains are mainly of the entomological type; a small number of vertebrates are present, especially lizards and birds (Klein, 1970; León, 1974; Campos, 1968; Klein and Campos, 1977). Because of the low diversity of the system, especially of the phytocoenosis, the stability of herbivorous and carnivorous insects is very low, and a high proportion of the primary production is consumed by them.

In 1963, a research program was started to look for ways to utilize the pampas for animal-raising purposes. The results of these studies were the basis for carrying on a reforestation program; up to 25,000 ha, mainly in the salt flats of Pintados and Zapiga in northern Chile, are now planted with *Prosopis tamarugo.* Improved breeds of livestock also have been introduced (Instituto Forestal, 1971; Lamagdelaine, 1974; Lanino, 1972).

## 2. PUNA

Ruthsatz (1977) thoroughly studied the plant communities and environmental conditions of the Andean half-deserts of northwestern Argentina.

The agricultural regions of the high Andes have been classified as homogeneous areas with indications of the potential productivity and variety adaptation. This has been done to provide a basis for a plan to grow Andean crops for human consumption. The system stability has its roots in the high diversity of crops and livestock, which characterizes traditional agriculture (Camino, 1977; Earls, 1977). The grasslands of the high Andes also have been considered (Tapia, 1976; Braun, 1964; Flores, 1967; Gómez, 1966; González, 1967, 1969). Great emphasis has been placed on introducing new species and varieties, even though the greatest potential lies in the cultivation of natural grasslands (Segura, 1976). Some studies have been done using an ecological approach (Cárdenas, 1971; Posnasky, 1971). There is abundant information derived from agrostologic studies (Tapia, 1976; Lara, 1972; Johnson *et al.*, 1968).

## 3. PATAGONIA

Ruiz Leal (1972b) performed studies in the northern portion of the Patagonian plateau and characterized the phytogeographical transition between the monte and Patagonia according to floristic evidence.

Among the programs of vegetation inventories and cartographical studies of semiarid Patagonia, several studies have been conducted to describe and classify those communities that are dominated by *Stipa speciosa* and *S. humilis* (Soriano and Brun, 1973). At the same time, three areas have been described using a geological, geomorphological, edaphic, vegetational, and meteorological approach (Brun *et al.*, 1971). In certain areas, plant communities have been described in large scale on a cartographic basis (De Anchorena, 1973). The flora and vegetation of Patagonia also have been studied (Latour, 1971).

Livestock exclusion from rangelands causes changes in the productivity and botanical composition, even when it happens for short periods of time. Plant succession induced by grazing expresses itself from the first year of use (Soriano, 1973). In the analysis of both existing and potential vegetation, Soriano *et al.* (1978) studied the structure of the climax community before and after utilization by sheep. In another study, range dynamics were analyzed through the measurement of diseminules density, both inside and outside the exclosures.

The natural psammophytes of the Bahía Blanca region were studied by Bishop *et al.* (1968) from a taxonomic, palatability, and bromatologic point of view. In some studies, biomass production of some species and range types has also been considered through the periodic harvest of herbaceous dominant components, especially *Stipa speciosa* and *S. humilis* (Soriano, 1974). The nutritive characteristics of the main range species of a broad Patagonian area have been described by Wernli *et al.* (1976). The structure of natural communities dominated by low, palatable grasses and shrubs can be modified by seeding with improved herbaceous range plants (Serra, 1970). Specifically, Abadie (1967) studied the native range dominated by *Festuca pallescens,* which has a high forage value, in order to increase its natural regeneration.

## 4. MONTE

Roig (1972) outlined a physiognomic vegetation map of the Mendoza Province, in the central western area of Argentina, in which he described formations having trees (in flatlands and mountains), shrubs (of halophytic, psammophytic, and mountainous swamps and *lacunes*), and mountain grasslands. Guevara *et al.* (1978) prepared an inventory of the natural, renewable resources of Mendoza. One of their conclusions is that the regional vegetation includes valuable forages, with regard to distribution, density, and fodder value.



Ruiz Leal (1965) referred to 16 different species not previously known in Mendoza. Several other floristic studies have been carried out, among which was one related to the species of the genus *Stipa*.

Ambrosetti (1971) studied some of the important species used in the management of regional watersheds in the central west of Argentina. The range changes originating from the exclusion of livestock from a piedmont alluvial basin were studied by Pedrani and Rodriguez (1978). The ecosystem structure of shrubby species, which characterize the monte, was studied through a process of breaking the equilibrium through biological procedures (Zuccardi, 1974). Vegetation dynamics have been studied where changes were triggered by fire (Roig *et al.*, 1972).

In the Mendozinan plain, primary production of a monte community dominated by *Prosopis flexuosa* was analyzed by Braun *et al.* (1978). The energy and nitrogen content of species of this community were studied by Braun and Candia (1980), while other woody and herbaceous species of western Argentina were also studied in detail by Wainstein *et al.* (1974, 1979).

## 5. CHACO

Large vegetational and environmental units were studied with the use of aerial photographs, as well as measurements and observations on the ground; soil, geomorphology, and vegetation were analyzed (Adamoli, 1972; Morello *et al.*, 1971, 1972, 1974). Vegetation dynamics were studied using remote sensors to detect changes in vegetation structure, and to evaluate invasion of woody species (Morello and Gomez, 1971). Morello and Adamoli (1973) described and defined the ecological subregions of the chaco and prepared the cartography. The variation of some characteristics of plant communities, which developed under extreme pluviometric conditions, also were analyzed (Sejzer, 1973).

A large number of arboreal, shrubby, and succulent species were analyzed from a structural point of view (Neumann, 1973). This has also been done for communities dominated by *Prosopis ruscifolia,* to gain data on their function, as well as their effect on the other components (Gomez *et al.*, 1973). The regional flora has been described in detail (Digilio *et al.*, 1971), including its spatial arrangement (Adamoli, 1972).

The indiscriminate harvest and exploitation of the natural resources of the chaco area, especially during the last century, produced an intensive retrodegradation over most of the area (Ledesma, 1978). One of the most outstanding colonizers is *Prosopis ruscifolia,* whose invasion mechanism has been described by Morello (1970). Gomez *et al.* (1974) described its selective control with herbicides to promote successional changes in the community. Other species also have been studied (Lagomarsino *et al.*, 1974). Some improved species were established in the northwestern area (Díaz, 1972a).

Díaz *et al.* (1972b) studied the digestible value of the most important species in this semiarid region. Aerial and subterranean biomass of some woody species of the occidental (dry) chaco forest, as well as their contribution to the nitrogen balance, have also been studied. Del Aguila *et al.* (1969) studied the animal carrying capacity of rangelands of Los Llanos in La Rioja.

The interstrata interference of some invader species, such as *Prosopis ruscifolia,* is due to the exudate production, which is able to inhibit or delay the seed germination of some subordinated species (Souto and Eilberg, 1972).

## 6. PAMPEAN FOREST AND DUNES

Several studies have been dedicated to the description of vegetation and productivity (Adler *et al.*, 1974; Cano and Fernández, 1974; Anderson *et al.*, 1970; Cano and Olmos, 1968; Lewis, 1973; León, 1973). Alliney *et al.* (1978) studied the size and number of samples in the range evaluation. The flora and vegetation of the semiarid pampean forest have been studied by Cano (1977), Ragonese and Cano (1971), and Covas (1971), while Anderson *et al.* (1974) studied relics on sandy soils.

Vegetation dynamics have been studied where changes were triggered by fire (Braun and Lamberto, 1974; Lamberto and Braun, 1974; Orionte and Anderson, 1976). In the same way, postfire successions have been studied by Cano and Holgado (1971). The range changes originating from the exclusion of livestock and wildlife were studied by Cano (1969). Recovery time of the desirable species was studied under exclosure conditions by Santo *et al.* (no date).

Feldman (1972) described the management and replacement of woody plant cover in the forest area. Range conditions and trends were studied by Anderson *et al.* (1971) in order to propose the proper management strategy and to optimize plant production. In other studies, ecological successions have been considered in a broader context, where, besides the ecological aspects, the genetic, biochemical, and evolutionary aspects have been considered in such a way as to analyze the ecological convergence when comparing analogous regions (Lowe *et al.*, 1972).

The primary production of ecosystems has been analyzed by several authors. Cano (1977) estimated a production (dry weight) of 2500 kg per hectare per year for shrubs and grasses. The range production that resulted after the controlled burning of pampean forest vegetation was studied by Lutz and Graff (1974) and Braun *et al.* (1974); it was found that during the dry years, the lower strata production was considerably reduced.



## 7. MEDITERRANEAN

Range associations were determined through phytological analyses (Etienne *et al.*, 1978). The botanical composition, nutritive value, and range production in an area with an annual precipitation gradient from 50 to 2000 mm has been estimated, both for granitic soils as well as marine terraces (Wernli, *et al.*, 1976). Quantitative relationships have been established between the ecological and climatic characteristics and the range structure (Gastó and Contreras, 1979; Parilo, 1978; Rojas, 1978).

The geographic-distribution studies have permitted a selection of native plant species that are adapted to improved environments. Some of the species cultivated at present were collected in natural environments and selected to be included on improved grasslands (Gastó and Contreras, 1972a, 1972b).

The absolute growth rate through the year and the relative growth rate were studied to obtain values for the natural ranges under normal grazing conditions, as well as with fertilizer (Parilo, 1978; Schenckel *et al.*, 1971; Segarra, 1979; Gastó and Contreras, 1979). The greatest increase in the growth rate of the range takes place at the end of winter and the beginning of spring, from August to October, when the best moisture and temperature conditions occur. The precipitation variability and the relationship between precipitation and primary production were studied in detail by Acuña (1978) and Gastó and Contreras (1979).

The ecological influence of fire on the natural shrubland was studied by Altieri and Rodriguez (1974).

Season and frequency of range utilization affect productivity and botanical composition. Experimental results indicate that when a range is utilized for short periods of time, it is not affected, even when heavily grazed. Continued intensive use causes range degradation, which ends in the destruction and change of its botanical composition (Olivares and Riveros, 1979; Olivares and Gastó, 1978; Contreras and Gastó, 1978). Animal nutrition under different range conditions has been studied by Riveros (1977) and Avendaño *et al.* (1978). The effect of livestock on the range, and vice versa, has been considered by Olivares and Riveras (1979) and Grez and Fernandez (1978). The supplementation of livestock feed under grazing conditions allows a better range utilization (Manterola *et al.*, 1979; Hechenleitner, 1973; Catalán, 1973). The influence of seasonal frequency and intensity of range utilization by livestock has been studied by Rodriguez (1978), Trivelli (1973), Di Marco (1973), and Concha (1975).

The range organization in fields and its utilization with rotation and grazing has been studied by Avendaño *et al.* (1978). The study is based on experimental results accumulated over a long period of years in the Mediterranean region of central Chile. Aranda (1971) studied the complementation of winter and summer ranges, as well as the routes and procedures followed in the process of moving the livestock to complementary areas. A general view of livestock migration over a long period was done by Cosio and Vicens (1969).

Range reseeding studies of herbaceous species have continued, even though less intensively than in previous years, since there is a clear knowledge of the adaptations of the main groups of plants (Uslar, 1972).

The study of natural phytocoenosis has increased the understanding of the basic structural elements of the matorral, which characterizes the Mediterranean environments of Chile. Based on its natural structure, a new community, similar to the original one in its morphology and stability, but with a larger rate of man-made irrigation, is created (Gastó and Contreras, 1972a,b) with the changing environment.

Most of the emphasis has been placed on species adaptation to environments that record 50–300 mm of precipitation per year (Gastó and Contreras, 1972a,b), even though moister ranges also have been studied (Cosio, 1970; Vicens and Cosio, 1968, 1970). The adaptations of shrubby species to different soil conditions (Lailhacar, 1976), as well as the natural population distribution (Badilla, 1975), have been studied.

Intraspecific interference is one of the areas that has received most of the attention during the last few years. This knowledge is considered basic for the development of bistratified phytocoenosis, which is required for ecosystem improvement in arid and semiarid Mediterranean regions of central Chile (Zuñiga, 1973; Gastó and Caviedes, 1976).

## B. Food Plants

The botanical, genetic, and agronomic characteristics of some native species of the Andean region have been studied. Among these are *Chenopodium quinua, C. pallidicaule, Lupinus mutabiles, Oxalis tuberosa, Ollucus tuberosum, Tropaeolum tuberosum,* and *Amaranthus caudatus* (Tapia, 1977). Most of the studies are being conducted in Peru and Bolivia (Vorano and García, 1976; Telleria, 1976; Lanino, 1976; Cardozo *et al.*, 1976; and Narrea, 1976). Basic regional studies have permitted the formation of germ-plasm banks in which a high proportion of the local varieties are included. At present, there are adequate facilities to preserve these banks in good condition. The exchange of genetic material with other scientists began in 1979.

Anatomical, morphological, and physiological studies have been done on the above-mentioned species and varieties, giving more information on the development of the areas where they occur (Cornejo, 1976; Lara, 1976; Ignacio *et al.*, 1976; Cortez, 1977; Canales and Baldomero, 1977). The most promising varieties have been selected from a nutritional, agronomic, and economic point of view (Lescano and Palomino, 1976; Lescano, 1976; Telleria and Ballón, 1976). At present, a basic knowledge of the growth of these species (especially *Chenopodium quinua, C. pallidicaule,* and *Lupinus mutabilis*) is available concerning fertilization, cultivation, and pest control (Gandarillas and Tapia, 1976; Chaquilla, 1976; Morales, 1976; Christiansen, 1977; De La Puente, 1977). Growth, productivity, digestibility, and utilization have been studied in general (Arze and Sotelo, 1976; Arze and Alencastre, 1976; Negron *et al.*, 1976; Cornejo, 1976).



New varieties have been developed by local experiment stations, especially in Peru and Bolivia; some of these varieties, in addition to having better agronomic characteristics, contain a lower percentage of saponin (Gandarillas and Tapia, 1976; Cano and Rosas, 1976). The productivity of one of these varieties, which is adapted to environments with frost-free periods longer than 140 days, reaches 2300 kg/ha, with 14% protein and 6% lysine.

Brücher (1962, 1965, 1973) and Viirsoo (1967) have studied wild potatoes in northwestern Argentina, which are a valuable source of germ plasm for the improvement of cultivated potatoes. In Argentina, *Ximenia americana* and *Geoffroea decorticans,* present in the monte (Ruiz Leal, 1972a), and *Celtis spinosa,* existing in the chaco (Schulz, 1963), have edible fruits of value. *Prosopis flexuosa* and *P. alba,* in the monte, and *P. torquata,* in the chaco, possess edible seeds. The fruits of other species of the monte also are indicated as possible sustenance foods (Ruiz Leal, 1972a): *Amaranthus viridis, Berberis* spp., *Cortesia cuneifolia, Ephedra triandra,* and *E. ochreata.* Additionally, *Portulaca oleracea* and *Arjona patagonica,* in Patagonia and the monte, are edible raw or cooked (Ruiz Leal, 1972a). In the chaco, people eat fruits of *Zizyphus mistol.*

Ortiz Garmendia (1969) has worked on Chilean wild plants with edible fruits; many are found in the arid zones. Among these are *Aristotelia chinensis, Beilschmedia berteroana, Cordia decandra, Cryptocaria rubra, Eugenai chequén, Eulychnia* spp., *Gourliea chilensis, Jubaea chilensis, Krameria cistoidea, Lithraea caustica, Lucuma valparadiceae, Margiricarpus seteous, Mühlenbeckia chilensis, Peumus boldus,* and *Prosopis chilensis.*

Acosta-Solís (1970) pointed out the edible cacti (*Opuntia* spp.) and several herbaceous legumes, such as *Crotolaria* spp., among the native species from Ecuador. Also, several woody legumes, such as *Prosopis pallida* and *P. juliflora,* are known to have edible parts. In Peru, fruits of *Acacia macracantha* and *Dioscorea chancayensis* are eaten.

## C. Forage Plants

The inventory of herbaceous and woody plants, which can serve to feed domestic animals, is very large. In arid zones, woody species attain singular importance as a permanent forage resource because of their resistance to the water deficit. Tinto (1974) has indicated the importance of several Argentine species:

Foliage and fruit: *Acacia aroma, Caesalpinia paraguariensis, Condalia microphylla, Ephedra triandra, E. ochreata, Geoffroea decorticans, Lycium chilense, Prosopis alba,* and *Zizyphus mistol*

Only foliage: *Acacia caven, A. praecox, Atriplex lampa, A. platensis, A.*

*semibaccata, A. undulatum, Capparis tweediana, Celtis tala, Gradowskia obtusa, Maytenus vitisidaea, Porlieria microphylla,* and *Trichomaria usillo*

Foraging fruits: *Prosopis alpataco, P. caldenia, P. denudans, P. nigra, P. patagonica, P. ruscifolia, P. sericantha, P. stricta,* and *P. torquata* (*Larrea* spp. also can be turned into forage)

It is frequently possible to use the above-mentioned plant resources for other purposes, giving a complementary usage and allowing new activities. Many of these species can be used as firewood or have wood that can be used for industrial purposes.

In Chile, according to several authors, there exist various important woody forage species: *Prosopis chilensis, P. tamarugo, P. alpataco, Geoffroea decorticans, Berberis* spp., and *Acacia caven.*

Acosta-Solís (1970) mentioned the following as forage species from Ecuador: *Mimosa quitensis* and several cacti of the genera *Opuntia, Cereus,* and *Trichocereus.*

The protein content and digestibility of some native plants of Argentina, such as *Condalia microphylla, Ephedra ochreata, E. triandra, Larrea* spp., *Lycium chilense,* and *Prosopis caldenia,* as well as native grasses of the pampean forest (*Poa ligularis, Stipa tenuis,* and *Piptochaetium napostaense*) have been studied by Abiusso (1974) and Magoja (1975). The phytochemical characteristics of the species of this region were analyzed in several other works (Rondina *et al.*, 1971; Mendiondo *et al.*, 1973; Hnatyszyn *et al.*, 1974). Wainstein (1974) discussed the nutritional value of some forage species of western Argentina: *Sphaeralcea miniata, Verbena mendocian, V. aspera, Adesmia filipes, Amaranthus crispus, Prosopidastrum globosum, Bougainvillea spinosa, Lycium chilense,* and *L. tenuispinosum.*

The Mediterranean species of Chile have been studied as a raw-material source to be used in the manufacturing of protein extracts. Soluble protein extracts from *Atriplex repanda* and *A. nummularia* leaves, according to Silva and Pereira (1976a,b), contain 19.6% and 26.2%, respectively, of the total protein present in the leaves. Amino acid analyses of the extracted proteins show a balanced composition with the exception of methionine, which is present in lower than usual amounts. Lysine and methionine amounts depend on the phenological stage of the plant (Ferrer *et al.*, 1977). Protein concentrates could be used as valuable supplements for other foods that are low in the essential amino acids (Silva and Pereira, 1976a).

## D. Medicinal Plants

Montes (1965) gathered knowledge on the composition of essences of Argentina. Among these are *Acacia caven, Acantholippia seriphioides, A. hastulata, Aloysia polystachia, Artemisia mendozana, Azorella* spp., *Chenopodium rigidum, Hedeoma multiflorum, Lippia trubinata, L. integrifolia, Myroxylon peruiferum, Schinus molle,* and *Trixis antimenorrhea.*



Mateu Amengual and Villa Carenzo (1971) published an extensive phytochemical bibliography; it includes references to Argentine species and those from other South American countries. The natural products of several composites of central western Argentina have been studied (Giordano, 1979): *Tessaria* spp., *Flourensia oolepis, Baccharis* spp., *Senecio* spp., and *Grindelia* spp.

In his work on the flora of Mendoza, Ruiz Leal (1972a) included an extensive list of plants that are popularly used and even sold, generally as infusions, because of their pharmacological value.

A list of herbs with which medicaments are prepared in Peru has been prepared by Vargas (1978). Among the native ones, the following can be cited: *Ambrosia peruviana, Caesalpinia* sp., *Cassia loretana, Chenopodium pallidicaule, Ephedra* sp., *Equisetum* sp., *Persea americana, Portulaca* sp., and *Schinus molle.* The essence of *Peumus boldus,* present in Chile from Coquimbo to the south, has been studied by Schimmel (cited by Fester *et al.*, 1960).

## E. Industrial Plants

### 1. FIBER PLANTS

As wood sources, one can mention (according to Tinto, 1974, and several other authors) *Acacia aroma, A. caven, A. praecox, Caesalpinia paraguariensis, Celtis tala, Geoffroea decorticans, Myroxylon peruiferum, Prosopis caldenia, P. alba, P. chilensis, P. ruscifolia, P. torquata,* and *Zizyphus mistol,* all of which occur in western Argentina. In Ecuador, Acosta-Solís (1970) reported *Cordia alliodora, Geoffroea spinosa, Libidibia corymbosa, Loxopterygium huasango, Prosopis juliflora,* and *Zizyphus thirsiflorus.*

*Lippia turbinata,* in Argentina, and *Sporobolus rigens,* in Argentina and Chile, are used for basketry; the latter species also is used for making brooms.

*Typha dominguensis* is used in western Argentina for binding vines, calking barrels, manufacturing of seats, covering greenhouses, protecting glass containers, and so on.

In Argentina, *Condalia microphylla, Porlieria microphylla,* and *Zizyphus mistol* are used for turnery.

The following species, belonging to arid zones of Argentina, are used as wood for industrial purposes: *Caesalpinia paraguariensis, Celtis tala, Condalia microphylla, Geoffroea decorticans, Prosopis alba, P. caldenia, P. chilensis, P. nigra, P. ruscifolia,* and *Zizyphus mistol.*

Tinto (1974) referred to the following species as firewood: *Acacia* spp., *Atriplex lampa, Celtis tala, Condalia microphylla, Geoffroea decorticans, Gradowskia obtusa, Prosopis* spp., and *Zizyphus mistol. Monttea aphylla* also is known for that purpose. In Chile, in addition to some of the above mentioned, *P. tamarugo* and *P. chilensis* are used for firewood, *Cordia decandra* for making charcoal (Ortiz Garmendia, 1969). In Peru, *P. pallida* and *P. chilensis* are used as firewood. Acosta-Solís (1970) mentioned *Mimosa quitensis* and *Baccharis* spp. for the same purpose in Ecuador.

#### 2. OIL PLANTS

*Acacia aroma* and *A. caven,* found in Argentina, have flowers with essential oils for perfumery (Tinto, 1974).

#### 3. WAX, RESIN, AND LATEX PLANTS

Tinto (1974) indicated that *Acacia caven* has a gummy substance, similar to gum arabic; *Prosopis alba, P. nigra, Porlieria microphylla,* and *Larrea* spp. also have resins. Rique (1974a,b) commented on *Gleditsia amorphoides* from the chaco area as an interesting species, which has a gelatinous gum in its seeds. Ruiz Leal (1972a,b) discussed *Cercidium australe,* from which a kind of glue is obtained, as well as *Bulnesia retama,* also from the monte, which gives wax similar to carnauba. In Peru, the glue of *Cercidium praecox* is used.

#### 4. TANNIN PLANTS

*Caesalpinia paraguariensis* from the chaco area has been mentioned by Tinto (1974).

### F. Other Plants

#### 1. TINCTOREAL PLANTS

Plants native to Chilean arid zones, some of which are also present in border countries, have been discussed by Ortiz Garmendia (1968). Among these, he includes *Balsamocarpon brevifolium, Sphacele campanulata, Berberis glomerata, Caesalpinia spinosa, Oxalis gigantea, Geoffroea decorticans, Tagetes glandulifera, Salix chilensis, Colliguaya adorifera, Bulnesia chilensis, Krameria cistoidea, Schinus molle, Ephedra andina, Lithraea caustica, Schinus polygamus, Berberis* spp., *Maytenus boaria, Cassia* spp., *Zuccagnia punctata, Budleia globosa, Phrygilanthus* spp., *Psittacanthus* spp., *Acacia caven, Prosopis chilensis, P. tamarugo, P. alpataco, P. strombulifera, Larrea* spp., *Bulnesia chilensis,* and *Porlieria chilensis.*

Ruiz Leal (1972a,b) included *Berberis* spp. and *Relbunium richardianum* in this group, the latter for the substances contained in its roots. Acosta-Solís (1970) cited *Coulteria tinctoria.*



#### 2. WASHING SUBSTANCES

*Solanum eleagnifolium,* with saponins for washing clothes, and *Cestrum parqui,* for washing hair, are found in the monte area (Ruiz Leal, 1972a,b).

#### 3. ANTIOXIDANTS

*Larrea* spp. and *Succagnia punctata* contain nordihydroguayaretic acid, which is an antioxidant for oils and fats (Ruiz Leal, 1972a,b).

Alkaline ashes are produced by *Allenrolfea vaginata,* a species present in the monte, and are used in the production of soap and the preparation of olives.

#### 4. SWEETENING SUBSTANCES

Olaechea *et al.* (1964) studied the chemical composition of *Glycyrrhiza astragalina,* a species that exists in the Patagonian and western regions of Argentina, and contains glycyrrhizin.

#### 5. SAND-BINDING PLANTS

*Hyalis argentea, Panicum urvilleanum, Plectrocarpa tetracantha,* and *Prosopis strombulifera* serve as sand binders in the monte and Patagonia. In Peru, *Krameria illucca* and *Pennisetum chinense* can be found performing the same function.

## IV. DESERTIFICATION

The natural ecosystems of the arid zones, which are in advanced successional stages, can reach an equilibrium between organizational and disorganizational forces.

Humans, who are socially, culturally, and politically organized, are capable of manipulating the topological arrangement of plant architecture through inputs to the ecosystem in the form of energy, matter, and information. This produces an ecological convergence that is different from the one in the natural state, where the anthropic component is absent (Fig. 3).

The technological capacity of organized humans enables them to transform arid and semiarid ecosystems; based on ecological laws, and through functioning and systemogenic processes, it also allows humans to channel these ecosystems to a new state of equilibrium. These processes are the basis for the management of natural ecosystems from an ecological and agronomical point of view.

A case study of desertification in the arid Mediterranean region of Chile was done at the request of UNESCO. The integrated study included specialists on

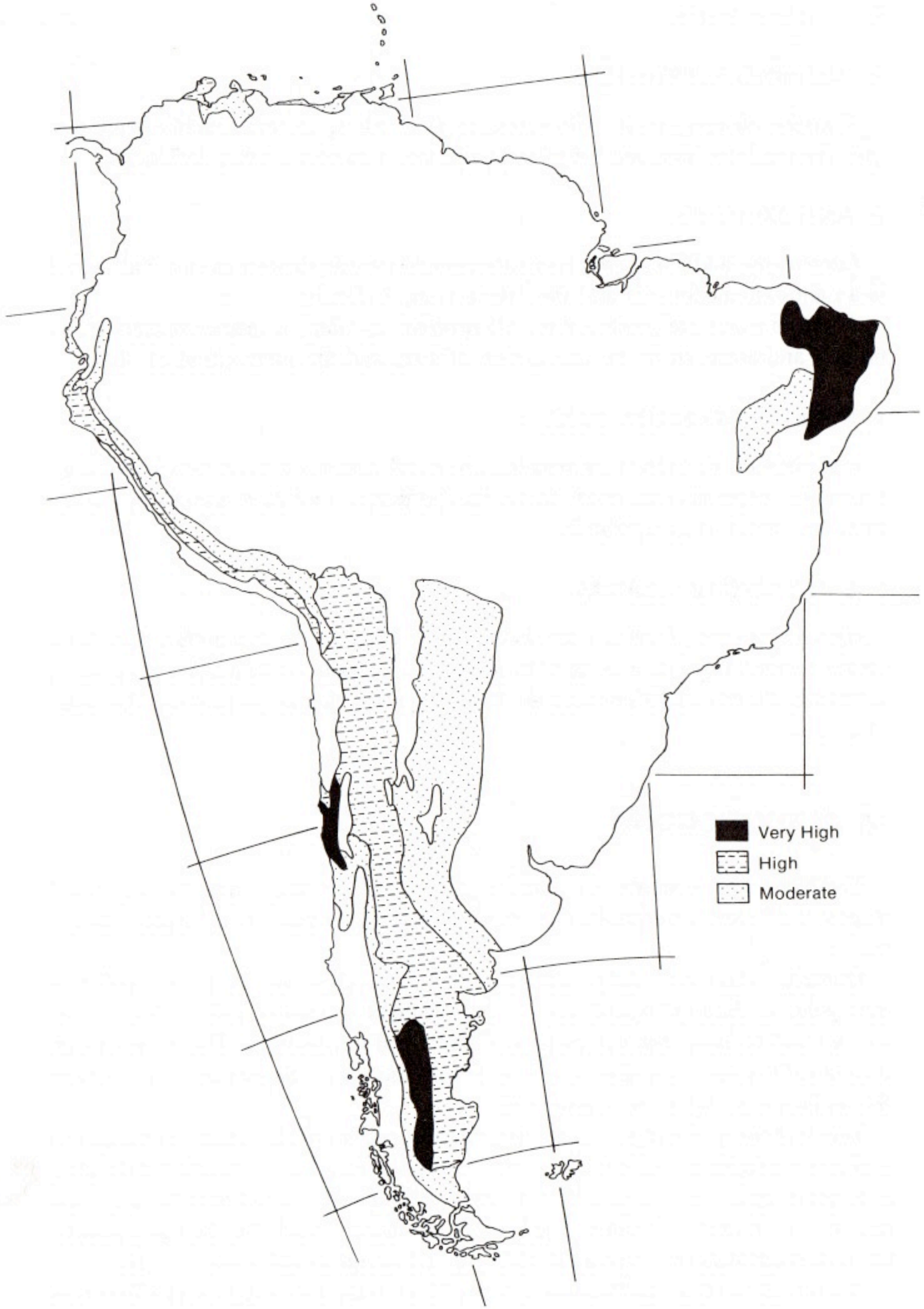


**Fig. 3.** Degree of desertification hazards in South America, according to the United Nations Conference on Desertification (1977).



geomorphology, geology, soils, bioclimatology, climatology, ecosystems, phytocoenosis, terrestrial and marine zoocoenosis, anthropology, range, and crops (INIA, 1977). The study presented a general scheme of the process of systemogenic degradation that ends in ecosystem desertification. In international meetings, representatives from several South American countries presented studies related to desertification. Also included were regions where precipitation is beyond the limits of aridity. The destruction of ecosystem components initiates a process of aridization, especially at the microclimatic level (Instituto Ecuatoriano de Recursos Hidráulicos, 1977). The United Nations has prepared a world map of desertification, where several studies conducted by the countries in these continents were included (United Nations, 1977; Peralta, 1977; Suarez de Castro, 1977).

## V. SUMMARY

Research to be conducted in the arid South American environments should be placed in a general framework whose purpose is to solve general problems in a global way, and in which sociostructure, technostructure, and incident systems are closely related with biogeostructure. Very commonly, there exists an excessive emphasis on detailed local studies, which are weakly connected with the general problems of each natural region. There is often an obvious gap in the scientific and technological knowledge, which is available and applicable to the South American continent. Frequently, the research being accomplished refers to problems that have already been solved, or to those that easily could be solved, using the available scientific and technological knowledge. There is an obvious lack of interest in conducting research projects that produce information of general value for solving specific local problems.

The material resources invested in arid-land research have not been scarce, especially in relation to the necessities and economic capacity of the region. Human resources, available for research, are also abundant. With good organization and integration in each region, and among homologous regions, it would be possible in a short period of time to reach results corresponding to the necessities of the area. The experience obtained in South American arid-land research and the adaptation of techniques developed in homologous regions of the world, has led to the development of well-qualified groups that are able to organize and carry out research to solve the regional problems of arid lands.

As time passes, the necessity of conducting integrated studies to solve problems on an ecosystem basis becomes obvious. The integration of research efforts among countries that share natural regions is a must, in order to optimize the utilization of human and material resources, and to achieve research goals.

A general ecosystem approach toward the elucidation of arid-land problems should give better results than sophisticated studies centered on detailed subjects of an ecosystem's components, which are unrelated to one another. Because of existing limitations in arid zones, a transformation based solely on technology is not possible. The natural ecological processes, especially ecological successions, combined simultaneously with the application of adequate levels of technology, should provide an optimum combination to allow arid-land ecodevelopment.

The efforts made in South America to search for solutions to arid-land problems is proof of the interest that most of these countries have in their arid lands. The effort to overcome human and material problems, which are often found in these regions, should be recognized as a demonstration of the intellectual and material possibilities to solve them.

## ACKNOWLEDGMENTS

The authors wish to acknowledge the contribution of regional information provided by the following persons: Dr. Mario Tapia, IICA, La Paz, Bolivia; Roberto J. Candia, IADIZA, Mendoza, Argentina; Prof. David Contreras, Universidad de Chile, Santiago; and Prof. Alfredo Gargano, Universidad del Sur, Bahía Blanca, Argentina. Some of the information presented in this chapter comes from summaries written by them.

## REFERENCES

Abadie, C. A. (1967). La regeneración de *Festuca pallescens* (St. Ives) Parodi en los pastizales del oeste del Chubut. *IDIA* **239,** 58–64. INTA. Buenos Aires, Argentina.

*Abiusso, N. G. (1962). Composición química y valor alimenticio de algunas plantas indígenas y cultivadas en la Rep. Argentina. *Rev. Invest. Agropecu.* **16**(2), 92–247. Buenos Aires.

*Abiusso, N. G. (1964). Composición química y valor alimenticio de algunas plantas indígenas y cultivadas en la Rep. Argentina. II. *Rev. Invest. Agropecu., Ser. 2* **1**(13), 311–338. INTA, Buenos Aires.

*Abiusso, N. G. (1973). Estudio químico de cuatro gramíneas forrajeras: *Eragrostis curvula, Agropyron intermedium, A. elongatum* y *A. cristatum. Rev. Invest. Agropecu., Ser. 2: Biologia y Producción Vegetal* **3,** 89–110. INTA, Buenos Aires.

Abiusso, N. G. (1974). "Niveles Proteicos y Valores de Digestibilidad (KIUMS) de Tres Gramíneas Invernales Nativas de La Pampa," Vol. 5. Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.

Acosta-Solís, M. (1970). "Geografía y Ecología de las Tierras Áridas del Ecuador." Instituto Ecuatoriano de Ciencias Naturales, Contribución No. 72., Quito, Ecuador.

Acuña, H. (1978). "Influencia de la Pluviometría en la Producción Primaria de Una Pradera Anual de Clima Mediterraneo." Facultad de Agronomía, Univ. de Chile. Tesis Mg. Sc. Santiago.

Adamoli, J. (1972). "Frecuencia, Confinamiento y Transgresividad en Especies del Chaco Argentino." I Reunión Argentina de Ecología, Vaquerías, Córdoba, Argentina.

*Adamoli, J. (1973). "Manejo y Recuperación de Recursos Forrajeros Degradados en el Chaco Salteño." II Reunión Argentina de Ecología, Salta, Argentina.

*General references for further information.



*Adamoli, J. *et al.* (1972). El chaco aluvial salteño. *Rev. Invest. Agropecu., Ser. 3* **9,** 165–237. INTA, Buenos Aires, Argentina.

Adler, M. *et al.* (1974). "Relevamiento Ecológico del Borde Occidental de los Llanos de la Rioja." III Reunión Argentina de Ecología, Puerto Madryn, Chubut, Argentina.

Aguilar, F. (1970). "Las Lomas Costeras del Perú." Univ. Nac. Agraria La Molina, Lima. Congreso Internacional de Zonas Aridas, Arica, Chile.

Alliney, J. E. *et al.* (1978). "Efecto del Tamaño y del Número de las Muestras para Medir Producción en el Pastizal Natural de San Luis." IV Reunión Argentina de Ecología, Corrientes, Argentina.

Altieri S., M. A., and Rodriguez M., J. A. (1974). "Acción Ecológica del Fuego en el Matorral Natural Mediterráneo de Chile, en Rinconada de Maipu." V Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.

Ambrosetti, J. A. (1971). Especies interesantes en la ordenación de la cuenca Papagayos. I. *Deserta* **2,** 207–237. IADIZA, Mendoza, Argentina.

Anderson, D. L., del Aguila, J. A., and Bernardon, A. E. (1970). Las formaciones vegetales en la provincia de San Luis. *Rev. Invest. Agropecu., Ser. 2: Biología y Producción Vegetal* **7**(3), 81–87. INTA, Buenos Aires, Argentina.

Anderson, D. L. *et al.* (1971). "La Dinámica y el Manejo de la Pastura Natural en el Centro-Sur de San Luis." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.

Anderson, D. L., Orionte, E. L., and Vera, J. C. (1974). "Un Relicto del Pastizal de San Luis." IV Reunión Argentina de Ecología, Río Cuarto, Córdoba, Argentina.

Aranda, X. (1971). "Un Tipo de Ganadería Tradicional en el Norte Chico, la Trashumancia." Centro Demostrativo Corral de Julio y Dep. de Geografía, Univ. de Chile, Santiago.

Arze, J. A., and Alencastra, S. J. (1976). "Digestibilidad de los Granos de Quinua (*Chenopodium quinua* Wild) y Canihua (*Chenopodium pallidicaule* Aellen) en Ovinos," pp. 166–171. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96., Potosí, Bolivia.

Arze, J. A., and Sotelo, G. (1976). "Epoca Óptima de Corte de Canihua (*Chenopodium pallidicaule* Aellen) para su Uso como forraje," pp. 155–162. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96., Potosí, Bolivia.

Avendaño, J., Ovalle, C., and Franco, I. (1978). "Un Sistema Ovino Propuesto para la Zona Centro-Sur del Secano-Interior. Descripción y análisis económico." Estación Experimental Quilamapu, Sub-Estación Cauquenes, Inst. Invest. Agropec., Bol. Tec. 13., Chile.

*Badilla, S. I. (1975). "Características Ecológicas y Fitosociológicas de *Atriplex repanda* Phil." Facultad de Agronomía, Univ. de Chile. Tesis Ing. Agrónomo. Santiago.

Bishop, J. P. *et al.* (1968). "Estudio de las Especies Espontáneas Psamofilas de la Región de Bahía Blanca en la Alimentación de Ovinos: Análisis Taxonómico y Nutritivo." III Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Trelew, Chubut, Argentina.

Botti, C. (1970). "Relaciones Hídricas del Tamarugo (*Prosopis tamarugo* Phil.) en la Localidad de Canchones." Facultad de Agronomía, Univ. de Chile. Tesis Ingeniero Agrónomo. Santiago.

Braun, O. (1964). "Forrajeras del Altiplano. Bolivia." Servicio Agrícola Interamericano, Boletín Experimental 30.

*Braun W., R. H., and Candia, R. J. (1980). Poder calorífico y contenidos de nitrógeno y carbono de componentes del algarrobal de Ñacuñán (Mendoza). *Deserta* **6,** 91–99. Mendoza, Argentina.

Braun W., R. H., and Lamberto, S. A. (1974). Modificaciones producidas por incendios en la integración de los componentes leñosos de un monte natural. *Rev. Invest. Agropecu. Ser. 2: Biología y Producción Vegetal* **9**(2), 11–24. INTA, Buenos Aires, Argentina.

*Braun, W., R. H., Verettoni, N. H., Gonzalez, M., and Lamberto, S. (1971). "Unidades de Vegetación en la Región Semiarida del Sur Bonaerense." IV Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Santa Rosa, La Pampa, Argentina.

Braun, W., R. H., McKell, C. M., and Lucero, J. C. (1974). "Eficiencia en el Uso de la Humedad Edáfica y Producción de Forraje en un Monte Quemado." IV Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.
Braun, W., R. H., Candia, R. J., and Leiva, R. (1978). Productividad primaria aérea neta del algarrobal de Ñacuñán (Mendoza). *Deserta* **5**, 7–43. Mendoza, Argentina.
Braun, W., R. H., and Candia, R. J. (1980). Poder calorífico y contenidos de nitrógeno y carbono de componentes del algarrobal de Ñacuñán (Mendoza). *Deserta* **6**, 91–99. Mendoza, Argentina.
Brücher, E. (1962). Nuevas especies de *Solanum* (Tuberarium) de la zona semiárida del NW Argentino. *Rev. Fac. Cienc. Agrar., Univ. Nac. Cuyo* **9**, 7–14. Mendoza, Argentina.
Brücher, E. (1965). Las papas indígenas en rápida desaparición en la Argentina. *Cienc. Invest.* **21,** 212–215. Buenos Aires.
*Brücher, H. (1968). Südamerika als Herkunftsraum, *In* E. J. Fittkau *et al.* "Biogeography and Ecology in South America," pp. 251–301. The Hage.
Brücher, E. (1973). Las especies tuberíferas de *Solanum* (papas silvestres) como elemento ecológico-florístico de la vegetación semiárida de Mendoza. *Deserta* **4,** 147–159. IADIZA, Mendoza, Argentina.
Brun, J. M., *et al.* (1971). "Relevamiento Ecológico en Áreas Piloto de la Patagonia." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.
Cabrera, A. L., and Willink, A. (1973). "Biogeografía de América Latina." Programa Regional de Desarrollo Ceintífico y Techológico, Dep. Asuntos Cientificos, OEA, Washington, D.C.
Cadahia, D. (1970). "Informe Sobre el Plan Forestal-Ganadero. Pampa del Tamarugal." Estudio FAO para BID. Corporación de fomento. [Mimeographic report].
*Cairnie, A., and Monesiglio, J. C. (1967). Composición química de especies forrajeras nativas e introducidas en la región semiárida pampeana. *Rev. Invest. Agropecu., Ser. 2* **4**(11), 207–221. INTA, Buenos Aires, Argentina.
Camino, A. (1977). "Monocultivo y Policultivo en las Montañas Tropicales: Un Estudio Preliminar en el Distrito de Cuyo-Cuyo (Provincia de Sandía, Puno)," pp. 44–51. Primer Congreso Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.
Campos, S. L. (1968). "Proyecto estudio entomológico del tamarugo. Insectos asociados con el tamarugo en la Pampa del Tamarugal," pp. 180–185. Facultad de Agronomía, Dep. Biol., Univ. de Chile. Memoria Anual, 1967. Santiago.
Canales, G., and Baldomero, O. (1977). "Características Morfológicas Asociadas al Rendimiento en Oca (*Oxalis tuberosa* Mol.) Bajo Condiciones de Allpachaka (3.600 m.s.m.) Ayacucho," pp. 244–247. Primer Congreso Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.
Cano, E. (1969). Dinámica de la vegetación de un pastizal de planicie de La Pampa. *Rev. Invest. Agropecu., Ser. 2: Biología y Producción Vegetal* **6**(12), 193–223. INTA, Buenos Aires, Argentina.
Cano, E. (1977). Pastizales en la Región Central de la provincia de La Pampa. *IDIA* **331–333,** 1–15. INTA, Buenos Aires, Argentina.
Cano, E., and Fernández, B. (1974). "Mapa de Vegetación de la Provincia de La Pampa." V Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.
Cano, E., and Holgado, H. O. (1971). "Cambios en la Vegetación de un Caldenal Despues de un Fuego." IV Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Santa Rosa, La Pampa, Argentina.
Cano, E., and Olmos, A. (1968). "Mapa de Vegetación del Departamento de Loventue, Provincia de la Pampa." III Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Trelew, Chubut, Argentina.
Cano, J., and Rosas, M. (1976). "Evaluación Cualitativa y Cuantitativa del Comportamiento de Siete Variedades de Quinua," pp. 106–112. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.
*Cano, J. *et al.* (1971). "Cambios en la Vegetación de un Caldenal Despues de un Fuego." IV



Reunion Nacional para el Estudio de las Regiones Arida y Semiáridas, Santa Rosa, La Pampa, Argentina.
*Cardenas, M. (1969). "Manual de las plantas económicas de Bolivia." Cochabamba.
*Cardenas, M. (1971). "El Altiplano Como un Sistema Ecológico," pp. 56–65. Primera Reunión sobre Pastura de los Andes Altos, La Paz, Bolivia.
*Cardozo, A. (1970). "Bibliografía Boliviana de Pastos y Forrajes." Ecuador. Inst. Interamericano de Ciencias Agricolas, Programa de Investigacion, Bol. Informativo 1(1), Suplemento Técnico 2, Turrialba, Costa Rica.
Cardozo, G., Romero, A., Sotomayor, E., and de Navarro, O. T. (1976). "El Cultivo de la Quinua en el Ecuador y Colombia," pp. 26–30. II Convención Inter. Quenopodiáceas, IICA. Infor., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.
Castaño, E. *et al.* (1978). "Diseño de un Sistema para el Desarrollo de los Recursos Naturales de las Lomas de la Costa Peruana." Proyecto Cooperativo en Ejecución de Oficina de Investigaciones de Tierras Aridas, Univ. of Arizona y Univ. Agraria La Molina, Lima, Perú.
Catalán, N. (1973). "Invernada de Novillos Hereford en Pradera Natural de Secano con Suplementación y Termino de Engorda en Dry-Lot con Urea." Facultad de Agronomia, Univ. de Chile. Tesis Ing. Agronomo.
Chaquilla, O. (1976). "Exploración de Herbicidas en el Cultivo de Quinua (*Chenopodium quinoa* Wild.)," pp. 127–129. II Convención Inter Quenopodiaceas, IICA. Inf., Conf., No. 178, Ayacucho, Perú.
Christiansen, J. (1977). "Las Papas Amargas: Fuente de Calorías y Proteinas en los Andes," pp. 201–203. Primer Congr. Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.
Concha, R. (1975). "Consumo y Ganancia de Peso Ovino Durante el Período Primavera-Verano en una Pradera Natural Biestratificada con *Atriplex repanda*." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago.
Contreras, D., and Gastó, J. (1978). "Comparación de Arquitecturas Fitocenósicas en el Secano Mediterráneo de Chile." Facultad de Agronomía, Univ. de Chile, Santiago. [Mimeographic report].
de Cornejo, Z. (1976). "Hojas de Quinua (*Chenopodium quinoa* W.) Fuente de Proteina," pp. 177–189. II Convención Inter. Quenopodiácea, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.
Cortez, H. (1977). "Avances en la Investigación en Oca," pp. 227–243. Primer Congr. Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.
Cosio, F. (1970). "Informe Técnico Anual. Proyecto de Praderas de Secano y Producción Animal, Area Sur." INIA, Est. Exp. Quilamapu, Chillán, Chile.
Cosio, F., and Vicens, J. (1969). "Efectos de la Fertilización de Fósforo de Mantención en Pradera Mejorada sobre la Producción de Lana." XX Jornadas Agronómicas, Chillán, Chile.
Covas, G. (1971). "Arboles y Arbustos Forrajeros Nativos en la Provincia de La Pampa." IV Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Santa Rosa, La Pampa, Argentina.
*Dawson, G. (1960). Los alimentos vegetales que América dio al mundo. *Mus. La Plata, Ser. Tecn. Didact.* **8,** 1–68. La Plata.
De Anchorena, J. (1973). "Relevamiento de vegetación en el Sudoeste del Chubut." II Reunión Argentina de Ecología, Salta, Argentina.
De La Puente, F. (1977). "Desarrollo Tecnológico del Cultivo de la Papa en el Perú," pp. 183–200. Primer Congreso Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.
Del Aguila, J. A., Bernardon, A. E., and Anderson, D. L. (1969). Contribución al estudio de los pastizales naturales de Los Llanos de La Rioja. *Rev. Invest. Agropecu., Ser. 1: Biología y Producción Animal* **6**(7), 81–87. INTA, Buenos Aires, Argentina.
Diaz, H. B. *et al.* (1972a). Estudio de las pasturas naturales e implantación de forrajeras cultivadas

en zonas ganaderas del noroeste Argentino (región semiárida). *Rev. Agrón. Noroeste Argent.* **9**(1), 32–53. Tucumán, Argentina.

Diaz, H. B. *et al.* (1972b). Determinación de la digestibilidad de las especies forrajeras naturales mas comunes y de algunas cultivadas en la zona semiárida del noroeste Argentino. *Rev. Agrón. Noroeste Argent.* **9**(1), 55–68. Tucumán, Argentina.

Digilio, A. P. *et al.* (1971). "Flora Chaqueña." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.

Di Castri, F., and Mooney, H. A. (1973). Mediterranean type ecosystems. Origin and structure. *In* "Ecological Studies," Vol. 7. Springer, New York.

Di Marco, O. N. (1973). "Consumo y Preferencia Ovina Estacional al Aumentar la Intensidad de Pastoreo de un Bioma Biestratificado con *Atriplex repanda*." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago.

*Duplancic, A. M., Gonzalez, S., Rey, E., and Avellaneda, M. (1981). Valor nutritivo de las especies forrajeras comunes de la zona precordillerana del centro de Mendoza. *IV Jornadas de Invest., Univ. Nac. Cuyo, Mendoza.*

Earls, J. (1977). "La Coordinación en la Producción Agrícola en el Tawantinsuyo," pp. 52–78. Primer Congreso Inter. Cultivos Andinos, IICA. Reuniones, Cursos Conferencias, No. 178, Ayacucho, Perú.

Elgueta, S. (1971). "Estudio del Tamarugo (*Prosopis tamarugo* Phil.) como Productor de Alimento para el Ganado Lanar en la Pampa del Tamarugal." Instituto Forestal, Informe Técnico 38, Santiago, Chile.

Elgueta, S., and Calderón, S. (1970). "Estudio del Tamarugo como Productor de Alimento de Ganado Lanar en la Pampa del Tamarugal Informe Técnico." Julio, 1970. Instituto, Forestal, Santiago, Chile.

Etienne, G., de la Caviedes, R., and Contreras, T. (1978). "Nuevo Enfoque en la Evaluación de la Productividad de las Praderas." Facultad de Agronomía, Univ. de Chile, Santiago. [Mimeographic report].

Feldman, I. (1972). "Ecología de la Pampa Central o Distrito del Caldenal. Manejo y Reemplazo del Tapiz Vegetal Leñoso." Ia. Reunión Argentina de Ecología, Vaquerías, Córdoba, Argentina.

Ferrer, I., Silva, E., and Barriga, R. (1977). "Evolución de la Distribución Proteica en una Especie con Mecanismo de Fotosíntesis C-4: *Atriplex repanda*." IX Jornadas Chilenas de Química, Soc. Chilena de Química y Univ. de Chile, Jahuel, Chile.

Fester, G. A. *et al.* (1960). Variedades fitoquímicas en plantas aromáticas Argentinas. *Rev. Fac. Cienc. Agrar.* **8**(2), 45–49. Univ. Nac. Cuyo, Mendoza, Argentina.

Flores, M. A. (1967). "Contribución al Estudio de los Pastos del Altiplano Peruano, Perú." Oficina Nacional de Reforma Agraria, Oficina de Catastros y D.R., Lima, Perú.

Gandarillas, H., and Tapia, G. (1976). "Requerimientos de Fertilizantes en la Quinua; Altiplano Central de Bolivia," pp. 116–123. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

Gastó, J., and Caviedes, E. (1976). Interferencia intraespecífica de *Atriplex repanda* en el secano Mediterráneo de Chile. Facultad de Agronomía, Univ. de Chile. *Bol. Tec.* **41,** 3–18. Santiago.

Gastó, J., and Contreras, D. (1972a). Análisis del potencial pratense de fanerófitas y caméfitas en regiones Mediterráneas de pulviometría limitada. Facultad de Agronomía, Univ. de Chile. *Bol. Tec.* **35,** 30–61. Santiago.

Gastó, C., and Contreras, D. (1972b). Bioma pratense de la región Mediterránea de pulviometría limitada. Facultad de Agronomía, Univ. de Chile. *Bol. Tec.* **35,** 3–29. Santiago.

Gastó, J., and Contreras, D. (1979). Fertilización nitrogenada y precipitación en la productividad de la pradera anual natural del secano Mediterraneo de Chile central. *Avances en Producción Animal* **4**(2), 111–128.



*Gastó, J., and Olivares, A. (1979). Análisis cuantitativo de la arquitectura de *Atriplex repanda* Phil. *Ciencia e Investigación Agrícola* **6**(2), 105–113. Santiago, Chile.

Giordano, O. S. (1979). "Productos Naturales de Compuestas de las Región de Cuyo." VIII Seminario Latinoamericano de Química, Buenos Aires, Argentina.

*Gomez, I., and Morello, J. (1972). "Incremento de la Vegetación Leñosa en el Chaco. El Papel del Vinal (*Prosopis ruscifolia*)." I Reunión Argentina de Ecología, Vaquerías, Córdoba, Argentina.

Gomez, I., Malverez, I., Morello, J., and Gazia, N. (1974). "Efectos de un Herbicida sobre la Problación de *Prosopis ruscifolia*." III Reunión Argentina de Ecología, Puerto Madryn, Chubut, Argentina.

Gomez, I. *et al.* (1973). Caracterización estructural de poblaciones de Vinal (*Prosopis ruscifolia* Gris.). *Rev. Invest. Agropecu., Ser. 2: Biología y Producción Vegetal* **4,** 143–150. INTA, Buenos Aires, Argentina.

Gomez, V. (1966). "Aspectos Generales sobre los Pastos Naturales en las Zonas Alto-Andinas de la Sierra Peruana," pp. 99–101. Inst. Veter. Inv. Tropic. y de Altura, Bol. Extraordinario, Lima, Peru.

González, B. G. (1967). Algunos aspectos sobre la situación de pastos y forrajes en Ecuador. *In* "Sexta Conferencia Interamericana de FAO sobre Producción y Salud Animal." Gainesville, Florida.

González, B. G. (1969). "Recomendaciones Generales para el Cultivo de Pastos en la Sierra." Inst. Nac. Invest. Agropecu., Bol. Divulgativo SC-69-12, Colombia.

*González, N., and Haart, E. (1960). "Análisis de Muestras Diversificadas de *Prosopis tamarugo*." Facultad de Medicina Veterinaria, Univ. de Chile, Informe interno, Santiago, Chile.

Grez, P., and Fernandez, M. (1978). "Encaste Prematuro de Borregas Merino Precoz Francés, Sometidas a Diferentes Planos Nutricionales." Facultad de Agronomía, Univ. de Chile. Tesis Ing. Agr. Santiago.

*Guevara, J. C., Candia, R. J., Mendez, E., and Roig, F. A. (1973). Modificaciones florísticas y producción forrajera invernal del estrato herbáceo de Ñacuñán en un año anormalmente lluvioso. *Deserta* **4,** 125–139. IADIZA, Mendoza, Argentina.

Guevara, J. C. *et al.* (1978). "Inventario de los Recursos Pastorales de la Provincia de Mendoza." VI Reunión Argentina de Ecologia, Corrientes, Argentina.

Hajek, E., and Saiz, F. (1976). Aplicación del método de la sacarosa a la caracterización micro-climática del Parque Nacional Fray Jorge, Chile. *An. Mus. Hist. Nat., Santiago, Chile* **9.**

Hechenleitner, K. M. (1973). "Suplementación Proteica a Vaquillas de Carne en Pradera Natural de Secano Durante la Estación Estival," p. 75. Facultad de Agronomía, Univ. de Chile. Tesis Ing. Agr. Santiago.

Hnatyszyn, D. *et al.* (1974). Estudio fitoquímico de plantas indígenas Argentinas. *Rev. Invest. Agropecu. Ser. 2: Biología y Producción Vegetal* **11**(1), 15–23. INTA, Buenos Aires, Argentina.

Ignacio, Q., Fernandez, A., and Cortes, G. (1976). "Contribución al Estudio Morfológico del Grano de Quinua," pp. 58–68. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

INIA (1977). "Lucha Contra la Desertificación: la Experiencia Chilena." Informe preparado por INIA para UNESCO, Santiago, Chile.

Instituto Ecuatoriano de Recursos Hidráulicos (1977). "El Problema de la Desertificación en la Provincia de Manabi, Ecuador," p. 19. Ministerio de Agricultura, INERHI, Quito, Ecuador.

Instituto Forestal (1971). "Estudio del Tamarugo como Productor de Alimento del Ganado Lanar en la Pampa del Tamarugal." Instituto Forestal, Bol. 38, Santiago, Chile.

Johnson, W. L., Zeppilli, R., and Delgado, D. (1968). "Respuesta a Diferentes Niveles de Alimentación de Vacas Pardo Suizas en Altura." Segunda Reunión Latinoamericana de Producción Animal, Lima, Perú.

*Johnston, M., and Olivares, A. (1976). "Condiciones de Cama de Semilla y Profundidad de Siembra en la Germinación de *Atriplex repanda*." XXVII Jornadas Agronómicas, Santiago, Chile.

*Josifovich, J., Maddaloni, J., Serrano, H., and Echeverria, I. (1982). Areas forrajeras y de producción animal en la Argentina. *Inf. Técnico* No. 169. EERA Pergamino; INTA, Pergamino.

Klein, K. (1970). "Evaluación de la Producción de Frutos en Tamarugos Adultos del Bosque Junoy, Temporada 1969–1970," p. 12. CORFO, Tarapaca. Laboratorio de Entomología, INCONOR, Canchones, Chile.

Klein, K., and Campos, L. (1977). "Biocenosis del Tamarugo (*Prosopis tamarugo* Phil.) con Especial Referencia a los Artrópodos y Fitófagos y Sus Enemigos Naturales," pp. 86–108. *Zeitschrift für Angewandte Entomologie*, Sonderdruck aus Bol. 85 (1977). Verlag Paul Parey, Hamburg, Germany.

Kummerow, J. (1966). Aporte al conocimiento de las condiciones climáticas del bosque Fray Jorge. Facultad de Agronomía, Univ. de Chile. *Bol. Tec.* **24.** Santiago.

Lagomarsino, E. D. *et al.* (1974). Control químico de un renoval en zonas ganaderas del N.W. Argentino. *Rev. Agron. Noroeste Argent.* **11**(3–4), 241–256. Tucuman, Argentina.

Lailhacar, K. (1976). "Effect of Soil Parameters on the Components of Biomass Production in *Atriplex polycarpa* (Torn.) Wats, and *Atriplex repanda* Phil." Univ. of California, Davis. Ph.D. Thesis.

Lamagdelaine, L. (1974). "Antecedentes sobre Forestación y Ganadería en la Pampa del Tamarugal y en el Altiplano de Tarapacá." Depto de Ciencias Sociales, Univ. de Chile, Iquique.

Lamberto, S. A., and Braun, R. H. (1974). Cambio en el estrato bajo de un monte natural inducidos por incendios. *Cienc. Invest.* **30,** 327–333. Buenos Aires, Argentina.

Lanino, R. I. (1966). "Comparación de Tres Razas Ovinas Alimentadas con Tamarugo (*Prosopis tamarugo* Phil.) en la Pampa del Tamarugal." Facultad de Agronomia, Universidad de Chile. Tesis Ingeniero Agrónomo. Santiago, Chile.

Lanino, R. I. (1972). "Instrucciones Generales para la Siemba y Plantación de Tamarugo (*Prosopis tamarugo* Phil.)." [Mimeographic report].

Lanino, R. I. (1976). "Informe Preliminar Sobre el Cultivo de Quinua en el Altiplano Chileno, Zona de Isluga," pp. 24–25. II Convención Inter. Quenopodiaceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

Lara, M. (1972). "Pastos Naturales del Altiplano de Bolivia." LBTA, Bol. 13, La Paz, Bolivia.

*Lara, R. R. (1976). "Algunos Caracteres Sistemáticos Exomorfológicos de Importancia para una Clasificación de Tipos Agronómicos de Quinuas Cultivades." pp. 51–57. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones No. 96, Potosí, Bolivia.

Latour, C. M. (1971). "Nuevo Estudio sobre Gramineas Forrajeras en la Patagonia." IDIA 283. INTA, Buenos Aires, Argentina.

Ledesma, N. R. (1978). "La Degradación Ecológica del Ecosistema en el Chaco." VI Reunión Argentina de Ecología, Corrientes, Argentina.

León, J. C. (1974). "Estudio Comparativo de Espolvoreos y Pulverizaciones para el Control de Insectos del Tamarugo (*Prosopis tamarugo* Phil.)" Facultad de Agronomia, Univ. de Chile. Tesis Ingeniero Agrónomo. Santiago.

Leon, J. C. (1973). "Delimitacion de Comunidades en el Pastizal Puntano y Sus Relaciones con el Pastores." II Reunión Argentina de Ecología, Salta, Argentina.

Lescano, J. L. (1976). "Cariotipo y Poliploidia en Canihua," pp. 81–88. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosi, Bolivia.

Lescano, J. L., and Palomino, C. (1976). "Metodología de Cruzamiento en Quinua." pp. 78–80. II Conv. Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Poposí, Bolivia.

*López Ocaña, C. E. (1978). 'Informe del Proyecto Especial "Desarrollo de Tierras Aridas y Semiáridas" en el Perú.' IIIa. Reunión de Cordinación, OEA, Washington, DC.



Lewis, J. P. (1973). "El Espinal Periestépico." II Reunión Argentina de Ecología, Salta, Argentina.

Lowe, Ch., Morello, J., and Goldstein, G. (1972). "Estructura y Variación de la Vegetación en los Desiertos del Monte y de Sonora. Proyecto: Origen y Estructura de Ecosistemas." Programa Biológico Internacional, I Reunión Argentina de Ecología, Vaquerías, Córdoba, Argentina.

*Luti, R., Galera, F. M., and Bertran, M. A. (1974). "Vegetacion de las Provincia de Cordoba: Una Primera Aproximacion." IIIa. Reunión Argentina de Ecología, Puerto Madryn, Chubut, Argentina.

Lutz, E. E., and Graff, A. B. (1974). "Evaluación de las Pasturas Naturales Resultantes de la Quema Controlada de Monte en la Región Semiárida Pampeana." V Reunión Argentina para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.

MAB-3 (1977). "Descripción, Funcionamiento y Transformación de los Ecosistemas Agropastorales en Bolivia, Chile y Perú para el Benficio del Hombre." Proyecto de Cooperación presentado a UNESCO por Comité MAB-3 de Bolivia, Chile y Perú.

Magoja, J. L. (1975). La composición mineral y su variación estacional de tres forrajeras nativas en La Pampa: *Stipa tenuis* Phil., *Poa ligularis* Nees *ex* Stendel y *Piptochaetium napostaense* Speg. Hacker ag. Stuckert. *Rev. Invest. Agropecu. Ser. 2: Biología y Producción Vegetal* **12**(1), 27–48. INTA, Buenos Aires, Argentina.

Manterola, H., Olivares, A., and Borquez, F. (1979). Efecto de la suplementación con nitrógeno no proteico y la presencia del arbusto *Acacia caven* en la utilización de la pradera natural Mediterránea. *Avances en Produccion Animal* **4**(2), 129–134. Santiago, Chile.

Mateu Amengual, B., and Villa Carenzo, M. (1971). "Catálogo Bibliográfico Fitoquímico Argentino," Vol. II. Miscelanea No. 36. Univ. Nac. de Tucumán, Tucumán, Argentina.

Mediondo, M. E. *et al.* (1973). Estudio fitoquímico de plantas indígenas Argentinas. *Rev. Invest. Agropecu. Ser. 2: Biología y Producción Vegetal* **10**(3), 137–141. INTA, Buenos Aires, Argentina.

Montes, A. L. (1965). "Produccion de plantas aromaticas nativas," pp. 103–111. Reunion de Programacion de Plantas Aromaticas, IDIA, No. 211. INTA, Buenos Aires, Argentina.

Morales, R. A. (1976). "Control de Plagas en Cultivo de Quinua," pp. 131–133. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

Morello, J. H. (1970). Modelo de relaciones en tres pastizales y leñosas colonizadoras en el Chaco Argentino. *IDIA* **276,** 31–52. Buenos Aires, Argentina.

Morello, J. H., and Adamoli, J. (1972). "Vegetacion y Ambiente del Chaco (Argentina)." Ia. Reunion Argentina de Ecología, Vaquerias, Cordoba, Argentina.

Morello, J. H., and Adamoli, J. (1973). Subregiones ecológicas de la provincia del Chaco. *Ecología* **1**(1), 29–33. Buenos Aires, Argentina.

Morello, J. H. *et al.* (1971). "Vegetación y Ambiente en la Provincia de Salta." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.

Morello, J. H., and Gomez, I. (1971). "Uso de Sensores en el Inventario de Recursos y Problemas de Leñosas en el Norte Argentino." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.

Morello, J. H., Lowe, Ch., Goldstein, G., and Luti, R. (1972). "Un Chaparral de Sensibilidad Estival en el Centro de la Argentina." I Reunión Argentina de Ecología, Vaquerías, Córdoba, Argentina.

Morello, J. H., Sancholuz, L. A., and Blanco, C. A. (1974). "Estudio Macroecológico de Los Llanos de La Rioja." V Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.

Muñoz, S. (1972). "Evaluación de la Proporción de Fruto en Tamarugos Adultos." CORFO, Informe Interno, Canchones, Chile.

Narrea, R. A. (1976). "La Producción de Quinua en el Perú," pp. 31–34. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

*Nava, C., Armijo, R., and Gastó, J. (1979). "Ecosistema. La Unidad de la Naturaleza y el Hombre." Serie Recursos Naturales, Univ. Auton, Agraria "A. Narro," Saltillo, México.

Negron, A. A., Alvarez, E., and Calmet, E. (1976). "La Quinua y la Canihua en Raciones de Pollos Parrilleros en Puno, Perú," pp. 172–176. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

*Neumann, E. (1978). "Variación Estacional del Contenido de Caroteno en la Pradera Mediterranea y Su Efecto en el Consumo de Forraje." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago, Chile.

*Neumann, R. (1972). "Productividad en el Chaco Seco, Provincia de Salta." Ia. Reunión Argentina de Ecología, Vaquerias, Cordoba, Argentina.

Neumann, R. (1973). "Perfiles Estructurales de Leñosas y Suculentas del Chaco Semiárido, Provincia de Salta." II Reunión Argentina de Ecología, Salta, Argentina.

Olaechea, V., Nico, R., and Escalante, M. (1964). Sustitución de "regaliz" por raíz y rizomas de *Glycyrrhiza astragalina*. *Rev. Farm.* **106**(5–6), 1–7. La Plata, Argentina.

*Olivares E., A., and Gasto, J. (1971). "Comunidades de Terofitas en Subseres Postaradura y en Exclusion en la Estepa de *Acacia caven* (Mol.) Hook et Arn." Facultad de Agronomía, Univ. de Chile. *Bol. Tec.* **34,** 3–24. Santiago, Chile.

Olivares E., A., and Gasto, J. (1978). Función de cosecha por ovinos de la pradera anual Mediterránea de Chile. *Avances en Producción Animal* **4**(1), 45–54.

Olivares E., A., and Johnston, B. M. (1978). Alternativas de mejoramiento en la emergencia de *Atriplex repanda* (Phil.). Revista de Botanica Internacional, *Øyton* **36**(2), 129–137.

Olivares E., A., and Riveros, E. (1979). Cambios en la composición botánica de la estrata de terófitas residentes de una pradera Mediterránea natural sometida a diferentes épocas y frecuencias de talajeo. *Avances en Produccion Animal* **4**(1), 35–44. Santiago, Chile.

Orionte, Y., and Anderson, D. L. (1976). "Influencia del Fuego en un Area Relicto del Sorgastral." IV Reunión Argentina de Ecología, Río IV, Córdoba, Argentina.

Ortiz Garmendia, J. (1968). "Plantas Tintoreas de las Zonas del Desierto y la Estepa Septentrional Chilenas." Contrib. Arqueol., No. 7. Museo de la Serena, Chile.

Ortiz Garmendia, J. (1969). "Plantas Silvestres Chilenas de Frutos Comestibles por el Hombre." Contribución Arqueol., No. 8. Museo de la Serena, Chile..

Parilo B., J. (1978). "Relaciones Sinecólogicas del Bioma Pratense en Suelos Graníticos de Chile y Productividad Potencial del Ecosistema." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago, Chile.

Pedrani, A. R., and Rodriquez, I. A. (1978). "Siete Años de Evolución en Una Reserva del Piedemonte Árido de Mendoza." VII Reunión Argentina de Ecología, Mendoza, Argentina.

Peralta, P. M. (1977). "Mapa Preliminar de los Procesos y Areas de Desertificación en Chile Continental." Facultad de Ciencias Forestales, Departamento de Silvicultura, Univ. de Chile, Informe Interno.

Pisano, E. (1966). Zonas biogeográficas de Chile. *In* "Geografía Económica de Chile." *Tomo* I, 62–72. CORFO, Chile.

Posnansky, M. (1971). "Aspectos Ecológicos sobre Pastos Nativos del Altiplano," pp. 24–31. Primera Reunión sobre Pasturas de los Andes Altos, La Paz, Bolivia.

Ragonese, A., and Cano, E. (1971). "La Vegetacion de la Provincia de La Pampa." Reunión de Programación sobre Pastizales de la Región Semiárida, Villa Mercedes, San Luis, Argentina.

*Ratera, E. L., and Ratera, M. O. (1980). "Plantas de la Flora Argentina Empleadas en Medicina Popular." Hemisferio Sur, Buenos Aires.

Rique, T. (1974a). "Aplicaciones Industriales de Extractivos de Especies Forestales Indígenas de las Zonas Áridas y Semiáridas del País." V Reunión Nacional para el Estudio de las Regiones Áridas y Semiáridas, Mendoza, Argentina.





Rique, T. (1974b). "Recursos Adicionales para Pobladores de Zonas Áridas y Semiáridas, Aprovechando Extractivos de Leguminosas Forestales." V Reunion Nacional para el Estudio de las Regiones Áridas y Semiáridas, Mendoza, Argentina.

*Riveros, E., Neumann, E., Olivares, A., Manterola, H., and Ramirez, R. (1978). Variaciones estacionales en el contenido de caroteno y proteina de la pradera natural y del forraje consumido por ovinos en ecosistemas semiáridos. *Avances en Produccion Animal* **3**(1), 23–30. Chile.

*Riveros, F. A., Avila, G., Aljaro, M. E., Araya, S., Hoffman, A. E., and Montenegro, G. (1976). Comparative morphological and ecophysiological aspects of two sclerophylous Chilean shrubs. *Flora* **165,** 223–234. Chile.

Riveros, V. E. (1977). "Influencia de las Variaciones Estacionales de Caroteno de la Pradera sobre el Contenido Plasmático de Caroteno y Vitamina "A" y sobre la Producción de Lana y Fertilidad de Machos Ovinos en Ecosistemas Semiáridos." Facultad de Agronomía, Univ. de Chile. Teses M.S. Santiago, Chile.

Rodríguez, D. (1978). "Influencia del Momento de Utilizacion de la Pradera Natural de la Zona Mediterranea Central de Chile en el Consumo Ovino." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago, Chile.

*Roig, F. A. (1964). Las gramineas mendocians del genero *Stipax*. *Rev. Fac. Cienc. Agrar.* **11**(1–2), 3–110. Univ. Nac. de Cuyo, Mendoza, Argentina.

*Roig, F. A. (1970). Flora y vegetacion de la Reserva Forestal de Nacunan. *Deserta* **1,** 25–232. IADIZA, Mendoza, Argentina.

Roig, F. A. (1972). Investigaciones climaxicas. II. Los pastizales disclimaxicos del Melocoton (Mendoza) y nuevas observaciones sobre la biologia de *Schinus polygamus*. *Deserta* **4,** 173–184. IADIZA, Mendoza, Argentina.

*Roig, F. A. (1976). Las comunidades vegetales del piedemonte de la precordillera de Mendoza. *Ecosur* **3**(5), 1–45. Buenos Aires, Argentina.

*Roig, F. A., and Ambrosetti, J. A. (1971). Investigaciones climaxicas. I. Restos de un estrato arboreo bajo de *Schinus polygamus* en la precordillera de Mendoza. *Deserta* **2,** 115–130. IADIZA, Mendoza, Argentina.

Roig, F. A. (1972). Investigaciones climáxicas. II. Los pastizales disclimáxicos del Melocotón (Mendoza) y nuevas observaciones sobre la biología de *Schinus polygamus*. *Deserta* **4,** 173–184. IADIZA, Mendoza, Argentina.

*Roig, F. A. *et al.* (1972). "Investigaciones Climáxicas. II. Los Pastizales disclimácicos del Melocotón, Mendoza y Nuevas Observaciones sobre la Biología de *Schinus polyganus*." II Reunión Argentina de Ecologia, Salta, Argentina.

Rojas, W. (1978). "Relaciones Sinecológicas del Bioma Pratense en Suelos de Terraza Marina de Chile y Productividad Potencial del Ecosistema." Facultad de Agronomía, Univ. de Chile, Tesis M.S., Santiago, Chile.

Rondina, R. V. D. *et al.* (1971). Estudio fitoquímico de plantas indígenas Argentinas. III. *Rev. Invest. Agropecu. Ser. 2: Biología y Producción Vegetal* **8**(1), 29–33. INTA, Buenos Aires, Argentina.

Ruiz Leal, A. (1965). Notas fanerogámicas mendocinas. II. *Rev. Fac. Cienc. Agrar.* **12**(2), 181–200. Univ. Nac. Cuyo, Mendoza, Argentina.

Ruiz Leal, A. (1972a). Flora Popular Mendocina. *Deserta* **3,** 3–296. IADIZA, Mendoza, Argentina.

Ruiz Leal, A. (1972b). Los confines boreal y austral de las provincias patagónica y central respectivamente. *Reedición Especial del Suppl. Bol. Soc. Arg. Bot.* **13,** 89–118. IADIZA, Mendoza, Argentina.

Ruthsatz, B. (1977). Pflanzengesellschaften und ihre Lebensbedingungen in den Andinen Halbwusten Nordwest-Argentiniens. *Dissertationes Botanicae* **39.** J. Cramer, Vaduz, Liechtenstein.

Santo, R., *et al.* (no date). "Comportamiento de Especies Forrajeras Nativas e Introducidas en el Oeste de La Pampa." Hoja informativa, INTA, Rama Caida, San Rafael, Mendoza, Argentina.

*Saravia, T. C. (1973). "Informacion Ecologica Cuantitativa del Efecto de Pastoreo y Explotacion Forestal en Bosques de Quebracho en la Provincia de Salta." II Reunion Argentina de Ecología, Salta, Argentina.

Schenckel, G. *et al.* (1971). Exploración de deficiencias nutritivas con suelos en macetas. II. Cálculo de las lineas de fertilidad sobre el diagrama de fertilidad. *Agric. Tec.* **31,** 106–115. Chile.

Schulz, A. G. (1963). Plantas y frutos comestibles de la región chaqueña. *Rev. Agron. Noroeste Argent.* **4**(1), 57–83. Tucumán, Argentina.

Segarra, F. (1979). "Caracterización de la Curva de Crecimiento de Pradera Natural en el Secano Interior Mediteraneo." Facultad de Agronomía, Univ. de Chile. Tesis Ing. Agr., Santiago, Chile.

Segura, B. M. (1976). Métodos de evaluación de pasturas naturales. *In* "Programación de la Investigación," pp. 33–47. Programa Andes Altos, IICA–OEA, La Paz, Bolivia.

Sejzer, D. (1973). Variación del caracteres estructurales y funcionales en comunidades vegetales chaqueñas. *Ecología* **1**(1), 25–28. Buenos Aires, Argentina.

Serra, J. (1970). Pasturas en Tierra del Fuego. *IDIA* **272,** 7–14. INTA, Buenos Aires, Argentina.

Silva S., E., and Pereira, C. (1976a). Aislación y composición de las proteinas de hojas de *Atriplex nummularia* y *Atriplex repanda. Cienc. Invest. Agrar.* **3,** 169–174. Santiago, Chile.

Silva S., E., and Pereira, C. (1976b). Concentrados proteicos de hojas de *Atriplex nummularia. Cienc. Invest. Agrar.* **3,** 153–157. Santiago, Chile.

Soriano, A. (1973). "Efecto de Diecinueve Años de Clausura sobre el Pastizal de *Stipa* del Oeste de la Provincia de Chubut." II Reunión Argentina de Ecología, Salta, Argentina.

Soriano, A. (1974). "La Producción de Fitomasa en el Pastizal de *Stipa speciosa* del Sudoeste del Chubut." V Reunión Nacional para el Estudio de las Regiones Áridas y Semiáridas, Mendoza, Argentina.

Soriano, A. *et al.* (1978). "Vegetación Actual y Vegetación Potencial en el Pastizal de Coiron Amargo en el S.W. de Chubut. Tendencias Registradas en Hipótesis Propuestas." VI Reunión Argentina de Ecología, Corrientes, Argentina.

Soriano, A., and Brun, J. (1973). Valorización de campos en el centro-oeste de la Patagonia: desarrollo de una escala de puntaje. *Rev. Invest. Agropecu., Ser. 2: Biología y Producción Vegetal* **10**(5), 173–186. INTA, Buenos Aires, Argentina.

Souto, J., and Eilberg, B. A. (1972). Efecto de extractos de hojas de vinal (*Prosopis ruscinfolia* Griseb.) sobre la germinación y el crecimiento de plántulas de varias especies cultivadas. *Rev. Invest. Agropecu., Ser. 2: Biología y Producción Vegetal* **9**(1), 19–27. INTA, Buenos Aires.

Suarez de Castro, F. (1977). "La Desertificación en América Latina desde una Perspectiva Ecológica y Agrícola." Reunión Preparativa Regional para América, IICA, Febrero (1977), Santiago, Chile.

*Sudzuki, H. F. (1969). "Absorcion Foliar de Humedad Atmosférica en Tamarugos (*Prosopis tamarugo* Phil.)." Estación Experimental Agronómica, Bol. Tec. 30, Facultad de Agronomía, Univ. de Chile, Chile.

Sudzuki, H. F. (1975). "Captación y Economía del Agua en Plantas que Viven en Ambientes de Desierto." Estación Experimental Agronómica, Bol. Tec. 40, Facultad de Agronomía, Univ. de Chile, Santiago.

Sudzuki, H. F., Botti, C., and Acevedo, E. (1973). "Relaciones Hídricas del Tamarugo (*Prosopis tamarugo* Phil.) en la Localidad de Canchones." Estación Experimental Agronómica, Bol. Tec. 37, Facultad de Agronomía, Univ. de Chile, Santiago.

Tapia, M. E. (1976). "Sistema de Producción Ganadera en Base a Pastizales y *Avena*-Alfalfa, en el Altiplano de Puno," pp. 16–32. Programación de la Investigación, Programa Andes Altos, IICA–OEZ, La Paz, Bolivia.

Tapia, M. E. (1977). "Características de los Sistemas Agrícolas Andinos." pp. 90–103. Primer Congreso Internacional de Cultivos Andinos, Univ. Nacional San Cristóbal-Huamanga, Ayacucho, Perú.



Telleria, W. (1976). "La Quinua y Cañihua en Bolivia," Vol. II, pp. 21–23. Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

Telleria, W., and Ballón, E. (1976). "Componentes de Rendimiento en Quinua." Vol. II, pp. 96–101. Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

Tinto, J. C. (1974). "Recursos Forrajeros Leñosos para Zonas Áridas y Semiáridas." V Reunión Nacional para el Estudio de las Regiones Aridas y Semiáridas, Mendoza, Argentina.

*Toro, J. M. (1967). "Desarrollo Radical del Tamarugo." Facultad de Agronomía, Univ. de Chile. Informe Interno. Santiago.

*Toursarkissian, M. (1980). "Plantas medicinales de la Argentina." Hemisferio Sur, Buenos Aires.

Trivelli R., A. (1973). "Fertilización, Época y Frecuencia de Utilización en la Bioma Biestratificada de *Atriplex repanda* Phil. y Terófitas Residentes." Facultad de Agronomía, Univ. de Chile. Tesis M.S. Santiago.

United Nations (1977). "World Map on Desertification." FAO, UNESCO, OMM.

Uslar, R. (1972). "Estudio de la Efectividad de Algunas Cepas Nativas de *Rhizobium trifolii* en Simbiosis con *Trifolium subterraneum.*" Facultad de Agronomía, Univ. de Concepción. Tesis Ing. Agrónomo. Chillán, Chile.

Vargas, V. (1978). "Manual para Preparar Medicamentos a Base de Hierbas." Ier. Seminario Nacional sobre Tecnologías Adecuadas, Ayacucho, Perú.

Vicens, O. J., and Cosio, F. (1968). "Resumen de Investigación en Praderas de Secano en el Campo Experimental Collipulli." INIA, Chile. [Inédito].

Vicens, O. J., and Cosio, F. (1970). "Productividad Potencial de Gramíneas con Distintos Niveles de Nitrógeno en el Secano Central." INIA, Chile. [Unpublished].

Viirsoo, E. V. (1967). Comportamiento de especies silvestres tuberíferas y de formas autóctonas del género *Solanum* en las Montañas de Catamarca. *IDIA* **231,** 16–31. INTA, Buenos Aires, Argentina.

*de Vizcarra, I. A. (1972). "Bibliografia de Pastos y Forrajes de los Andes Altos." IICA, La Paz, Bolivia.

Vorano, A. E., and García, R. C. A. (1976). "La Quinua (*Chenopodium quinoa*) en la Provincia de Jujuy. Informe Preliminar de Su Situación Actual y Perspectivas Futuras." pp. 19–20. II Convención Inter. Quenopodiáceas, IICA. Inf., Conf., Cursos Reuniones, No. 96, Potosí, Bolivia.

*Wainstein, P. (1974). "Valor Nutritivo de Plantas Forrajeras del este de la Provincia de Mendoza," Vol. III. V. Reunión Nacional para el Estudio de Zonas Aridas y Semiáridas. I Encuentro de la Zona Arida Latinoamericana. Mendoza, Argentina.

*Wainstein, P., and Gonzalez, S. (1962). Valor forrajero de trece especies de *Stipa* de Mendoza. *Rev. Fac. Cienc. Agrar.* **9**(1), 3–18. Univ. Nac. de Cuyo, Mendoza, Argentina.

Wainstein, P. *et al.* (1974). "Valor Nutrilivo de Plantas Forrajeras del Oeste de la Provincia de Mendoza," Vol. III. V Reunión Nacional para el Estudio de Zonas Áridas y Semiáridas. I Encuentro de la Zona Árida Latinoamericana, Mendoza, Argentina.

Wainstein, P., Gonzalez, S., and Rey, E. (1979). Valor nutritivo de plantas forrajeras de la provincia de Mendoza. III. *Cuaderno Técnico* **2,** 97–108. IADIZA, Mendoza, Argentina.

Wernli, K., Silva, C. M., and Trucco, A. (1976). "The Nutritive Value of Range Pastures in Chile," pp. 149–157. I Mediterranean Grasslands of Central Chile. Proc. First International Symposium Feed Consumption, Utah State Univ., Logan.

Zuccardi, R. (1974). "El Ecosistema de Los Valles Calchaquies." III Reunión Argentina de Ecología, Puerto Madryn, Chubut, Argentina.

Zuñiga F., M. (1973). "Determinación de Curvas de Crecimiento en *Atriplex repanda* Phil. en Función de las Densidad Poblacional." Facultad de Agronomía, Univ. Católica de Chile. Tesis Ing. Agr. Santiago.