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Shrub control and seeding influences on grazing capacity in Argentina

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Abstract

Total vegetation cover, forage species cover, litter cover, and carrying capacity were determined during 3 growing seasons (1979-80, 1980-81, and 1981-82), for plots cleared of shrubs with or without sowing of native grasses in a site characteristic of the Monte Phytogeographical Province in mid-west Argentina. We tested the hypothesis that shrub removal with or without sowing of native grasses increases aerial cover of forage, especially species capable of quick establishment ("pioneers"), that ultimately results in a greater carrying capacity. When shrubs were removed and the cut material was left on the soil surface, average cover of forage species increased 156% over the control at the end of the third growing season. Increased carrying capacity (229%) also resulted from shrub control on the study area. Sowing with grasses produced a response in only 1 species. Thus, shrub control with or without additional sowing of native grasses appears capable of improving the carrying capacity of shrub communities of low forage value, typical of this temperate arid zone.

Key Words: *Larrea cuneifolia*, forage grasses, litter, carrying capacity, arid ecosystem

The Monte Phytogeographical Province in Argentina comprises 414,000 km^2. It is characterized by a dominant shrub layer coexisting with an herbaceous layer which consists mainly of perennial grasses (Morello 1958, Cabrera 1976). The Biosphere Reserve of Ñacuñan (Mendoza, Argentina) is an area (12,282 ha) located within this province. Annual rainfall (15-yr average) recorded at the study site is 311 mm, most of which is received in summer (Estrella et al. 1980).

Communities dominated by jarilla (*Larrea cuneifolia* Cav.) cover more than 10% of the surface of the reserve, which is common to a wide area of cattle breeding in western Argentina. Jarilla (a nonforage shrub for livestock) forms nearly monospecific communities (Roig 1971), which prevail in areas of clayey soils. These communities typically have a low carrying capacity. Anderson et al. (1957) showed that as creosotebush (*Larrea tridentata* [Sesse & Mocino ex DC.] Coville) densities increased, perennial grass densities declined in southern Arizona. The same situation is common in the rangelands of western Argentina. Shrub control may help to increase the carrying capacity of such areas for grazing animals.

We tested the hypothesis that removing shrubs, with or without sowing of native grasses, increases cover of forage species especially those capable of quick establishment ("pioneers"), which ultimately results in a greater livestock carrying capacity.

Materials and Methods

This study was conducted in the Biosphere Reserve of Ñacuñan, Mendoza, Argentina (34° 02′ S Lat., 67° 58′ W Long., 572 m elevation), during the growth periods (September–April) of 1979–80, 1980–81, and 1981–82. During the past 21 years, the study area has been ungrazed by domestic animals. Soils are alluvial in origin, (sandy, mixed, *Typic Torrifluvents)* and horizons are not differentiated. Soils have a top layer of clay, (0–40 cm) and a sandy texture at greater depths (Tanquilevich 1971). Rainfall data from a station 1,900 m northwest of the study site were examined for the periods July–June for the annual precipitation and September–April for the precipitation during the growing season of the study.

Treatments were arranged in a latin square design with 4 replicates each. Plots were 12 × 12 m and 5 m from one another. The following treatments were established: Control (intact plots), intact-sown, cleared-unsown, and cleared sown. In "cleared" plots, shrubs were removed at crown level with axes. Fallen shrub material was then cut into pieces 40–50 cm long to simulate the action of a roller chopper. This material was scattered on the soil surface to obtain a mulch.

We sowed plots with a mixture of 7 grass species to determine adaptability: pasto amargo (*Pappophorum caespitosum* R. Fries), pasto de hoja (*Trichloris crinita*[Lag.]Parodi) pasto algodón (*Digitaria californica* [Benth.] Henrard), cola de zorro (*Setaria leucopila* [Scribner et Merrill] K. Schumann), pasto dulce (*Diplachne dubia* [H.B.K.] Scribn.), flechilla (*Aristida mendocina* Philippi), and esporobolo (*Sporobolus cryptandrus* [Torr.] A. Gray). These species were harvested at the study site in 1978.

The number of seeds of each species in the mixture was calculated to potentially achieve 100% cover by considering germination percentages, viability, and purity, and then raked into the soil manually.

Seeds were scattered on the soil surface by hand after being mixed with fine sand to obtain uniformity of dispersion.

Total aerial cover, forage species cover, and litter cover were determined using the point quadrat method (Daget and Poissonet 1971) modified for the Monte area by Passera et al. (1983). Fixed transects were established along the diagonals of each plot and a total of 200 points (15 cm apart) were observed on the 2 transects. Carrying capacity of each treatment (expressed in hectares per cow equivalent [Cocimano et al. 1973]) was also determined by the point quadrat method (Passera et al. 1983). Observations were made in September of 1979 (initially) and at the close of the growth periods (May–June) of 1979–80, 1980–81, and 1981–82, which appear in the tables as 1979, 1980, 1981, and 1982, respectively.

Cover values of the most important species (pasto amargo and pasto de hoja) were analyzed individually while those of pasto algodón, cola de zorro, pasto dulce, flechilla, esporobolo, *Neobouteloua lophostachia* (Gris.) Gould, *Scleropogon brevifolius* Phil., *Stipa tenuis* Phil., *Lecanophora heterophylla* (Cav.) Krapovickas, *Glandularia mendocina* (Phil.) Covas et Schnack, *Phacelia artemisioides* Gris., *Spaeralcea miniata* (Cav.) Spach., and *Pitraea cuneato-ovata* (Cav.) Caro, were analyzed together as "other forage species".

Data were subjected to analysis of variance (ANOVA), and difference between means were tested using Tukey's test. Angular transformations were made for the analysis of percentage data.

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Results and Discussion

Vegetation Cover

In September 1979, before treatment, all 16 plots had similar values of total aerial cover, and forage species aerial cover (Table 1), and litter cover (data not shown). Mean total cover was similar among treatments in 1979–80 and 1980–81 but cleared-sown plots had about 28% more total cover than the other treatments in 1981–82 (Table 1).

Table 1. Total and forage aerial plant cover (%), for different treatments, at the Biosphere Reserve of Ñacuñán, mid-west Argentina (n=4). Data from 1979 correspond to initial state.

	Total species cover				Forage species cover			
Treatment	1979	1980	1981	1982	1979	1980	1981	1982
	%				%			
Control	46 a	50 a	51 a	49 a	10 a	14 a	15 a	16 a
Intact-sown	53 a	56 a	48 a	51 a	10 a	15 a	20 ab	21 a
Cleared-unsown	48 a	46 a	44 a	48 a	10 a	33 ab	38 bc	41 b
Cleared-sown	54 a	51 a	53 a	63 b	13 a	35 b	40 c	53 b

Means in the same column followed by the same letter are not significantly different at the 0.05 probability level, according to Tukey's mean separation test.

The total percentage of plant cover (with $\alpha = 0.05$) does not show significant differences on the sowed and nonsowed areas—cleared or not—during the first 3 years.

Forage species cover showed significant increases after the shrub control treatments (Table 1). Cleared-sown plots, were significantly higher beginning in the first year post treatment, but cleared-unsown plots were significant only in the last 2 years. This difference was mainly due to cover increases in pasto amargo and "other forage species" when shrubs were controlled. The nonsignificant difference in forage species cover between cleared unsown and cleared-sown plots during the study suggests the existence of a substantial natural seed bank of these native grasses in the exclosures. Only pasto de hoja had a better response in the cleared-sown treatment than in the cleared-unsown (Table 2).

Pasto amargo had the greatest cover values among all forage species with the shrub control treatments in 1980–81 and 1981–82. The heliophytic characteristics of this species may have contributed to this response (Roig 1971).

Cover of "other forage species" under the shrub removal treatments was greater 1979–80 and 1981–82. This may have been related to the greater rainfall received during those years (Table 4). This did not occur in the treatments without clearing, probably due in part to the potential competitive interference with the shrub layer. In similar ecosystems, Passera and Borsetto (1989) found a high degree of competition for aerial and underground space between zampa (*Atriplex lampa* Gillies ex Moq.) and other species.

Jarilla cover increased by 8% from resprouting at the end of the third year, which is a fifth of the initial cover (36–40%). Similar results were obtained by Tanner et al. (1988) after a single pass of a roller chopper or web plow for saw-palmetto (*Serenoa repens* [Bartr.] Small) control in southern Florida.

Table 3. Total aerial cover of "other forage species" (%), for different treatments, at the Biosphere Reserve of Ñacuñán, mid-west Argentina (n=4). Data from 1979 correspond to initial state.

	"other forage species"			
Treatment	1979	1980	1981	1982
	%			
Control	6.8 a	6.8 a	5.5 a	7.6 a
Intact-sown	4.5 a	1.5 a	6.5 a	7.4 a
Cleared-unsown	6.0 a	21.5 b	13.4 b	14.5 ab
Cleared-sown	7.6 a	18.4 b	12.4 b	23.1 b

Means in the same column followed by the same letter are not significantly different at the 0.05 probability level, according to Tukey's mean separation test.

Litter cover, on the average was 60% greater in cleared versus uncleared plots at the end of 1979–80 as a result of chopping. Litter is a component of the soil system that acts as a soil physical conditioner and chemical improver, since it brings about a better mineral cycling (Clark and Paul 1970, Charley 1972).

Table 4. Annual and September-April accumulated rainfall record of 1979–80, 1980–81, and 1981–82 vegetation seasons.

Years	Annual rainfall Jul–Jun	Rainfall Sept.–Apr.
	(mm)	(mm)
1979–80	414	371
1980–81	277	276
1981–82	360	306

Data from a station 1900 m northwest of the study site.

This mulch might favor seed germination and establishment of newly emerged seedlings by moderating sunlight, wind, and evapotranspiration effects. Springfield (1972) showed, for example, that different types of mulch improved conservation of soil moisture, decreased thermal fluctuations, and increased germination of fourwing saltbush (*Atriplex canescens* [Pursh] Nutt.) and winterfat (*Eurotia lanata* [Pursh] Moq.).

Pasto amargo and pasto de hoja are the species that contribute most to an increase in forage cover. They behave as pioneers, occupying most of the space from which shrubs were removed. After, the third growing season, we observed that shrub regrowth (without any establishment of jarilla from seed) caused a recovery of shrub cover to about 25% of the control. Furthermore it was accompanied by an herbaceous layer made up mostly of grasses.

Grazing Capacity

The increased herbaceous layer in the cleared plots resulted in an increased carrying capacity in these treatments (Table 5). Similar studies conducted in other areas of this Reserve having higher forage species cover (45%) and a carrying capacity of 5.13 ha/cow equivalent did not show; however, increases either in cover of

Table 2. Aerial cover of pasto amargo and pasto de hoja (%), for different treatments, at the Biosphere Reserve of Ñacuñán, mid-west Argentina (n=4). Data from 1979 correspond to initial state.

	pasto amargo				pasto de hoja			
Treatment	1979	1980	1981	1982	1979	1980	1981	1982
	%				%			
Control	2.0 a	5.8 a	8.2 a	6.3 a	1.2 a	1.3 a	2.0 a	1.8 a
Intact-sown	3.3 a	6.0 a	4.5 a	7.3 a	0.1 a	0.5 a	1.7 a	0.7 a
Cleared-unsown	4.5 a	12.8 a	31.3 b	33.7 b	0.8 a	1.3 a	1.2 a	1.2 a
Cleared-sown	3.0 a	18.3 a	29.3 b	31.0 b	2.8 a	3.5 a	7.3 b	5.7 b

Means in the same column followed by the same letter are not significantly different at the 0.05 probability level, according to Tukey's mean separation test.

Table 5. Carrying capacity (ha/cow equivalent), for different treatments at the Biosphere Reserve of Ñacuñán, mid-west Argentina (n=4). Data from 1979 correspond to initial state.

Treatment	1979d	1980	1981	1982
	ha/cow Equivalent			
Control	43 a	21 a	28 a	16 a
Intact-sown	42 a	31 a	20 a	28 a
Cleared-unsown	47 a	18 a	22 a	7 b
Cleared-sown	39 a	7 b	7 b	5 b

Means in the same column followed by the same letter are not significantly different at the 0.05 probability level, according to Tukey's mean separation test.

forage species or in carrying capacity after shrub control treatments (Passera, unpublished data). The lack of response to shrub removal in the latter case, was due to the very low shrub coverage. Thus, the elimination of these few shrubs did not benefit the remaining forage species. Shrub control with or without additional sowing would then be only advisable in areas with low forage species cover and poor carrying capacity.

Management Implications

The results lead us to recommend shrub control where nonforage vegetation cover is high. Although shrub removal was done manually, we simulated the action of a roller chopper. Thus the use of a roller chopper should work on a larger scale.

Although sowing was not generally successful, we think sowing to grasses could be an important complement to brush clearing if the soil seed bank has been depleted.

Literature Cited

Anderson, D., L.P. Hamilton, H.G. Reynolds, and R.R. Humphrey. 1957. Reseeding desert grassland ranges in southern Arizona. Ariz. Agr. Exp. Sta. Bull. 249.

Cabrera, A.L. 1976. Regiones fitogeográficas argentinas. Enciclopedia Argentina de Agricultura y Jardineria. Fasciculo I. Buenos Aires.

Charley, J.L. 1972. The role of shrubs in nutrient cycling, p. 182–203. *In:* C. McKell, J.P. Blaisdell, and J.R. Goodin (eds.) Wildland shrubs—Their biology and utilization. USDA-Forest Serv. Gen. Tech. Rep. INT-1 Ogden, Utah.

Clark, F.E., and E.A. Paul. 1970. The microflora of grassland. Adv. Agron. 22:375–435.

Cocimano, M., A. Lange, and E. Menvielle. 1973. Equivalencias ganaderas para vacunos de carne y ovinos (escalas simplificadas). Publicaciones (Técnicas de AACREA, Buenos Aires.

Daget, Ph., and J. Poissonet. 1971. Une méthode d'analyse phytologique des prairies. Annales Agronomiques 22:5–41.

Estrella, H.A., V.A. Heras, and V.A. Guzzetta. 1980. Registro de elementos climáticos en áreas criticas de la provincia de Mendoza. Cuaderno Técnico IADIZA 1-79:49-71.

Morello, J. 1958. La Provincia Fitogeográfica del Monte. Opera Lilloana 2:1–155.

Passera, C.B., A.D. Dalmasso, and O. Borsetto. 1983. Método de "Point Quadrad Modificado", p. 135–152. *In:* R. Candia, and R. Braun (eds.) Taller sobre arbustos forrajeros de zonas áridas y semiáridas, Mendoza, Argentina.

Passera, C.B., and O. Borsetto. 1989. Aspectos ecológicos de *Atriplex lampa*. Investigación Agrária, Prod. y Prot. Veg. 4:179–198.

Roig, F.A. 1971. Flora y vegetación de la Reserva Forestal de Ñacuñá. Deserta. 1:25–232.

Tanner, G.W., J.M. Wood, R.S. Kalmbacher, and F.G. Martin. 1988. Mechanical shrub control on flatwoods range in south Florida. J. Range Manage. 41:245–248.

Tanquilevich, R. 1971. Los suelos de la Reserva Ecológica de Ñacuñá. Deserta. 2:131–206.

Springfield, H.W. 1972. Using mulches to establish woody chenopods, p. 382–391. *In:* C. McKell, J.P. Blaisdell, and J.R. Goodin (eds.) Wildland shrubs—Their biology and utilization. USDA Forest Serv. Gen. Tech. Rep. INT-1, Ogden, Utah.