Native Grassland Improvement on Basaltic and Granitic Soils in Uruguay[1]

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Abstract

Soils over basaltic and granitic materials cover an important area. Range derived from such soils, show moderately low productivity. Phosphatic fertilization and surface seeding of legumes, is an alternative to increase productivity. Different experiments consitently show improvements from 50 to more than 100 % in forage yield, quality, as well as an interesting successional trends of the vegetation on both soil types.

[1] Presented at the Fifth International Rangeland Congress (Salt Lake City, Utah, July 23-28, 1995).

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Introduction

Basaltic and granitic soils of Uruguay cover 4,028,800 ha (25%) and 2,192,000 ha (13%) respectively. Medium to deep soils are aproximately 50% with moderately low pH (5.3 - 5.5), in both cases being deficient in phosphorus (P) and nitrogen (N).

Cattle and sheep husbandry is mainly based on native pastures, dominated by C_4 grasses, some forbs and brushes; legumes are in very low frequency (<1%), varying according to soil type.

Such ranges present severe winter deficits, with forage annual production and quality, medium to low (4.800 kg ha^{-1} on deep basaltic soils and 3,150 kg ha^{-1} on medium granitic ones).

Introduction of adapted legumes is a mean to improve forage yield and quality. For the establishment and persistence of the introduced species, fertilization with P at sowing and periodically is required and grazing management must be directed to enhance such species (Millot et al., 1987).

The objectives of this paper are to discuss the effects of such improvement, on primary productivity and the dynamics of vegetation on both native pastures.

Materials and Methods

a) On a native pasture of a typical deep basaltic soil, Brunosol eutrico (MGAP, 1976), a mixture of white clover *(Trifolium repens)*, cv 'E. Zapicán' at 2 kg ha^{-1} and birdsfoot trefoil (*Lotus corniculatus*) cv 'San Gabriel' at 8 kg ha^{-1}, was seeded at 2 cm depth using a grassland sodseeder. Initial P fertilization was of 60 kg P_2O_5 ha^{-1}, while 40 kg P_2O_5 ha^{-1} were applied every year.

Canopy was preconditioned to reduce competition before the fall seeding, by alternated grazings of hoggets (12 animals ha^{-1}). (Risso,1991).

Vegetation dynamics was evaluated by the modified double meter method (Daget and Poissonet, 1971), employing a 50 m transect with fixed extremes and points every 50 cm. Presence and relative frequency of the species were estimated.

Seasonal forage growth was estimated using exclosure cages, and herbage mass, by cutting a 5 x 0,07 m strip at 1 cm heigh, with electric hand shears (Frame, 1981).

Table 1. Annual forage production (kg DM ha^{-1}) of a native pasture and the same, improved with P and oversown legumes.

	1988	1989	1990	1991	1992	1993	Mean
Native Pasture	3878	2928	5658	6250	5407	3830	4658 ±1295
Oversown pasture	5476	6665	5707	8391	6367	8024	6772 ±1198

b) On a typical medium granitic soil, Brunosol subeútrico (MGAP,1976) a study of the vegetation was performed in an experiment started in 1993, evaluating the effect of grazing management on the behaviour of two improved pastures. These, resulted from the oversowing of either a mixture of white clover cv 'E. Zapicán' and birdsfoot trefoil cv 'San Gabriel' (at 4 and 12 $kgha^{-1}$) or annual lotus cv 'El Rincón' at 5 kg ha^{-1} fertilized with 45 kg P_2O_5 ha^{-1} $year^{-1}$. The layout of the experiment is arranged in an incomplete factorial, with two replicates.

Vegetation dynamics was also evaluated by the double meter method through 12 m transects totalling 50 points per treatment.

The Spearman's coefficient of Rank Correlation (Steel and Torrie, 1981) was used to compare vegetations within each experiment.

Table 2. Botanical composition of native and improved pastures for different years and seasons. Species with a relative frequency higher than 5%.

Species		Winter 1989 Native	Winter 1989 Improv.	Spring 1993 Native	Spring 1993 Improv.
Andropogon ternatus (spr) Nees	WS P	5,95	0,52	15.44	0,00
Aristida uruguayensis Henr.	WS P	8,33	0,52	8,09	0,46
Bothriochloa laguroides (DC) Herter	WS P	4,76	0,00	5.88	5,07
Carex spp.	CS P	16,67	4,12	2.94	2,76
Dichondra microcalyx (Hall.)	WS P	2,38	7,22	0.00	2,30
Lolium multiflorum Lam.	CS A	0,00	7,73	0,00	23,50
Lotus corniculatus L.cv 'San Gabriel'	WS P	0,00	5,67	0,00	0,46
Paspalum notatum Fluegge	WS P	10,71	0,00	12,56	0,00
Piptochaetium stipoides (Trin.et Rupr.)	CS P	4,76	2,58	1.47	5,99
Poa lanigera Nees	CS P	1,19	17,53	0,00	4,61
Schizachyrium spicatum (Sp.) Herter	WS P	2,38	0,52	9,56	0,46
Stipa setigera Presl.	CS P	21,43	9,79	10,28	5,99
Trifolium repens L.cv 'Bayucuá'	CS P	0,00	9,79	0,00	17,51
Vulpia australis (Nees) Blom.	CS A	0,00	21,13	0,00	8,29

WS = Warm-season CS = Cool-season A = Annual P = Perennial

Results and Discussion

a) Basaltic soils: annual primary production of both pastures types, is shown in Table 1.

Variation among years is mainly due to rainfall. Annual average is about 1300 mm, with somewhat more rain in summer, but due to the higher potential evapotranspiration, frequently occur periods of water deficits at this time.

Annual forage yield is almost 50% higher in the improved pasture, that also show higher stability among years.

Largest differences in seasonal production occur in winter when the improved pasture outyields the range by more than twofold. During summer, this situation reverses, due to the dominance of the range by C_4 grasses (70%), quality being lower. Mean annual Crude Protein content is higher in the improvement (16,5%) than in the range (7,86%).

Table 3. Botanical composition of the native and improved pastures, during winter 1994. Species with a relative frequency higher than 5%.

Species		Natural Pasture	Lotus Subbi.	L.corn. + T.rep.
Axonopus affinis Chase	WS P	4,64	6,40	0,51
Carex spp	CS P	17,25	9,02	7,43
Chevreulia sarmentosa (Pers.)Blake	CS P	9,38	0,00	0,51
Lotus corniculatus L.cv 'San Gabriel'	WS P	0,00	0,00	5,37
Lotus subbiflorus cv 'El Rincón'	CS A	0,00	35,35	0,00
Micropsis spathulata (Pers)Cabr.	CS A	7,77	0,00	0,00
Trifolium repens L.cv 'E.Zapicán'	CS P	0,00	0,00	26,23
Vulpia australis (Nees)Blom.	CS A	9,38	10,03	14,67

WS = warm season CS = cool season A = annual P = perennial

Important differences in botanical composition of both vegetations occured, in different years and seasons, (Table 2).

For winter 1989 and spring 1993, both vegetations are significantly different (p<0,05). In addition to white clover, there is an increase in winter native species like *Poa lanigera* (high quality perennial) and *Vulpia australis*, as well as some naturalized ones, like *Lolium multiflorum* (annual ryegrass).

Warm season species like *Paspalum notatum*, *Andropogon ternatus* and *Aristida uruguayensis* tend to be subsituted in the improved vegetation. Its higher winter forage yield can be explained by a greater frequency (P<0,01) of winter growing species in relation to the range without external subsidies (Berretta and Levratto, 1990; Bemhaja and Berretta, 1991).

The increase in high quality species: white clover, annual ryegrass, *Poa lanigera* and the decrease in low quality grasses: *Andropogon*, *Aristida* and *Schizachirium spicatum*, results in a marked difference in forage quality.

During spring of 1993 both, white clover and annual ryegrass have a greater relative frequency than in 1989. The increase of cool season annuals is related to the end of the grazing season in late spring, to favour persistence of introduced species.

b) Granitic soils: the plant community in this soil is integrated by a lower number of less productive species than in the basaltic one, revealing a lower productive potential, (Risso and Morón, 1993).

The evaluation of the vegetation shows good adaptation of the introduced legumes to this acid and low fertility soil (Table 3).

Just in the second year of the improved pastures, there is a reduction in the frequency of native species, otherwise abundant on degraded areas, like *Micropsis spathulata* and *Chevreulia sarmentosa*, that are suffering strong competition from sown species. Conversely, there is an increase in the frequency of *Vulpia australis*.

In this and the basaltic sites, there was a change in range condition; the improvement triggered a secondary succession that promoted the range, through a threshold, to a new stable state (Laycock, 1991). This state, will be dependent upon maintenance of the inputs (management) to avoid reversion.

Conclusions

Canopy preconditioning, conservative P fertilization, legume introduction by surface sowing and controlled grazing conform a simple and low cost method, allowing for significant improvements in forage production and quality of the range in the basaltic and granitic areas.

There is a change in the native vegetation derived of an increase in C_3 species and a decrease in C_4 grasses, originally dominant. The pressure of external factors involved, must be sustained no to revert to a lower equilibrium, even though of better condition than that of the original vegetation.

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