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Long term productivity of a ley farming system in the "secano interior" of central Chile

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SUMMARY - Pasture dry matter production and wheat yield were evaluated in a rotation of 3 years of a pasture legume (*Medicago polymorpha*) following 1 year of wheat (i.e. a ley farming system), over 8 years (1984 - 1991). Liveweight gains of sheep were also assessed the last 4 years. Biomass production of the pasture legumes ranged between 4.6 - 7.8, 2 - 11, and 4.2 - 8.6 ton ha^{-1} of dry matter, in the first, second and third year after the wheat crop. Wheat grain yield fluctuated between 2.2 and 4.5 ton ha^{-1}, and animal production was on average 248 kg ha^{-1} of liveweight, which represent 2 to 5 times greater for both commodities than in the traditional local system based on a wheat/fallow rotation without annual legumes.

Key words: Bur medic, *Medicago polymorpha*, Chile, sheep production, wheat.

RESUME - *"Productivité à long terme dans un système de prairies temporaires dans le "secano interior" du Chili central". On a évalué la production de matière sèche d'un pâturage et le rendement de blé dans une rotation de 3 années d'une légumineuse (*Medicago polymorpha*) suivi de 1 année de blé (c.a.d., un système de culture de prairies temporaires), pendant 8 années (1984-1991). Le gain de poids vif des ovins a aussi été évalué pendant les 4 dernières années. La production de biomasse des légumineuses de pâturage était entre 4,6 - 7,8, 2 - 11, et 4,2 - 8,6 tonnes ha^{-1} de matière sèche, pendant la première, deuxième et troisième année après la récolte de blé. Le rendement en grain de blé a fluctué entre 2,2 et 4,5 tonnes ha^{-1}, et la production animale était en moyenne de 248 kg ha^{-1} de poids vif, c'est-à-dire, qui représente 2 à 5 fois plus pour les deux produits que dans le système local traditionnel basé sur une rotation blé/jachère sans légumineuses annuelles.*

***Mots-clés** : Luzerne hérissée,* Medicago polymorpha, *Chili, production d'ovins, blé.*

Introduction

Ley farming combines rainfed cereal growing with the sowing of self-regenerating annual medics (*Medicago* spp.), clovers (especially *Trifolium subterraneum*, *T. balansae*) or other annual legumes (Puckridge and French, 1983). The pasture-cereal rotation generally involves 1-3 years of pasture before cropping, depending on rainfall, local soil and current market conditions (Reeves and Ewing, 1993).

There appears to be potential to replace the pasture or unimproved annual pasture in Chile with a pasture based on selected annual legumes (Ovalle *et al.*, 1995). A promising annual legume for improving pastures in the context of ley farming systems in the secano interior is *Medicago polymorpha.* It is widely naturalized in the region today (Del Pozo *et al.*, 1989a; Ovalle *et al.*, 1993) and is recognized as being the most valuable annual legume occurring in natural, i.e., volunteer pastures. It has also been found particularly useful in Western Australia on slightly acid soils in low rainfall areas (Ewing, 1989).

In this paper, results of an annual medic (*Medicago polymorpha*)-wheat rotation system are presented and discussed. Pasture dry matter production and wheat yield were evaluated in a rotation of 3 years of a pasture legume, and 1 year of wheat (ley farming system), during 8 years between 1984 and 1991. Also, stocking rate and productivity of ewes and their lambs were assessed on the last 4 years.

Ley farming system in the secano interior

The "secano interior" of central Chile is a large dryland area of more than 2 million ha, located at the east side of the coastal mountains (32°-37°S), in the Mediterranean climate area. In the subhumid region, annual mean rainfall is 650 mm, mean maximum temperature of the warmest month (January) is 30ºC, and mean minimum temperature of the coldest month (July) is 5°C.

In 1984, an experiment in ley farming was begun on a *M. polymorpha* pasture at Santa Dolores, near Cauquenes (35°18' S; 72°12' W). A rotation of 4 years was established (3 years of medic and 1 year of wheat) in an area of 4 ha, divided in 4 paddocks of approximately 1 ha each. After the wheat crop the pasture of annual medic was self-regenerated and remained for 3 years. Therefore, from 1986 onwards, there were pastures of 1, 2 and 3 years old after the wheat crop.

Wheat was sown between May and June at a rate of 140 kg ha^{-1} and received an annual fertilization of 65, 16 and 16 kg ha^{-1} of N, P and K, respectively, and 20 kg ha^{-1} of boron calcite. The cultivar changed through the years but only spring cultivars were used. Weeds were controlled chemically. The whole paddock was harvested in December and yield calculated.

Pastures received 16 kg ha^{-1} $year^{-1}$ of P. Botanical composition was measured on 4-6 permanent lines of 100 points each, distributed on each pasture paddock, and the percentage of *M. polymorpha* calculated. Pasture availability during the grazing period and total dry matter was measured on 6 exclusions of 1 m^2. Weight of pods on soil surface was evaluated in December, between 1989 and 1991.

Pastures were grazed according to pasture availability. Liveweight gains of ewes and lambs, and grazing period were evaluated on each medic pasture from 1988 to 1991 (Avendaño *et al.*, 1994).

Wheat and pasture productivity

Wheat grain yield ranged from 2.2-4.5 ton ha^{-1}, whereas average yields on nearby farms during the same years were only 1-1.2 ton ha^{-1} (Table 1).

Table 1. Productivity of a medic (*M. polymorpha*)-wheat system in Cauquenes (from Ovalle, Del Pozo y Avendaño, 1994)

Year	Pasture production (ton DM ha-1)			Wheat grain yield (ton ha^{-1})
	1st year[1]	2nd year	3rd year	
1984	5.2 (73%)[2]	n.e.	n.e.	4.5
1985	5.2 (39%)	5.3 (36%)	n.e.	3.6
1986	4.6 (74%)	6.9 (4%)	5.9 (60%)	2.6
1987	5.4 (54%)	4.2 (3%)	8.6 (31%)	2.2
1988	5.1 (36%)	5.9 (54%)	4.2 (52%)	n.e.
1989	4.6 (36%)	2.0 (22%)	2.1 (22%)	n.e.
1990	7.8 (24%)	11.0 (43%)	6.0 (58%)	3.3
1991	4.9 (83%)	4.3 (11%)	7.1 (21%)	2.6
Mean	5.4 (52%)	5.7 (25%)	5.9 (41)	3.1

[1] Years after wheat crop
[2]( ) means % of annual medic in the pasture
n.e.: Not evaluated

Medic pastures yield on average 5.7 ton DM ha^{-1} (Table 1) which were about 3.5 times greater than the productivity of natural pastures of the area. Even in a year of lower-than-average rainfall (440 mm), pasture yields were between 2-4 ton DM ha^{-1}. No clear differences in total dry matter were observed between medic pastures of different ages after wheat, but the percentage of *M. polymorpha* in the pasture was greatest in the first year, and lowest in the second year after wheat (Table 1). The amount of pods on the surface of medic pastures, at the end of the grazing periods, were on average 125 (± 50), 147 (± 102) and 177 (± 50) kg ha^{-1} after 1, 2 and 3 years after wheat, respectively.

Animal productivity

Stocking rate decreased as the age of the pasture increased (Table 2). Ewes and lambs gained more weight grazing on the medic pasture of one year old after wheat, which had the greatest percentage of *M. polymorpha*. Grazing periods ranged from 120-195 days, depending on the year. These were much higher stocking rates and liveweight gains than those obtained anywhere else in this region during the same period.

Table 2. Stocking rates and liveweight gains of ewes (and their lambs), grazing on medic pastures of 1, 2 and 3 years old after wheat crop, in Cauquenes from 1988 to 1991 (modified from Avendaño *et al.*, 1994)

	Medic pasture		
	1st year[1]	2nd year	3rd year
Stocking rate (ewes ha^{-1})			
1988	7.0	7.9	5.0
1989	4.7	2.6	2.6
1990	8.5	7.7	6.5
1991	5.4	3.5	3.3
Mean	6.4 (± 1.7)	5.4(± 2.8)	4.4(± 1.8)
Liveweight gains (kg ha^{-1} $year^{-1}$)			
1988	297	336	192
1989	287	148	183
1990	151	351	229
1991	516	153	137
Mean	313 (± 151)	247 (± 112)	185 (± 38)

[1] Years after wheat crop

Conclusions

Ley farming with self-regenerating annual legumes should be considered as an important first step in improving pasture and cereal crop productivity in the secano interior. The inclusion of *M. polymorpha* in pastures also leads to significant increases in organic matter, N, P and K (Del Pozo *et al.*, 1989b), just as has been shown on a broad scale for annual legumes used in Western and Southern Australia (Reeves and Ewing, 1993).

The specific benefits of the ley farming system for Chilean farmers should include not only improved soil fertility and soil structure, but also: (i) increased cereal crop production and greater cropping flexibility; (ii) increased herbage growth and better quality dry feed in summer resulting in increased livestock production from high protein legume pasture residues; (iii) control of soil erosion; and (iv) greater farming stability as farmers are able to diversify on the basis of greater field crop and livestock yields and greater flexibility to respond to fluctuating national and international markets for animal products (especially wool and meat) and cereals (Ewing, 1989).

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