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Forage system to replace marginal, rainfed cereal areas by sheep production. An experimental study

I. Delgado, D. Andueza, F. Muñoz and F. Lahoz
Centro de Investigación y Transferencia Tecnológica de Aragón (CITA),
P.O. Box. 727, 50080 Zaragoza, Spain

SUMMARY – The replacement of marginal cereal crops in semi-arid, rainfed areas by a forage system keeping a stable stocking rate throughout the year was studied. The trial was conducted in an experimental farm of thirty-two ha, divided into four fenced plots dedicated to different crops: (i) alfalfa; (ii) winter cereal; (iii) *Lolium rigidum* + annual medics; and (iv) *Atriplex halimus* shrubs. Crops were grazed rotationally by a flock of local ewes during the year. Natural mating took place in October. Ewes lambed outdoors and the lambs were kept permanently with their mothers until reaching a slaughtering weight of 22-25 kg. The forage system, based on the successive use of alfalfa, winter cereals and the shrub *Atriplex halimus*, made possible a stocking rate of two ewes/ha and a mean production of 1.2 lambs/ewe/year with only one lambing period in March.

Key words: Forage alternative, alfalfa, winter cereal, *Atriplex halimus*, livestock systems.

RÉSUMÉ – *"Un système fourrager pour remplacer les zones céréalières non irriguées et marginales par une production ovine. Etude expérimentale". L'objectif de cette étude a été la substitution des céréales dans les terrains semi-arides, peu productifs, par une alternative fourragère permettant une charge stable tout au long de l'année. L'essai a été développé dans une exploitation expérimentale de trente-deux ha, divisée en quatre parcelles clôturées dédiées à différentes cultures : (i) luzerne ; (ii) céréales d'hiver ; (iii)* Lolium rigidum + *medics annuelles ; et (iv) arbustes d'*Atriplex halimus*. Les cultures ont été pâturées en rotation par un troupeau de brebis locales pendant l'année. La lutte naturelle a eu lieu dans le mois d'octobre. Les brebis ont agnelé en plein air et les agneaux sont restés en permanence avec leur mère jusqu'au moment où ils atteignent un poids d'abattage de 22-25 kg. L'alternative fourragère obtenue, fondée sur l'utilisation successive de luzerne, céréales d'hiver et l'arbuste* Atriplex halimus*, a permis de maintenir un taux de charge de deux brebis/ha et une production moyenne de 1,2 agneaux/brebis/année avec un seul agnelage annuel ayant lieu dans le mois de mars.*

Mots-clés : *Alternative fourragère, luzerne, céréale d'hiver,* Atriplex halimus*, systèmes d'élevage.*

Introduction

The traditional feeding system of sheep farms in rainfed cereal areas is based on grazing stubbles, fallows and hard grasslands. Nowadays, this traditional system is in crisis because of the scarcity of shepherds and the limited gross margins of the farms, even negative in some cases. Since 1978, some studies have been carried out in the Centro de Investigación y Transferencia Tecnológica de Aragón (CITA) with the aim of developing a forage system that can increase forage production (Delgado, 1984; Joy and Delgado, 1989; Delgado, 1992a,b, 1995, 1997; Delgado *et al.,* 1996, 1998; Andueza *et al.,* 1997; Ansón *et al.,* 1997). The replacement of cereal crops by a forage system would permit keeping the sheep stocks as well as contributing to the establishment of the human population. Forage culture would also restore soil fertility and stop erosion and desertification.

This work summarizes the different trials carried out with the purpose of obtaining a forage alternative to cereal rainfed areas.

Materials and methods

The study has been carried out at Zuera (Zaragoza) (41º53'N, 0º37'E), at 400 m above sea level, under semiarid conditions during ten years (from October 1992 to June 2002). The average maximum and minimum temperatures reached in the period were 19.5 ºC and 8.1 ºC respectively, and the

absolute extreme temperatures were 39 ºC and -10 ºC. The annual average rainfall was 399 mm, going from 227 to 660 mm. The soil was mainly of loamy texture, non saline, with basic pH and intermediate fertility. The average barley production in the area was 1862 kg/ha, in an alternate cereal-fallow system, and the stocking rate 0.7 ewes/ha, taking into account the surface likely to be grazed (Gobierno de Aragón, 1993-2000).

The experimental farm of thirty-two ha was divided into four fenced plots of 8 ha. Each plot was dedicated to one of the following crops: (i) alfalfa, cvs 'Aragón' and 'Tierra de Campos', at a seeding rate of 20 kg/ha; (ii) winter cereal, barley cv 'Albacete' or triticale cv 'Noe', 125 kg/ha; (iii) *Lolium rigidum* cv 'Wimmera' + *Medicago polymorpha* 'Santiago' + *M. trucatula* 'Paraggio', 10 + 5 + 5 kg/ha; and (iv) the shrub *Atriplex halimus* 'INRA 70100' at a spacing of 4 x 2 m. Alfalfa and forage shrubs remained in the same plot for the ten years of the experiment; cereals and the mixture of *Lolium rigidum* + *Medicago polymorpha* + *M. truncatula* were rotated five years after the beginning of the trial.

In the first five years, the offer of forages and stocking rates were studied with a grazing sheep flock whose number varied according to the forage availability. Stocking rates were estimated taking into account the number of days the flock remained grazing in the plots. Considering previous studies, a stocking rate of 2 ewes/ha/year was established, adjusted to forage resources of those years with the most adverse climatic conditions.

In the last five years, the experimental plots were rotationally grazed by a flock made up of 64 ewes, 50% 'Rasa Aragonesa' and 50% 'Churra Tensina' breeds. Natural mating took place in October with six 'Fleischschaf' males that were withdrawn at the end of the period. Ewes lambed outdoors and the lambs were kept permanently with their mothers until reaching a slaughtering weight of 22-25 kg without receiving any type of feeding supplement. Once a month, ewes were weighed and their body condition estimated by the Russell *et al.* method (1969). Plots had no shade available and water for animal consumption was supplied by a tank. Neither vaccinations nor antiparasitic treatments were necessary, only in the summer against oestrosis.

Results and discussion

Tables 1 and 2 present the forage offer estimated for each crop in the ten years of study and the corresponding stocking rates. These stocking rates do not correspond with the annual forage offers but with the general schedule of exploitation applied.

Table 1. Forage yield (kg dry matter/ha) of the different crops

Crop	Year								
	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cereal	1947.5	2573	2580	1509	1773	2254.5	4588	3257	6567
Lolium rigidum	2960	1776	1996.5	1255	875	448	1974	207	4022
Alfalfa	224	1352	1368	3797	3934	1478.5	3217	2929	3503
Atriplex halimus	0	0	850	2332	1563	2058	2880	1992	1811

Table 2. Stocking rates (ewes/ha/year) used in the different crops

Crop	Year								
	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cereal	3.3	1.8	2	2.1	2.4	3.4	1.4	1.9	2.9
Lolium rigidum	1.3	0.5	2.2	0.9	1.4	0.6	1.6	0.75	1.1
Alfalfa	0.25	1.3	2	4.2	3.2	1.75	1.9	1.6	2.6
Atriplex halimus	0	0	0.8	2.1	1.8	2.35	3	2.1	1.9

There were some years where, due to the favourable rainfall, the offer was higher than the ewes' feeding needs in some crops such as alfalfa or winter cereals. However, at the end of the winter, the flock's needs frequently surpassed the pasture available and the animals lost some weight that was recovered in the spring and summer. In spite of the differences between the offers in the winter and summer, the initial stocking rate of two ewes/ha/year was considered adequate. Higher stocking rates would have required punctual feeding supplementation, obtained from outside the farm or kept as hay from the alfalfa or cereals surpluses when available. Nevertheless, this possibility was rejected *a priori* as expensive or due to the need of extra labour.

The analysis of the results points to the consideration of other possible forage alternatives which should be carried out for a better adjustment of the stocking rate to the annual forage offer, such as increasing the surface area devoted to forage shrubs, and reduce, and even eliminate, the culture of *Lolium rigidum* + annual medics. The aim of that crop is to cover the feeding needs at the end of the winter and self-resow in spring. Therefore, its establishment cost is much reduced. However, though the first results in experimental plots were promising (Delgado, 1992b, 1997; Ansón *et al*., 1997), in the long-term alternative, plant density was notably reduced after the third year and it was necessary to resow twice. In addition, to produce pasture at the end of the winter, rainfall must be abundant in the month of October, which is very unpredictable.

The above proposals suggest that the culture of *Lolium rigidum* + annual medics could be eliminated and establish a forage alternative based on three crops with the same surface: alfalfa, winter cereals and the shrub *Atriplex halimus*. The calendar of the use of crops is presented in Fig. 1.

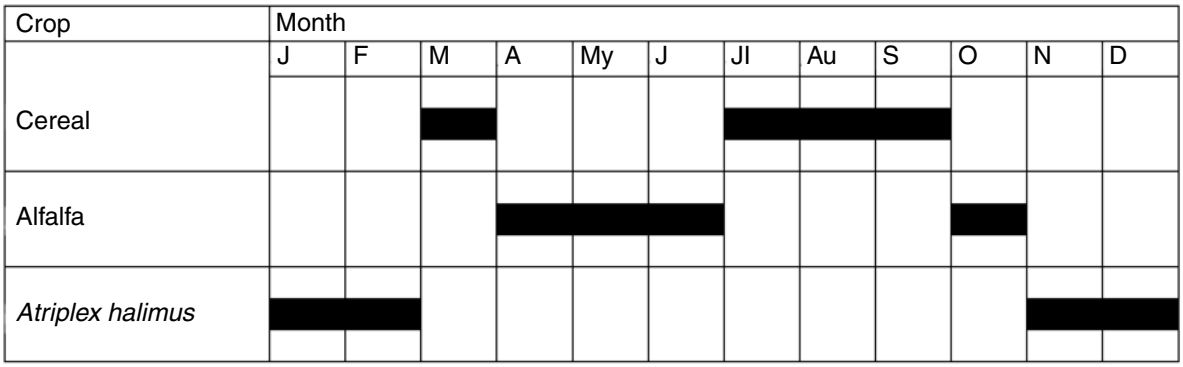

Fig. 1. Calendar of the use of crops from the proposed forage alternative.

The results obtained with the experimental flock in four seasons (1997-2001) are given in Table 3. In the last five years, the average live weight of the experimental flock was 60.6 kg/ewe in 'Rasa Aragonesa' with an annual maximum of 70.9 kg in November and minimum of 50.6 kg in March; and 56.0 kg/ewe in 'Churra Tensina' with an annual maximum of 65.9 kg in November and minimum of 47.4 kg in March. The average body condition varied between 3.9 and 3.1 in 'Rasa Aragonesa' in November and March respectively; and between 3.8 and 3.1 in 'Churra Tensina'. Ewes did not need manpower during lambing or lactation. No considerable damages caused by wild predators (mainly foxes and birds of prey) were found, only dead animals and those lambs from double lambing that were not looked after by their mothers, were taken by predators. Mortality occurred in the six years of trials, attributed to different causes, including nine 'Rasa Aragonesa' ewes and ten 'Churra Tensina' ewes, which represents 30% of the flock.

It can be deduced that with a production of 2.4 lambs/ha and slight expenses caused by crop maintenance, the proposed forage alternative could compete from the economical point of view with cereal crops in that area, taking into account that the average productions are 1863 kg barley/ha in an alternate crop with a fallow system.

On the other hand, it is necessary to consider the different environmental advantages involved in the proposed forage alternative, such as the few cultural operations and reduced mineral applications

needed by these crops, the absence of phytosanitary applications, and the flock upkeeping and lamb fattening without concentrate supplementation or health products.

Table 3. Average productive yield results of the experimental flock (64 ewes as average)

Season	1997-98	1998-99	1999-00	2000-01
'Rasa Aragonesa' live weight (kg)	53.4	59.5	62.5	63.4
'Churra Tensina' live weight (kg)	50.5	55.1	57.5	58.7
'Rasa Aragonesa' body condition	3.4	3.4	3.6	3.6
'Churra Tensina' body condition	3.3	3.6	3.6	3.5
Fertility (%)	95.2	88.7	98.3	91.2
Prolificacy (%)	138.3	123.6	155.0	137.1
Lamb mortality (%)	1.2	5.9	15.05	3.5
Number of lambs sold/ewe/year (%)	130.2	103.2	117.7	120.0
Daily gain (g)	315	342	322	–
Lamb slaughter weight (kg)	21.5	23.9	23.8	23.6

Conclusions

From the obtained results, the forage alternative presented in Fig. 1 for the replacement of marginal cereal crops in semiarid rainfed areas can be proposed. This forage system can support a stocking rate of two ewes/ha/year, though other more intensive productive managements could be studied in the future.

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