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Possibilities for the introduction of legumes in dairy sheep feeding in Northern Evros (Greece)

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Abstract. The debate about legume crops is becoming more relevant, mainly because the changes in the Common Agricultural Policy have increased their competitiveness against other crops. Indeed, they constitute a low-cost alternative source of protein for animal nutrition. The purpose of this study is to report the findings of an experiment regarding the introduction of legumes in sheep nutrition in Northern Evros, Greece. Two alternative feed mixtures were provided to two groups of 35 Lacaune sheep; the first mixture included soybean meal and the second faba bean (*Vicia faba* L.) meal as main sources of protein. The two alternative mixtures were equal in terms of energy and protein content. Milk production was recorded for all animals every 7 days and the milk was analysed for its chemical composition. The results indicate only significant differences in the protein content of milk. Economic benefits of the introduction of legumes in sheep nutrition are accounted for through partial budgeting. The generalized introduction of legumes in sheep nutrition is linked to the achievement of higher crop yields, as they are currently rather low. In addition, collaboration between farmers and livestock producers, or even on-farm production by the latter, will induce a widespread cultivation of legumes in the area.

Keywords. Faba bean – Feed alternative – Milk yield – Milk composition.

Les possibilités d'introduction des légumes à la nutrition des moutons laitiers dans la région d'Evros du Nord en Grèce

Résumé. Le débat sur la production de légumes est devenu constamment plus pertinent, principalement parce que les changements dans la politique agricole commune ont augmenté leur compétitivité par rapport à d'autres cultures arides. En effet, ils constituent une autre source de protéines à faible coût pour la nutrition des animaux. Le but de cette étude est de rapporter les résultats d'une expérience concernant l'introduction de légumineuses dans l'alimentation de brebis laitières dans la région de Evros du Nord, Grèce. Deux régimes différents ont été fournis à deux groupes de 35 Lacaune; le premier mélange comprenait du tourteau de soja et le second la farine de féverole (*Vicia faba* L.) comme sources principales de protéines. Les deux mélanges étaient égaux en termes d'énergie et de protéines. La production de lait a été enregistrée pour tous les animaux tous les 7 jours et le lait a été analysé pour déterminer sa composition chimique. Les résultats indiquent seulement des différences significatives dans la teneur en protéines du lait. Les avantages économiques de l'introduction de féverole dans l'alimentation des brebis sont comptabilisées. L'introduction généralisée de légumineux dans l'alimentation des brebis est conditionnée à la réalisation de rendements plus élevés, car ils sont actuellement plutôt faibles. En outre, la collaboration entre les agriculteurs et les éleveurs, ou même la production à la ferme, aidera la culture systématique et généralisée de légumineuses dans la région.

Mots-clés. Fève – Nourriture alternative – Production laitière – Composition chimique du lait.

I – Introduction

The introduction and use of legume crops is actually an important topic of debate. These crops are favored by the new Common Agricultural Policy through coupled payments, which increases their competitiveness against other crops (Reg. EC/1307/2013). They are also environmental friendly, being suitable for crop rotation schemes, due to the fact that they perform nitrogen fixation. In particular, faba bean is a low-cost alternative source of protein for livestock feeding compared to soybean meal (Bonanno *et al.*, 2012); faba bean grains (*Vicia faba* L.) are rich in protein in spite of containing anti-nutritional factors such as tannins, vicine and convicine (Crépon *et al.*, 2010) and can be produced on-farm or even locally due to their ability to grow even in dry climatic conditions (Loss and Siddique, 1997). Despite the potential benefits from the use of legumes compared to soya bean, Vasta *et al.* (2008) reported that there are only a few studies examining the use of alternative sources of protein in dairy sheep.

The purpose of this study was to investigate the possibilities for the introduction of faba bean meal instead of soybean meal as a source of protein in dairy sheep nutrition in Northern Evros, Greece in terms of its cost effectiveness and of its effects on animal performance and milk composition.

II – Materials and methods

The region of Northern Evros is characterized by intensive sheep farms, heavily based on the provision of feedstuff (forage and concentrates), thus their economic performance is highly dependent on the cost of feedstuff.

The production of legume crops in Greece is not very widespread; however, a small-scale survey of the three farms systematically cultivating faba bean in the study area revealed considerable advantages. The cultivation does not require additional investments in machinery – common wheat seeding machines and harvesters are appropriate. Only medium depth soil tillage is required using conventional equipment and sowing takes place in late October/early November. About 150 kg of faba bean seed are required per hectare and the average price of certified seed is currently 1.2-1.5 €/kg. The prevailing management practices in the area are very extensive, as no fertilizers or pesticides are used and no irrigation is needed, thus being appropriate for non-irrigated land parcels. Under this extensive pattern, the average yield fluctuates between 2000-3500 kg/ha depending on weather conditions.

The experiment took place in 2013 in one sheep farm applying an intensive production system, based solely on the provision of feedstuff, without any grazing. Two alternative feedstuff mixtures were provided to two groups of 35 Lacaune sheep; the animals were at their 2nd lactation period – the experiment took place during its final stage - and of average live weight of 70kg. The first mixture included soybean meal (SB) and the second (FB) faba bean meal (*Vicia faba* L.) as the main sources of protein (Table 1). The two alternative mixtures were equal in terms of energy and protein content after cereal and by-products addition (Table 2). All animals in both groups were fed with 1400g/d of lucerne and 850 g/d of mixture (A or B, depending on the group).

Individual milk production was recorded twice a day (7 a.m. and 8 p.m.), using milk meters adjusted on the milking machine, for all animals every 7 days for the whole experimental period (4 weeks). The daily milk yield was calculated as the sum of the two records whereas milk samples of 50 ml were taken in order to analyze their chemical composition (fat, protein, total solids). All recorded data were analyzed using the General Linear Model (GLM) (SPSS, 2002). Several specifications were tested as dependent variables: milk production, fat content, protein content, total solids content, and as independent variables: the type of diet (i.e. the type of mixture – A or B), the date of sampling and their interactions.

Table 1. Composition of the feed mixtures provided to the two experimental groups

Components	Mixture A (/kg)	Mixture B (/kg)
Corn	370.0	170.0
Wheat	100.0	210.0
Barley	70.0	50.0
Wheat bran	143.8	143.8
Gluten (20%)	70.0	70.0
Soybean meal (48% CP) (A)	90.0	–
Faba bean meal (25% CP) (B)	–	200.0
Sunflower meal (26%)	80.0	80.0
Additives + Mineral feeds	76.2	76.2

Table 2. Nutritional value of the two feed mixtures

Mixture	DM ^a (g/kg)	NEL ^b (Mj/kg DM)	Crude protein (CP) (g/kg)	Crude fat (g/kg)	Crude fiber (g/kg)
A (Soy bean meal)	828.1	6.9	154.5	23.3	33.5
B (Faba bean meal)	823.6	6.8	154.5	21.9	61.0

^aDM = dry matter, ^bNEL = net energy for lactation.

III – Results and discussion

The results of the GLM (Table 3) indicate significant differences in the protein content of milk, as mixture B diet resulted in higher protein contents. No significant differences in milk fat content or in milk yield were found. This finding is somewhat different than the results of Christodoulou *et al.* (2005), who found no differences in milk yield, milk fat and protein content in an investigation of the total replacement of soybean meal by chickpeas in dairy sheep nutrition in Greece. Similar results were reported by Masucci *et al.* (2006) in a study of the use of *Lupinus albus* L. instead of soybean meal in Sarda ewes diet.

Table 3. Effects of use of faba bean in sheep nutrition on milk production and chemical composition

	Day of lactation period	Daily milk production (gr)	Fat (%)	Protein (%)	Total solids (%)
Mixture A	137	1153.5	6.52	4.98	16.74
	144	1106.5	5.82	4.88	15.91
	151	1093.5	5.91	4.82	15.99
	158	1096.4	6.32	5.19	17.06
Mixture B	137	1105.2	6.06	5.25	16.68
	144	1105.3	5.96	5.14	16.56
	151	1101.3	5.81	5.09	16.37
	158	997.9	6.69	5.40	17.74
Effects (P =)	Diet	0.6298	0.9437	0.0065***	0.1346
	Sampling Date	0.8821	0.0071***	0.0605	0.0069***
	D x S	0.9538	0.2673	0.9946	0.7578

***Significant at the P<0.01% level.

Partial budgeting analysis (Table 4) revealed that if higher protein content is not remunerated to producers by dairy industries, the current price of FB meal (0.45 €/kg) is very high and renders diets with mixture B economically unprofitable. Nevertheless, if FB meal can be purchased at any price lower than 0.40 €/kg or if it is produced on-farm, mixture B becomes more profitable than the one including on SB.

Table 4. Economic performance of the two experimental feed mixtures – partial budgeting

	Mixture A (soybean meal)			Mixture B (faba bean meal)		
	Quantity (kg)	Price (€/kg)	Value (€)	Quantity (kg)	Price (€/kg)	Value (€)
Maize	370	0.21	77.7	170	0.21	35.7
Wheat	100	0.21	21.0	210	0.21	44.1
Barley	70	0.22	15.4	50	0.22	11.0
Soybean meal 48% (A)	90	0.62	55.8	–	–	–
Fababean meal (B)	–	–	–	200	0.45	90.0
Total (€/ton)			169.9			180.8

IV – Conclusions

The increased protein content of milk is very important for cheese production and reveals that there is room for the use of faba bean legumes in sheep nutrition. Legumes are appropriate for the soil and climatic conditions of the study area and constitute an alternative to non-irrigated cereal crops. Their large-scale adoption would be easy, as no additional equipment is required and their labor requirements are low, so they are suitable for the family livestock farms of the area. The main condition for the introduction of legumes in sheep nutrition to become economically profitable is the achievement of higher crop yields. In addition, the production of faba bean on-farm by livestock farmers would provide the required quantities at a much lower price than the one prevailing in markets actually.

The introduction of an alternative to soybean would ensure less dependence on the volatility of international markets, thus reducing risk and uncertainty and increasing efficiency. In the near future, the potential of collective procurement of faba bean by livestock farmers' Unions would be beneficial in achieving economies of scale and multiplier effects. Note also that the cultivation of legumes entails environmental benefits, because of nitrogen fixation, so these plants improve soil fertility, have minimal requirements in fertilizers and can be integrated into crop rotation systems in order to achieve – inter alia – lower production costs for cereal.

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