Use grassland diversity to improve efficiency of milk production in dairy ewe systems: case study in the Roquefort French region.

Vincent Thenard, Olivier Patou, Marie-Angélina Magne

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Thénard V.[1*], Patout O.[2], Magne M.A.[3]

[1]INRA-UMR AGIR, F-31326 Castanet Tolosan, France
[2]AVEM, F-12100 Millau, France
[3]ENFA-UMR1248 AGIR, F-31326 Castanet Tolosan, France
*E-mail: vincent.thenard@toulouse.inra.fr

Abstract:

In southern France, the area producing the "Roquefort" cheese is mainly a limestone karst plateau whose the semi-natural calcareous grasslands are holding conservation stakes. For many years, most farmers have not used these semi-natural calcareous grasslands to feed their ewes because of intensification of the milk production per ewe. However faced with the livestock farming crisis, few farmers consider changing their pastoral scheme in order to use more semi-natural calcareous grasslands and long-term seeded grasslands too. To maintain a high milk production level at the beginning of the grazing period, farmers have to define the best combination between the seeded grassland use on one hand and the semi-natural grassland use on the other hand. The aim of this study is to characterize the diversity of grasslands' management by shepherds. Twenty farmers' interviews were carried out to give an insight into grasslands' management and flock feeding practices. The milk production of each farm was analysed for the two first months of the grazing period by considering milk production level and persistency. We identified a wide range of grassland use mainly during the turn-out to pasture period. Following the farmers' practices analysis, we described five feeding patterns based on a combination between the grazing of seeded grassland and semi-natural grasslands, possibly associated with feed supplementation. Two main benefits of semi-natural grasslands use were recognized: firstly the well-adapted grassland use for low levels of milk production; secondly, the leading role of grasslands as a "buffer feed" during rainy periods to maintain grazing. The main conclusion focuses on the benefits of a combination between a large range of seeded grasslands and semi-natural grasslands to provide more flexibility in farm management. We consider this is a first stage to improve new agroecological farming systems.
Keywords: Livestock farming system, forage practices, technical change, cheese production, sheep

Introduction

In the last century, the intensification of livestock production and the development of larger and more specialized farm units have resulted in a decrease in grassland use (Kristensen et al. 2005). In mountain and less favoured areas, rural exodus and agricultural modernization in the 1960s induced the abandonment of the less productive land (Quetier et al. 2005). Livestock is faced with new agricultural context and grassland use comes back as an alternative to intensification. To develop agroecological farming systems, livestock animals can play a role in increasing agroecosystem diversity (Gliessman 1998). According to Altieri (2002) the diversity of resources is one of those agroecological principles. At the farm level diversity of resources can improve sustainable farming systems. The diversity of grassland resources and livestock management enable farms to cope with changes and variability in the context of production (Darnhofer et al., 2008). Firstly, managing the diversity of resources ought to ensure the "*room for manoeuvre*" at the farm scale thus improving its adaptive capacity. Farmers build management schemes with different combinations of land use and livestock practices (Thénard et al., 2006). Regardless of the diversity of resources and management, practices' combinations are not random but combined to preserve the farm consistency (Meynard et al., 2001). Secondly, maintaining the diversity of resources ought to increase the role of the farm to favour the preservation of the biodiversity. Nevertheless increasing grassland use requires having a well-adapted quality of grass to ensure it meets the livestock's needs. The milk production is highly impacted by grazing conditions. In the sheep dairy systems the main important period is the turn-out to pasture (TOP). This is a critic period because a decrease in the milk production cannot be made up the lack of milk later. Milk

production persistency can be used as a criterion of grassland management efficiency. In southern France, in the area known to produce "Roquefort" cheese, farmers have developed many different grassland management practices during the TOP period. A study was undertaken to design and assess the grazing and feeding management practices through this key-period. This study was conducted with farmers within the framework of a participatory research project. In this paper, after a few explanations of the methodology, we focus on the results defining a range of patterns of different TOP managements. In a second part, we propose new elements to link farmer's practices and the persistency of milk production. These preliminary results could be used in future projects to improve farm adaptability.

Materials & Methods

Case study: A training framework in The Roquefort cheese context.

This study takes place in the "Grands Causses" region, a limestone plateau in south central France (3270 km² around Millau - 44°05'N-3°04'E). The altitude ranges from 700 m to 1200 m above sea level. The climate is under three influences; oceanic, Mediterranean and continental. The annual average rainfall is from 700-1000 mm in accordance with region and altitude, but with a significant contrast between years, and with a dry summer. Average temperature is 12°C (-20 to +40°C). The climate and natural soil conditions favour very specific vegetation: the semi-natural calcareous grassland. Plants on calcareous grassland are typically short and hardy including grasses and legumes. In this region, farming activities are mainly sheep farming systems based on the Lacaune breed. It is the traditional area of Roquefort cheese production. This PDO cheese is produced with raw ewe's milk and aged for three months in natural calcareous caves. Ewes are milked during 6 months, with 2 or 3 months while the grazing period. To maintain the level of milk production farmers must use high quality forages. From the 1960s to the 1980s, milk production had been intensified and grazing use had regressed. During the last 50 years, farmers have developed production of many forage types (alfalfa, Italian rye-grass, forage cereals.) to improve milk production. Also many intensive farms were based on intensive forage production and farmers decided to abandon semi-natural calcareous grassland because of their low production. But during the 1990s farmers had to reduce production costs and they have searched less intensive practices. They have developed long term grassland based on alfalfa and orchard grass or based on a many-species seed mixture. The types of grasslands used and mentioned in this paper are described in table 1. Since 2000, the new PDO specifications have new requirement: 75% of the forage is produced in the PDO area, grazing must be used in spring.

Table 1: Types of grassland grazed at turn-out to pasture period

SNG	Semi-Natural Grassland: typical calcareous grassland	Rangeland grazing
PG	Permanent Grassland: no typical calcareous grassland	Grassland grazing
STG	Short-term seeded Grassland: 1-2 grasses; 1-2 years	Sown Grassland grazing
LTG	Long-term seeded Grassland: 1-2 grasses + 1-2 legumes; 5 years	Sown Grassland grazing
MSG	Long-term seeded Grassland based on multi-species seed mixture	Sown Grassland grazing
FC	Forage Cereal grazed at immature stage	Cereal grazing

In this context, an association of farmers and veterinarians (AVEM) was founded at the end of the 1980s. This association is based on the exchange of knowledge and know-how between farmers, veterinarians and some researchers. Advices and exchanges are based on a holistic approach of flock functioning. Many farmers of this association would like to improve grassland use for dairy ewe diet and to developed grassland management practices around TOP period which have favourable impacts on milk production. We have lead with them a study about these questions. We decided to analyse the first two months of grazing for a farms' sample. To explain the links between grassland diversity and grazing management practices at the TOP, we have defined a 20-farm sample. Firstly, it was interesting to study these links at the beginning of the lactation period, while milk production level was important for annual production; we have chosen farms which begun the milking for a short time before TOP date. Secondly, it was necessary to limit the impact of the lactation stage; thus we have decided to choose farms with a similar lambing date.

Methods to analyse practices and to define management patterns

From March to June 2009, semi-directive interviews were carried out among 20 farmers to identify flock management during the grazing period and more particularly during the TOP period. In this farm's sample, the date of TOP ranged from March 9th to April 20th. We used the milk production data previously published

(Thénard et al., 2010). At the TOP date the milk production was 2.00±0.45 litre per day per ewe. Farms were characterised by 4 levels of milk production persistency defined by the milk level at the TOP date and the milk production decrease during the 2 first-months of the grazing period (table2):

Table 2: Milk Production Persistency after the first two months of grazing (Thénard, 2010)

Low milk production persistency	High milk production persistency
P1: High Milk production and large decrease (more 35 %)	P3: Low milk production and low increase (0-10%)
P2: Low Milk production and average decrease (20-25%)	P4: High Milk production and average decrease (20-25%)

Farmer's interviews were analysed by identification of farmers' practices (Girard, 2006), we have built criterion and their modalities based on the diversity of practices explained by farmers. These criterion and modalities can be statistically analysed. To perform management patterns, we used a descriptive analysis of practices based on Multivariate Component Analysis and Clustering method. These analyses were computed with the *factominer-Package* of R software (R Core team, 2012).To identify the main practices linked with the milk production efficiency, Classification and Regression Tree method was used and computed with the *rpart-package* of R software (R Core team, 2012).

Results

Diversity of the farmer's practices

Collected data allowed identifying 10 different criteria to describe practices of grassland management and animal feeding. Each criterion is defined with 2 or 3 modalities (table 3).

Table 3: Criterion and modalities of the farmers 'practices (Thénard, 2013)

	Diversity of grassland grazed		
A	Sown pasture (3 farms)	Sown pasture, PG and SNG (6farms)	Sown pasture and FC (11 farms)
	Daily combination of resources grazed		
B	One type of grassland (11 farms)	Two types of grassland (4 farms)	Grassland(s) and FC (5 farms)
	Rangeland grazing		
C	No rangeland (13 farms)	Rangeland use (7 farms)	
	Type of seed-mixture		
D	1-2 grasses (5 farms)	1-2 grasses + 1-2 legumes (4 farms)	many-species seed mixture (11 farms)
	Forage supplementation		
E	Quick decreasing (5 farms)	Slow decreasing (10 farms)	No decreasing (5 farms)
	Concentrate supplementation		
F	Energy supply (9 farms)	Energy and protein supply (11 farms)	
	Daily Grazing time after 4 weeks of grazing		
G	Short-time 3-4 hours (7 farms)	Medium time 6 hours (2 farms)	Long-time > 8 hours (11 farms)
	Grazing system		
H	Leader-Follower grazing (7 farms)	Leader grazing (5 farms)	Free-Grazing (8 farms)
	Area per ewe at the start of one parcel use		
I	>650 ewes/ha (6 farms)	250-650 ewes/ha (7 farms)	<250 ewes/ha (7 farms)
	Grazing habit during raining		
J	Grazing under raining (4 farms)	Limited Grazing under raining (7 farms)	No Grazing under raining day (9 farms)

Diversity of the TOP managements

The three first axes of the MCA have explained 48.6% of the observed variability. The first axis (19.1%) represented the diversity of resources and grazing systems. It compared farmers who fed their ewes with grassland and forage cereal during the TOP period *vs.* those who fed them only with different types of grasslands. The second axis (17.8%) represented the grazing system and the rangeland grazing. It compared farmers who done Leader Grazing and used rangeland *vs.* those who used free grazing and had a high level of forage supply. The third axis (11.8%) represented the daily grazing time and the daily combination of resources grazed. It compared farmers who used Long time grazing and use at least two daily resources including cereals *vs.* those who limited the daily grazing time. The clustering method revealed a range of four patterns of turn-out to pasture management. The first group was composed of 6 farms which have a **diversified grazing management system**. These farmers used daily MSG and FC, but no SNG. Ewe grazed for a long time every day, except during rainy days. The second group was composed of 5 farms which have a **limited grazing management system**. These farmers used STG, LTG, MSG or FC, but only one type of

grassland for a short time every day. The third group was composed of 5 farms which have a **supplemented grazing management system**. These farmers use only STG, LTG and PG (without SNG) and they provided a large forage supplementation and protein supply to the animals. The fourth group is composed of 4 farms which have an **alternative grazing management system**. This group used rangelands (SNG) during this period in association with another grazed resource (STG, LTG, MSG, FC).

Key-Practices and milk production efficiency

Based on the 4 levels of milk efficiency, the CART method shows that the main practices involved in the success of the TOP managements. In the table 4, we present the TOP managements could be discerned as a failure or a success in the practices choice (table 4).

Table 4: Examples of successful or unsuccessful combinations of factors to maintain milk production during the turn-out period

	Success in turn-out to pasture	Milk Efficiency	Failure in turn-out to pasture	Milk Efficiency
Diversified Grazing	Daily FC grazing Protein supply	P4	MSG grazing No Protein supply --- STG grazing only	P2 P1
Limited Grazing	Energy and protein supply MSG grazing Grazing under raining	P4	No Protein supply --- STG grazing only	P2 P1
Supplemented Grazing			Energy and protein supply MSG grazing --- STG grazing only	P2 P1
Alternative Grazing	Maintaining energy and protein supply MSG grazing SNG grazing	P3	Energy supply only STG grazing only	P2 P1

Discussion and conclusion

The aim of this study was to improve grassland use to maintain milk production. The main results are related with the links interactions between feeding practices and milk production. Many practices are favourable for maintaining a high level of milk production: a wide diversity of grassland grazed, forage cereals grazing, and protein supply. Two main benefits of semi-natural grasslands use were recognized: firstly the well-adapted grassland use for low levels of milk production; secondly, the leading role of grasslands as a "buffer feed" during rainy periods to maintain grazing. Milk persistency can be maintained through grassland management practices, by using a wide diversity of resources in accordance with this agroecological principle. The two main recommendations are firstly that the traditional feeding system can be used for low levels of milk production. Secondly, the livestock intensification needs a supplementary protein supply combined with the use of a large diversity of cultivated grasslands. According to our experience, these two practices can be easily adopted by farmers. The study showed the benefits of a large diversity of seeded grassland to provide more flexibility in farm management.

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