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Variability of multispecies grasslands production in a diversified agroecological dairy system
Novak S. ¹, Didiot C. ¹, Bourgoïn F. ¹, Guyard R. ¹, Chargelègue F. ¹, Audebert G. ¹, Delagarde R. ²

¹ INRAE, FERLUS, 86600 Lusignan, France, DOI : 10.15454/1.5572219564109097E12

² PEGASE, INRAE, Institut Agro, 16 Le Clos 35590 Saint Gilles, France

Abstract

The objective of the study was to evaluate over 2017-2020 the grassland production and the profile of the cattle diet in a mixed crop-dairy system named OasYs. Conducted without irrigation and with limited inputs, it was designed with an agroecological approach to permit farmers to live from their dairy system in a context of climate change, while preserving environment and contributing to animal welfare. The forage system is based on multispecies grasslands and on the grazing of several forage resources. Grasslands are diversified in terms of composition (mixtures of different species and cultivars), management (from 100% grazed to 100% cut) and age (1 to 5 years). Their yields ranged from 2.2 to 12.9 t DM/ha/year and were greater i/for cut *versus* grazed and cut grasslands and ii/ for grasslands containing chicory. Over 2017-2020, herbage (grazed and conserved) represented 28 to 100 % of the monthly diet of the dairy herd. Other forages were grazed fodder beet or other grazed crops and silages of sorghum, maize or of cereal-legumes mixtures. This diversification allowed the system nearly reaching self-sufficiency in forages and in protein.

Keywords: mixed crop-dairy system; temporary grasslands; agroecology; grazing; low-input; OasYs

Introduction

Grassland-based dairy systems present several assets both environmentally and economically (Delaby *et al.*, 2020). Their capability to provide enough forage to feed a dairy herd in the context of climate change may yet be challenged, especially if droughts increase in frequency and intensity. Achieving self-sufficiency in forage with grass seems all the more difficult in dairy systems aiming to limit the use of external inputs and irrigation. In this context, the diversification of composition, management and age of grasslands, coupled with the diversification of complementary forage resources seems promising to attain self-sufficiency in forages. This diversification of forages resources and a new livestock breeding strategy are tested in the climate-smart agroecological dairy cattle system “OasYs” (Novak *et al.*, 2018). We present here the grazed and/or cut grasslands production per year at the farm level, and the profile of the dairy cattle diet at a monthly scale over the 2017-2020 period.

Materials and methods

The OasYs dairy cattle system is carried out since June 2013 in a plain area already affected by summer droughts (mean total summer rainfall of 134 mm over 2017-2020), located south of the French leading dairy regions (Lusignan, Nouvelle Aquitaine, France) in an INRAE facility. The forage system (91.5 ha) aims to produce the fodder necessary to feed the dairy cattle herd (72 milking cows, and replacement heifers) without irrigation and with limited use of mineral nitrogen (N) fertiliser and pesticides. Forage resources are diversified in terms of species, cultivars, age and management, and 2/3 of the area is accessible to grazing (Novak *et al.*, 2018). Five- and four-year multispecies and legume-rich grasslands (52 ha, 18 plots on

average) represent the heart of the forage system, complemented by annual crops (mainly maize, grain sorghum, cereal-legumes mixtures, fodder beet) that are cut or grazed. Grasslands included tall fescue, cocksfoot, perennial and annual ryegrass, lucerne, chicory, plantain, sainfoin, and various perennial and annual clovers. Only 27 of the 71 plot.year modalities in grasslands were fertilised with organic or mineral N, half of them receiving less than 50 kg N/ha/year. The livestock breeding strategy is in coherence with the forage system, with two calving periods in spring and autumn, lactation lengths of 16 months and three-way crossing of dairy breeds (Holstein, Scandinavian Red, and Jersey) (Novak *et al.*, 2018). The amounts of herbage grazed by the dairy herd were evaluated at paddock level for each rotation over 2017-2020 by the Herbvalo method (Delagarde *et al.*, 2018). The amounts of the non-herbage forage crops (*e.g.* fodder beet) grazed were estimated by linking weekly measurements of the crop yields with the daily grazed area and herd size. Intake of conserved forages fed in the barn was measured daily.

Results and discussion

The growing season (March to November, mean temperature of 14.9°C) was characterised by a high variability of its total amount of rainfall, ranging from 384 mm in 2020 to 778 mm in 2019. Grazed and/or cut grassland yields ranged from 2.2 to 12.9 t DM/ha/year over the 2017-2020 period (Table 1), and averaged 6.6, 6.3 and 7.9 t DM/ha/year respectively for grazed, grazed and cut, and cut grasslands. They were statistically higher i/for cut *versus* grazed and cut grasslands and ii/ for grasslands containing chicory (7.9 compared to 6.0 t DM ha⁻¹). Forage chicory was already shown to produce large quantity of high quality feed, especially in warm and drought conditions (Li and Kemp, 2005). The great intra-annual variability of yields may be due to quality of seedling establishment, fertilisation, age of the grassland, its composition and the soil nutrient status. These annual yields are in the same order of magnitude compared to local references for temporary grasslands which averaged 7.2 t DM/ha/year on this period and were generally more fertilised (Agreste, 2020). The large use of legumes in sown grasslands certainly explains these results.

Table 1: Grazed and/or cut grassland yields per year at the system level (t DM ha⁻¹)

	Grazed grasslands		Grazed and cut grasslands		Cut grasslands	
	Mean	Min-max	Mean	Min-max	Mean	Min-max
2017	6.8	4.2 - 8.4	5.8	2.6 - 7.4	7.7	5.6 - 11.6
2018	6.6	2.2 -12.9	6.8	3.3 - 9.2	8.6	6.0 - 12.9
2019	7.3	4.0 -10.8	6.7	5.9 - 7.8	8.7	5.7 - 11.7
2020	5.8	2.7 -11.5	5.8	5.0 - 7.3	6.9	5.8 - 7.6
mean	6.6 ^{ab}		6.3 ^b		7.9 ^a	
s.d.	2.6		1.5		2.1	
n	26		22		23	

Letters indicate significant differences ($P < 0.05$) according to pairwise t-tests.

Over the 2017-2020 period, herbage (grazed and conserved) averaged 70% of the annual diet of the dairy cattle herd and ranged from 28 to 100 % at a monthly time scale (fig. 1). Grazed herbage was the main forage in the diet during April, May and June. Other grazed forage resources were mainly fodder beet, grazed from summer to winter, and various intercrops including either grass intercrops or crop residues and re-growths of cereal-legumes mixtures and grain sorghum after their silage. Annual crops such as mixtures of rape and turnip, and grain sorghum associated to lablab, were also grazed. Conserved forage proportion ranged from 0 (in May) to 95% (in January) in the monthly diet with an annual average value of 49%. They were mainly composed of herbage (on average 6% of hay and 26% of silage over

the year), followed by silages of sorghum (7%), maize (6%) or cereal-legumes mixtures (5%). Concentrates proportion ranged from 0 to 10%, representing only 4% of the average annual diet, on a DM basis, and 47 g per litre of milk. The annual average of fat and protein corrected milk production ranged from 6468 to 6978 litres per cow.

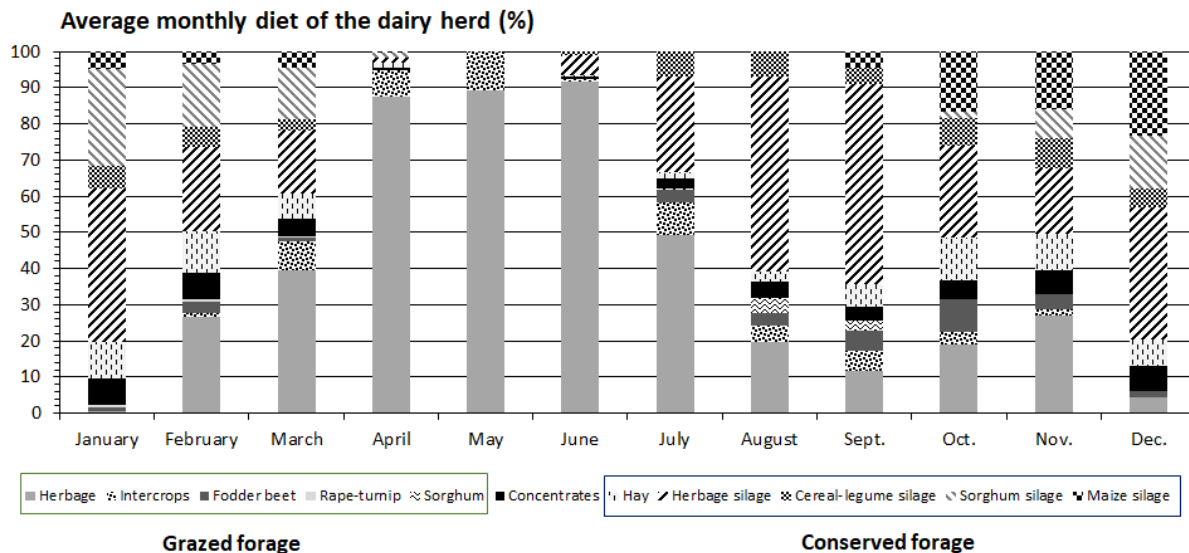


Figure 1: profile of the dairy cattle diet at a monthly scale over the 2017-2020 period.

Conclusion

The multispecies and legume-rich temporary grasslands allowed good forage production levels whatever the year and the management (grazing or cutting), over the 2017-2020 period, despite the low N fertilisation. Chicory was useful to extend grazing season, especially during dry periods. Thanks to the diversification of grazed or conserved forage resources, including mainly multispecies grasslands but also grazed annual crops or intercrops, and to a large use of legumes, the low-input dairy cattle system OasYs nearly reached self-sufficiency in forages and protein.

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