Design and assessment of multispecies pastures for sustainable dairy goat production systems in Western France

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Abstract

Greater use of multispecies pastures can be a viable option for improving the sustainability and protein self-sufficiency in goat farming. A 3-year study was conducted to measure the forage yield, botanical composition and nutritive value of a multispecies pasture that was established both on-station at INRA (FERLus-Patuchev) and on eight farms (REDCap network) under a large diversity of soil and climatic conditions and of pasture utilization (grazing, cutting or both). In autumn 2012, multispecies seed mixtures containing 9 species were sown on 11 fields (19 hectares). The mixture was composed of 60% grass and 40% legumes. On the experimental farm, total annual dry matter (DM) yield from the ungrazed (exclusive cutting) plots was 10.0±2.3 t ha^{-1}. Average crude protein (CP) content of forages was 17.8±2.8% DM. On farms, the specific diversity increased over the years, thanks to sown species and due to germination of adventitious plants. On average, the DM yield and CP content of the second cut forage were 3.1±1.8 t DM ha^{-1} and 14.1±2.9% DM, respectively. This study presents an initial step for designing multispecies pastures for goat grazing.

Keywords: multispecies pastures, dairy goat, sustainability, western France

Introduction

Achieving self-sufficiency is a major goal for dairy farming to alleviate the negative effects of high input costs and environmental pollution. Increasing home-grown feedstuff and protein production to improve protein self-sufficiency which is currently quite low (38%) are the main challenges of dairy goat farming in western France (Broccard *et al.*, 2016). It is also vital to improve the traceability of feed and reduce the dependency on imported proteins. Multispecies pastures present a potential for improving dry matter production and protein self-sufficiency in goat farming (Lüscher *et al.*, 2014; Protin *et al.*, 2014). The network REDCap and the experimental platform Patuchev of INRA work on these research areas, through applying agroecological principles (Altieri, 2002), such as (1) designing farming systems based on biological regulations and interactions between the components of the farm, (2) increasing local feed resources and inputs of self-sufficiency, (3) working with local actors (Caillat and Jost, 2015). This approach was used to design and assess multispecies pastures for sustainable dairy goat production systems in western France.

A 'passkey' multispecies pasture co-built by breeders, advisors and researchers

Lucerne and red-clover are the most important legumes used in goat diets in western France (Caillat *et al.,* 2016). However, under unfavourable cropping conditions or in the context of more persistent and sustainable grasslands, multispecies pastures are an important alternative for promoting the feed and protein self-sufficiency of goat farms. It is also a way to produce a well-balanced feed suitable for cutting with more flexibility (Huyghe *et al.,* 2008). As there are few references available for western France, our challenge is to design a multispecies pasture that is: (a) suitable for goat farming; (b) productive, sustainable and rich in protein; (c) adapted to different uses (grazing or hay) and soil types. To answer to these objectives, a multispecies pasture was designed by the REDCap, e.g. goat breeders, advisors and researchers.

A same multisward in different environments

A trial was conducted on both the experimental farm (FERLus-Inra) and on eight farms (REDCap) in Poitou-Charentes during three years. In Autumn 2012, a similar sward of 9 species composed of 60% of grass (*Lolium perenne* & *Lolium multiflorum*, *Festuca arundinacea* & *Festuca pratensis*, *Phleum pratense*) and 40% of legumes (*Medicago*, *Trifolium pratense* & *Trifolium repens*, *Lotus corniculatus*). The seed mixture was sown in 11 fields (19 ha), of which three were located on the experimental farm of INRA (1 ha is only cut for hay and 2 ha are used for both hay making and pasture). The seed density was 26.7 kg ha^{-1} (about 1,500 seeds m^{-2}). Selected cultivars were diploid and non-alternative and according to earliest heading date. This study is carried out under a large variety of soil types (dry, hydromorphic, healthy), soil textures (silt, clay-limestone) and forage utilization (cutting and/or grazing) conditions to assess the suitability of the multispecies pasture mixtures for different environments.

Sward measurements

This study was conducted on farms and on the experimental farm, with the same evaluation of botanical diversity and yields before the second cut/grazing of every year. During three years, yield is estimated once a year, through biomass density of 6×0.25 m^2 plots per field. From each plot, two subsamples were collected to measure botanical composition and nutritive value of the forages.

Additional continuous measures were made after each use on the experimental farm, to produce annual references. Yield is measured by harvesting of total biomass. For grazing fields, grass yield has been calculated by multiplication at each cycle the number of days of grazing (effective × time) by the average feeding intake of the herd, estimated by a simplified model of intake capacity of INRA (Delagarde *et al.*, 2017). Botanical composition of each cutting is estimated by proportion of each species from sampling of 6 plots ha^{-1} of 0.2×0.3 m.

For biochemical analyses, all samples are dried at 60 °C for 48 h and ground to pass a 1 mm screen and analysed by the reference methods at LABCO of Surgères. Feeding values are calculated from tables (INRA, 2007).

Results: a short-term productive grassland

On average, the second cut produces 3.1±1.8 t dry matter (DM) and crude protein (CP) content was 14.1± 2.9%. This represents 500 kg of CP ha^{-1}. On the experimental farm, herbage yield was by 9.4±2.2 t DM per hectare per year, with differences between exclusive cutting (10.0±2.3 t DM) and grazing/cutting (8.8±2.5 t DM) plots. Harvesting type had few consequences on CP content, at 17.8%±2.8 DM or on energy levels, at 0.82±0.09 UFL (feed unit for lactation).

During the first and second year, *L. multiflorum* and *T. pratense* represented more than 75% of the botanical composition of the pastures. The proportion of *L. perenne* and *T. repens* were low but stable during the 3-year study (respectively 3% and 6%). *Medicago* did not appear in the botanical composition of pastures, except in three fields during years 2 and 3. In the third year, the proportions of *L. multiflorum* and *T. pratense* decreased, which was favourable for the development of *F. arundinacea* and *F. pratensis* (+28% between year 2 and 3). *Lotus corniculatus* and *P. pratense* rates also improved. With years, we can notice a better balance between species, even if legumes stay low (between 40 to 30%). Finally, we can notice a development of non-sown species which doubled (from 10 to 20%). These non-sown species may sometimes be interesting (in terms of yield or feeding value), as *Rumex obtusifolius*, *Dactylis glomerata*. Finally, during the third year, grass represented 70% of DM. This evolution was also observed on the experimental farm during the fourth year, where 86% of the field consisted of grass. These facts provide answers about the durability of this mixture.

Prospects

Forage and protein yields are high with a low-input management. Yields are mainly made thanks to two short-term-productive species (*L. multiflorum* and *T. pratense*). But these species are also well-known to be aggressive compared with *Medicago* or *Festuca*. This lack of diversity limits the persistence of the mixture.

Moreover, the amounts of legume remain quite low during the experiment (43 to 30%) and *Medicago* was absent, except in 3 fields (<12% of DM diversity). Two facts may explain this evolution: (1) *Medicago* was not inoculated; and (2) the fields were sown late (at the beginning of October 2012). Indeed, autumn 2012 was not favourable conditions for sowing legumes: dry weather before seeding (12.5 mm of rain in August, 60 mm in September) and rainy weather after seeding (183 mm in October) (MeteoFrance data – Lusignan).

This trial allowed us to highlight that multispecies pastures can provide an opportunity to develop protein self-sufficiency for dairy goat farms. But the multisward still needs to be designed, and other mixtures have to be assessed. A second trial is in progress, focusing on two main challenges: persistence and site-specific adaptation. As *Medicago* suffers from the aggressiveness of *L. multiflorum* and *T. pratense*, the main adaptations are to remove *L. multiflorum*, reduce *T. pratense* and increase *Medicago*. Other species will stay in similar amounts in the mixture. Seeding conditions will also be checked, so as to be favourable for legume development.

References

Altieri M. (2002) Agroecology: the science of natural resource management for poor farmers in marginal environments. *Agriculture, Ecosystems & Environment* 93, 1-24.

Brocard V., Jost J., Rouillé B., Caillaud D., Caillat H. and Bossis N. (2016) Feeding self-sufficiency levels in dairy cow and goat farms in Western France: current situation and ways of improvement. *Grassland Science in Europe* 21, 53-55.

Caillat H. and Jost J. (2015) PATUCHEV and REDCap: two additional research and development schemes for high performance and sustainable goat farming. *5th International Symposium for Farming Systems Design*, Montpellier, France.

Caillat H., Bossis N., Jost J., Pierre P., Legarto J., Lefrileux Y. and Delagarde R. (2016) Les légumineuses dans les systèmes caprins: quelles espèces pour quelles valorisations? *Fourrages* 227, 199-206.

Delagarde R., Caillat H. and Fortin J. (2017) HerbValo, une méthode pour estimer dans chaque parcelle la quantité d'herbe valorisée par les ruminants au pâturage. *Actes Journées AFPF*, Paris, 21-22 mars 2017 (in press).

Huyghe C. and Litrico I. (2008) Analyse de la relation entre la diversité spécifique des prairies et leur valeur agronomique. *Fourrages* 194, 147-160.

INRA (2007) Alimentation des bovins, ovins et caprins. Besoins des animaux – Valeurs des aliments. Ed. Quae, Versailles, France.

Lüscher A., Mueller-Harvey I., Soussana J. F., Rees R.M. and Peyraud J.L. (2014) Potential of legume-based grassland-livestock systems in Europe: a review. *Grass and Forage Science* 69, 206-228.

Protin P.V., Pelletier P., Gastal F., Surault F., Julier B., Pierre P. and Straëbler M. (2014) Les prairies multiespèces, un levier pour des systèmes fourragers performants. *Fourrages* 218, 167-176.