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How to optimize the carrying capacity of Jura summer pastures?

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Abstract. Swiss summer pastures management is constrained by an official carrying capacity limit for benefiting from governmental subsidies. The grazing duration and number of animals are set accordingly either to long-term practices or to pastoral plans established by means of vegetation mapping. This paper presents results issued from three case studies in the Jura mountain area. It confirms that botanical surveys lead to correct annual DM yield assessment. They give however no information about the grass growth dynamics. Our measurements show that the distribution of production during the season may vary significantly from one year to another. Moreover, the impact of climate change reinforces the need to adapt pasture management. Finally, the discussion focuses on the short-term adjustment of the stocking rate to the grass production potential.

Keywords. Mountain pastures – Botanical survey – DM yield – Grass intake – Milk production.

Comment optimiser le chargement animal des pâturages d'estivage du Jura ?

Résumé. *En Suisse, la gestion des pâturages d'estivage est réglementée par une limite de chargement animal, de façon à pouvoir bénéficier de subventions gouvernementales. La durée de pâturage et le nombre d'animaux sont fixés en considérant les pratiques à long terme ou sur la base d'un plan de gestion établi au moyen d'une cartographie de la végétation. Cet article présente les résultats issus de trois études de cas dans la région d'estivage du Jura. Il confirme que les relevés botaniques conduisent à une évaluation correcte du rendement annuel en matière sèche. Ces relevés ne donnent en revanche aucune information sur la dynamique de croissance de l'herbe. Nos mesures montrent que la répartition de la production en cours de saison peut varier considérablement d'une année à l'autre. En outre, l'impact du changement climatique renforce la nécessité d'adapter la gestion des pâturages. Enfin, la discussion se concentre sur l'ajustement de la charge instantanée au potentiel de production d'herbe.*

Mots-clés. *Pâturages de montagne – Relevés botaniques – Rendement – Ingestion – Production laitière.*

I – Introduction

In the Swiss southern Jura foothill, a transdisciplinary project aims at prospecting on how dairy farmers can improve their forage autonomy taking into account the climate change. In this lowland region, dairy production concerns either industrial milk with silage or PDO cheeses with hay based foraging. Cows' productivity and grassland utilisation intensity are rather high. This may lead to an imbalance between the forage potential and the herd's requirement. Recent drought events negatively affected grassland productivity. Consequently, forage maize surface has expanded up to 900 m elevation. Above this altitude, summer pastures beneficiate from a favourable relief and are less encroached in comparison with sloping Alp regions. They draw more and more attention, as they complete forage shortage. In particular, the mosaic patchiness of wood-pastures may buffer impacts of drought (Gavazov *et al.*, 2013).

Summer pastures management is subject to legal constraints that limit the amount of concentrate (no more than 1 kg concentrate per day and per Livestock Unit LU) and the carrying capacity (grazing duration and number of animals). In cases of significant structural changes, any modification of the carrying capacity requires the establishment of a pastoral plan including an actual map of vegetation. On this basis, the annual production is estimated and used to calculate the carrying capacity. Pastoral plans do not take into account temporal and spatial variability of grass growth. The objectives of this study are to illustrate the range of variation and to discuss the possibilities of adaptive management.

II – Materials and methods

The **study area** is located in the Jura Mountains ('Combe des Amburnex' 46°32' latitude north and 6°13' longitude east) at about 1300 m elevation. The climate is harsh and rainy, with mean annual air temperature of 5.9 °C and mean annual precipitation of 1920 mm. The soils are characterised by the karst, with an upper decalcified layer (pH of about 5) and high organic matter content (up to 10%). The texture and the depth of the soils are highly variable, depending on the local topography. The vegetation is dominated by *Festuca rubra* and *Agrostis capillaris*. Three summer pastures (P1, P2 and P3) situated in this valley have been observed between 2012 and 2014.

Experimental plots (one per vegetation unit) were fenced on representative paddocks of the pastures. DM production and grass growth were measured using a design inspired by Corrall and Fenlon (1977) and simplified for marginal areas. Two plots of 6.5 m^2 were mown and weighted alternatively every two weeks during the whole vegetation period. Botanical composition and pastoral value (PV) were determined according to the method of Daget and Poissonet (1971).

Grass height was measured in each paddock of the pastures P2 and P3 in 2014 with a plate pasture meter. Grass cover (available biomass) was then calculated using an average grass density of 240 kg DM ha^{-1} cm^{-1}.

III – Results and discussion

1. Soil depth and grass growth

In 2012, two experimental plots were located on pasture P1 on shallow (20 cm) and deep soil (60 cm) with diverse botanical richness (31 *vs.* 21 plant species). The pastoral value (PV) reached 27.9 on shallow soil and 46.0 on the deep one. Accordingly, annual DM yield reached 890 and 2,960 kg DM ha^{-1}, respectively Grass growth dynamic was similar for both situations (Fig. 1), but means from May to September differed from 5.2 on shallow to 16.9 kg DM ha^{-1} day^{-1} on deep soil.

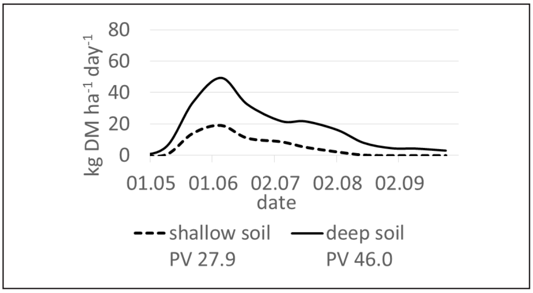

Fig. 1. Grass growth related to soil depth (P1, 2012).

Figure 1 illustrates the huge **spatial variability** encountered in the study area. As expected, with increasing soil depth, the botanical diversity decreased and the pasture yield increased. Accordingly, the pastoral plan of P1 (Brühlmann *et al*., 1997) indicates the following yield ranges established by means of a vegetation mapping : 600-1,000 kg DM ha^{-1} year^{-1} on shallow soil and 2,600-3,100 kg DM ha^{-1} year^{-1} on deep soil. The whole pasture P1 (102 ha) potential yield was assessed to 1,600 kg DM ha^{-1} year^{-1} and is grazed from 29th May until 3rd October (127 days) by 80 LU suckler cows. With a theoretical grass intake of 15 kg day^{-1} LU^{-1}, herd requirement reaches 1,594 kg DM ha^{-1} and fits to grass supply.

2. Climate and grass growth

In the study area, drought exerts less impact on highland than lowland pastures (Meisser *et al*., 2014). On summer pastures, evapotranspiration is lower and vegetation is more resistant to drought. Inter-annual climate variability is a great source of variation that influences production and grazing management. Especially late spring snow melting and severe summer drought affect pastures DM productivity. Figure 2 illustrates the **temporal variability** of pasture P2 production in the years 2014 (late and humid) and 2015 (early and dry).

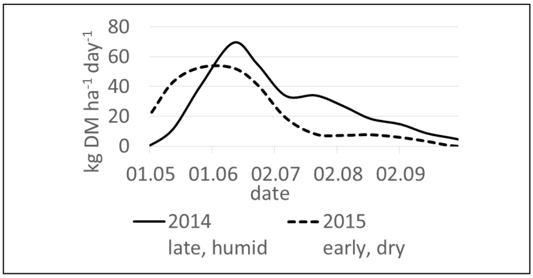

Fig. 2. Grass growth related to climate (P2, 2014-15).

Even if the mean grass growth rate from May to September was similar in both years (23.5 and 20.0 kg DM ha^{-1} day^{-1} in 2014 and 2015, respectively), grazing management was hardly constrained in 2015. Climate conditions influenced grassland with over yielding in spring and growth stop in summer. This unusual distribution of the DM production imposed changes such as an earlier leaving of herds in September.

3. Grazing management and grass utilisation

In 2014, two neighbour dairy summer pastures (P2 and P3) characterised by similar natural conditions and grazing systems (rotation on 6 paddocks) were investigated. Herders provided information on pasture and herd management, as well as milk production. Table 1 shows important differences between both pastures in terms of grazing intensity. The ratio surface per cow almost varies from single to double. The cows feeding requirement (concentrate and hay) as well as the milk production per cow were the highest for P3.

Table 1. Key numbers of two dairy pastures (P2 and P3, Wettstein and Lincio, 2014)

Pasture	Duration [days]	Surface [ha]	Dairy cows [nb]	Surface per cow [ha cow^{-1}]	Milk [kg cow^{-1} day^{-1}]	Concentrate [kg cow^{-1} day^{-1}]	Hay [kg cow^{-1} day^{-1}]
P2	111	42.5	28	1.5	16.6	0.9	0.0
P3	100	58.0	75	0.8	18.8	1.6	3.4

These data allowed calculating the hypothetical grass quantity grazed by cows. Figure 3 compares grass supply and intake and shows some unbalance. At the beginning of season, excess production and low intake led to biomass accumulation. This trend appears clearly in Figure 4, which illustrates the evolution of the grass cover issued from grass height measurement.

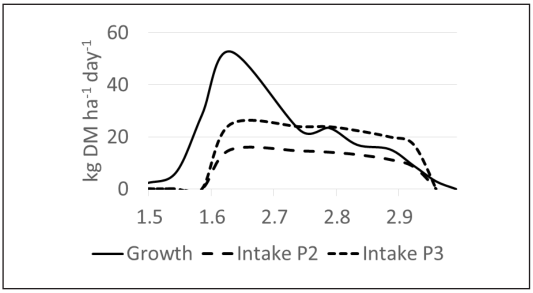

Fig. 3. Grass growth and intake (P2 and P3, 2014).

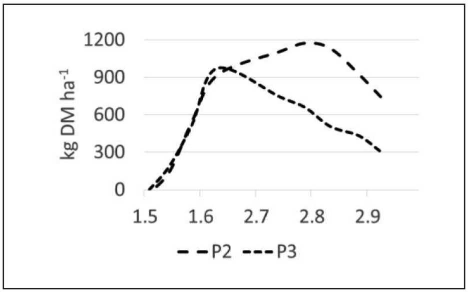

Fig. 4. Grass cover (P2 and P3, 2014).

This case study revealed that carrying capacity and grazing management widely differ in the same area. Anyway, an earlier begin of grazing and a regulation of the stocking rate by variation of the herd size should contribute to improve the pastures efficiency (Mosimann, 2007). In mid-September, dairy cows left both summer pastures and heifers were set on P2 in a way to clean residual grass before winter.

IV – Conclusions

Pastoral value (Daget and Poissonet, 1971) is suitable to link botanical composition and foraging potential of grassland, but the specific indexes of plants remain key factors (D'Ottavio *et al*., 2009; Lombardi *et al*., 2011). The method has been adapted to the Jura context, integrating specificities of wood pastures. It forms the basis for the calculation of carrying capacity in pastoral plans (Barbezat and Boquet, 2008). Although the annual DM yield estimation is good, it remains difficult to predict its temporal distribution. Grass growth measurement helps to understand the broad variation observed year after year by herders. Moreover, it facilitates the search for improvement factors, such as an adjustment of the herd size over the time. Regular assessment of the grass cover leads to constructive discussions on grazing management. However, agronomical recommendations must respect the political will to preserve mountain landscape and biodiversity. Optimisation of rangelands pastures carrying capacity should not compromise their long-term sustainability.

Acknowledgments

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