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A French classification of permanent grasslands at national level to evaluate their forage and environmental services

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Abstract

To demonstrate and quantify the forage and environmental services provided by permanent grasslands, a research program (2008-2011) was performed, including together INRA, Institut of Élevage and 23 extension services. A national network of 190 permanent grasslands was sampled in a database of 1500 grasslands, to represent the diversity of management and agro-climatic conditions, and has been studied for two years. On each plot, a botanical survey was carried out (2009). Grass production, functional composition of the grassland and forage nutritive value for ruminants were measured at four dates during the growing season (2009, 2010). Data of functional and botanical composition were analyzed to define 19 types of grasslands identifiable from a simple decision key (agro-climatic conditions, management). For each type, quantitative references of seasonal evolution of functional composition, biomass production and nutritive value are provided. The contribution of the different types of grasslands to ecosystemic services was evaluated.

Keywords: permanent grassland, classification, production, environmental value

Introduction

The contribution of permanent grasslands in the ruminant feeding is considerable and the economic interest of these surfaces in the fodder systems is now recognized. Their environmental interest is also important, e.g. fauna flora biodiversity (Farruggia *et al.*, 2008) or carbon sequestration (Soussana and Lüscher, 2007). However, these surfaces are decreasing in France for 50 years and are mainly replaced by maize for silage or more profitable annual crops. This decrease can be partly explained by a deficit of technical and scientific knowledge about the agronomic, ecological value and the management of the permanent grasslands. To revalue permanent grasslands in the forage systems, a R&D Program (funded by the French Ministry of Agriculture) was set up (2008-2011). The objective of this program was to build a reference tool (a classification) reporting the diversity of agronomic and environmental value and of some ecosystemic services of French permanent grasslands. This tool was intended for education and actors of development with the aim of managing better and valuing these surfaces in the fodder systems.

Material and methods

A set of 190 permanent grasslands was selected from 1500 listed by a survey conducted in 2008 on 78 farms (in which permanent grasslands represented more than 50% of forage area) distributed in the main lowland and mountain grassland areas of France except the Alps and

the Mediterranean area. Information concerning management practices and the characteristics of the permanent grasslands of the network (location, type of soil) were listed. Botanical composition (exhaustive inventory of the species and the estimation of their dominance) was determined in spring 2009 on each grassland in a homogeneous plant community (Michaud et al. 2011). The seasonal dynamic of forage production and nutritive value was assessed during 2009 and 2010 on the dominant homogeneous plant community of each grassland. The proportions of grasses, legumes and forbs were estimated visually, according to volume, and on a sub-sample of 40 tillers grasses the proportion of functional types were determined according Cruz et al. (2010). On dried samples, the nutritive value of the herbage (organic matter digestibility and crude protein content) was estimated using NIRS (Michaud et al. 2015).

Principal component analysis based on six criteria of vegetation (proportion of legumes in the beginning and at the end of spring, proportion of forbs at the end of spring, proportion of function type C in the beginning and at the end of spring, proportion of function type B at the end of spring) contributed to build a classification of permanent grasslands. A first classification based on this criteria of vegetation and criteria of nutritive value allowed to identify 15 types of permanent grasslands related to forage services. At the same time, a second classification based on criteria of the vegetation and criteria relevant for the prediction of the environmental value (floristic composition and dominance of entomophilous species) contributed to identify 12 types of grasslands related to environment services. The crossing of these two classifications ended in the classification in 19 defined types each by a particular combination of six characteristics of the vegetation retained. A key of determination allowing to recognize the types of grasslands was established by leaning mainly on the nature of the environment (height ...) and management of practices.

Results and discussion

The 19 types of permanent grasslands are distributed in four groups according to the characteristics of climate and height (Figure 1): mountain permanent grasslands (5 types), plains and hills with semi continental climate permanent grasslands (6 types), plains and hills oceanic permanent grasslands (5 types), atlantic coast permanent grasslands (3 types). The proportion of legumes in biomass contributes to discriminate semi continental permanent grasslands. Management practices and particularly fertilization contribute to discriminate all types of permanent grasslands.

The 19 types are described in a book (Launay *et al.* 2011). For each grassland type, an index card describes the geographical conditions, type of soil, management practices and the botanical characteristics (presence and dominance species). Proportion of grasses, legumes and forbs and stages of development, dry matter yield and nutritive value are given for the various periods of measures (Figure 2). These values allowed to estimate some ecosystemic services (biomass production, biodiversity, pollination). This tool field. Its ambition is to bring references of agronomic values and ecosystemic services provided by various types of permanent grasslands.

Conclusion

This national classification reports the diversity of French permanent grasslands and so the diversity of ecosystemic services provided. This classification of permanent grasslands constitutes a tool used in agronomic and environmental assessments. The methodology could be used in other European countries.

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Figure 1 Distribution of the types of permanent grasslands (--- Mountain permanent grasslands, - - Plains and hills with semi continental climate permanent grasslands, — Plains and hills oceanic permanent grasslands, ***** Atlantic coast permanent grasslands). A circle represents a partner farm of the project.



Figure 2. Example of references brought by the classification: a) biomass production marks for each type of permanent grasslands in t DM/ha/year, b) specific richness in each type of permanent grasslands (in number)

