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Profitability of permanent grasslands: How to manage them in a way that combines profitability, carbon sequestration and biodiversity?

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Abstract. The Focus Group "Profitability of Permanent Grassland" of the EIP-AGRI addressed the challenge of evaluating the current situation and defining paths for increasing profitability in a sustainable way. The multiple aspects of enhancing profitability and sustainability were grouped into seven key issues:

- Definition of a grassland typology in relation to their biodiversity and productivity.
- Achieving grassland production and quality that matches animal needs.
- Benchmarking grassland production.
- Increased grassland functionality through diversification of sward composition.
- Increased resource efficiency to improve profitability and sustainability.
- Differentiation of grass-based products for higher market value.
- Evaluation of the environmental impacts of grassland-based and livestock systems using Life Cycle Thinking.

The main conclusions include practical recommendations, the identification of relevant fail factors and ideas to overcome them, and potential innovative and research actions, such as:

- Provide farmers with appropriate technology to optimise grass production, including tools to better manage grazing systems.
- Integrate data sets at local level and implement ICT tools for interconnecting advisory services and other stakeholders.
- Develop benchmark systems.
- Develop management tools of animal-sward interactions to maximise productivity and biodiversity (including animals adapted to grassland management systems).
- Develop tools to describe ecosystem services and link grassland management to local demands.
- Define technical and political solutions to capture value of high quality products and ecosystem services.
- Evaluate grassland-based and livestock systems through Life Cycle Assessment.
- Develop knowledge production through a participatory process notably with Operational Groups.
- Identify different farmers' incentives for innovation and for using the innovative solutions.

Keywords. Management tools – Ecosystem services– Product quality – Participatory approaches.

Rentabilité des prairies permanentes : Comment les gérer de façon à combiner rentabilité, stockage du carbone et biodiversité ?

Résumé. Le Groupe Cible « Rentabilité des prairies permanentes » de l'EIP-AGRI a relevé le défi d'évaluer la situation actuelle et de définir des voies pour atteindre une plus grande productivité de manière durable. Les multiples aspects relatifs à l'augmentation de la productivité et de la durabilité ont été groupés en sept questions clés :

- Définition d'une typologie des prairies par rapport à leur biodiversité et productivité.
- Production de qualité qui répond aux besoins des animaux.
- Analyse comparative de la production des prairies.
- Fonctionnalité accrue des prairies par la diversification de la composition de leurs couverts.
- Augmentation de l'efficacité de l'utilisation des ressources pour améliorer la rentabilité et la durabilité.
- Différenciation des produits basés sur herbe pour une valeur marchande plus élevée.
- Évaluation des impacts sur l'environnement des systèmes basés sur les prairies et l'élevage en utilisant le Raisonnement du Cycle de Vie.

Les conclusions principales comprennent des recommandations pratiques, l'identification des facteurs d'échec, des idées pour les surmonter, et des actions potentielles innovantes et de recherche, comme :

- Fournir aux agriculteurs la technologie appropriée pour optimiser la production d'herbe, y compris au pâturage.
- Intégrer des ensembles de données au niveau local et mettre en œuvre les outils ICT pour mettre en réseau diverses parties prenantes.
- Développer des systèmes d'analyse comparative.
- Développer des outils de gestion des interactions entre animaux et couverts prairiaux pour maximiser la productivité et la biodiversité.
- Développer des outils pour décrire des services écosystémiques et faire correspondre la gestion des prairies aux demandes locales.
- Dégager des solutions techniques et politiques pour prendre en compte la valeur des produits de haute qualité et celle des services écosystémiques.
- Comparer les systèmes basés sur les prairies et l'élevage par l'Évaluation du Cycle de Vie.
- Développer la production de connaissances par un processus participatif notamment dans des Groupes Opérationnels.
- Identifier différents incitants pour les agriculteurs pour qu'ils innovent et utilisent ces innovations.

Mots-clés. Outils de gestion – Services écosystémiques – Qualité des produits – Approches participatives.

I – Introduction

In 2012, permanent grasslands (PG) covered more than 60 million hectares across the EU-28 according to Eurostat. They accounted for 34.6% of the total Utilised Agricultural Area (UAA), although there were large differences between countries. The highest percentages were found in Ireland (80% UAA), the United Kingdom (65%) and Slovenia (65%) (Huyghe *et al.*, 2014).

Permanent grasslands are by far the first crop in Europe although their area has declined due either to abandonment and afforestation, to urbanization or to conversion to arable crops including green maize. These changes affect many livestock production systems which play a role in maintaining natural resources such as local breeds and their associated products. They also influence PG biodiversity and ecosystem services they provide, e.g. C sequestration, cultural heritage, including the contribution to beautiful and living landscapes.

Within the context of the European Innovation Partnerships for Agricultural Productivity and Sustainability (EIP-AGRI), several Focus Groups (FG) were created for "helping the agricultural and forestry sectors to become more productive, sustainable and capable of tackling current challenges such as fiercer competition, more volatile market prices, climate change and stricter environmental rules" (<http://ec.europa.eu/eip/agriculture/>).

All the aspects mentioned above on permanent grasslands motivated the creation of a Focus Group "Profitability of Permanent Grassland". In 2014 and 2015, this FG regularly met and addressed the challenge of evaluating the current situation, the status, the constraints and the perspectives for these habitats and their related rural communities. The group included farmers, farmers' advisers, representatives of Farmers Unions and other NGOs, and scientists.

PGs were defined as "any land/vegetation that can be grazed/mown and that has not been included in the crop rotation of the holding for a minimum of five years, independently of the type of vegetation, the type of animal or the type of farming system". Other definitions are though available in Europe such as the one of the EC Regulation N° 1307/2013 published on 17 December 2013 and that of a group of recognised grassland scientists (Peeters *et al.*, 2014).

The full report of the Focus Group is available on the web site: <https://ec.europa.eu/eip/agriculture/en/content/profitability-permanent-grassland>.

II – Permanent grassland issues or functions

The Focus Group clustered the multiple aspects of enhancing permanent grassland productivity and sustainability into seven key issues:

1. Definition of a grassland typology in relation to their biodiversity and productivity.
2. Achieving grassland production and quality that match animal needs.
3. Benchmarking grassland production and its utilisation at regional and national levels.
4. Increased grassland functionality through diversification of sward composition.
5. Increased resource efficiency to improve profitability and sustainability.
6. Differentiation of grass-based products for higher market value.
7. Evaluation of the environmental impacts of grassland-based and livestock systems by using Life Cycle Thinking (LCT).

The seven topics identified by the Focus Group are interrelated (Fig. 1).

European farmers deal with very different environmental and socio-economic conditions. For this reason, permanent grasslands are not uniform and neither are the associated production systems. Therefore a proper typology of PG is needed (Issue 1) to evaluate their potential from economic and environmental perspectives (Peeters, 2015). By understanding the diversity of management scenarios linked to the diversity of PG, their quality and quantity can be increased as well as the efficient use of available resources. In particular, the FG discussed which tools and strategies farmers can apply to match animal needs (Issue 2).

Proper data and benchmarks are needed at site and region levels to increase profitability (Issue 3). By benchmarking grass production and establishing the reasons for differences in grass output, botanical composition, grazing season length, ratio of grazing to harvesting, etc., a better understanding of PG potential and management could be obtained. The FG discussed tools that could be used at farm level by farmers to increase their knowledge with reference to the benchmarks of their farm.

The sustainable management of PG requires a compromise between different factors (Issue 4). The challenge when balancing sward composition is to optimise productivity, climate adaptation, environmental impact or nutrient efficiency by improving functional group diversity of sward species. Sward components vary in their morphological characteristics, feeding quality, nutrient uptake, water needs, etc. Therefore, their relative presence significantly affects animal performance, health and welfare, as well as product quality and environmental impact. Functional benefits of increasing sward diversity should be appreciated when considering simultaneously productivity and ecosystem processes and services.

Proper resource use efficiency (land, vegetation and animal) should be optimised. This involves considering trade-offs between profitable use and delivery of ecosystem services by using a minimum level of complementary external inputs to ensure profitability (Issue 5). It also requires that the livestock type is adapted at different levels (Ferreira *et al.*, 2013) to local resources and to a forage self-sufficient system (Osoro *et al.*, 2015).

There is a great potential to add value to products from PG. The FG explored how premium grassland-based products can achieve a high market value (Issue 6).

Maximising positive ecological impacts (Rosa *et al.*, 2013) could be highlighted to improve competitiveness of grassland-based farming through market mechanisms or by public incentives linked to enhanced services provided to society. Life Cycle Thinking approaches and evaluation methods should help to accordingly identify, quantify and showcase ecosystem services provided by PG-based farms (Issue 7). This is particularly important for PG located on marginal lands or within protected and High Nature Value (HNV) areas.

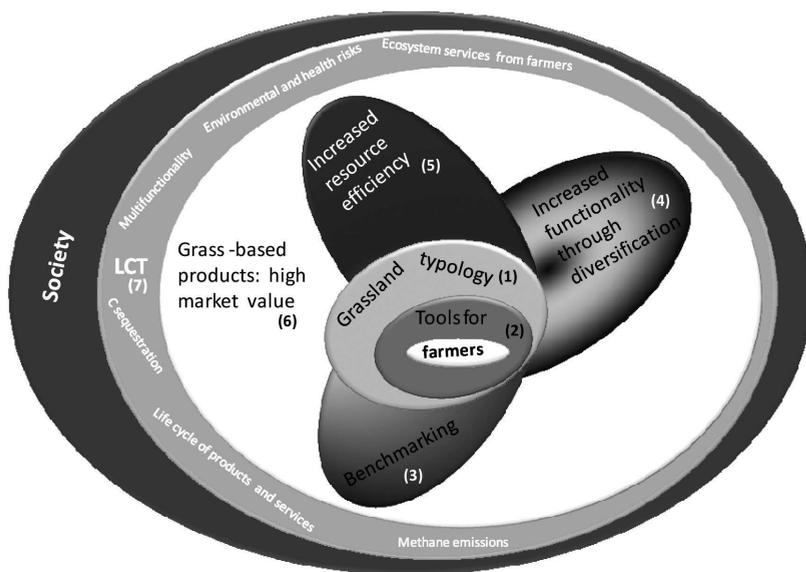


Fig. 1. Relationship and interactions between issues (issue number in brackets).

III – Innovative actions and research needs: a summary of the Focus Group findings

1. Definition of grassland typology in relation to their biodiversity and productivity

Innovative actions

- Create a typology of permanent grasslands according to their multi-functionality, particularly to their productivity and biodiversity values.
- Document easy-to-use indicators for PG identification based on their production potential, management and main ecological conditions.
- Document ecological relationships among PG types that can be used in management: how to maintain PG types or how to move from one type to another.
- Map PG types and adapt existing vegetation maps to PG typology and Land Parcel Information System maps.

Research needs

- Design new methods and tools to evaluate the role of functional biodiversity in the field, including legumes and woody vegetation.
- Develop comparable botanical methods easily implemented at plot and farm level for a variety of vegetation types.
- Develop remote sensing based technologies and statistical classification techniques for easy and broad scale classification.
- Develop models to better understand interactions among biodiversity components for different soil and climate conditions.

2. Achieving grassland production that matches animal needs

Innovative actions

- Develop methods to quickly measure grass yield.
- Promote “brain storming” and learning processes in mixed groups, where farmers could learn from farmers and other stakeholders, and could identify possible solutions.
- Develop internet/smartphone applications for grassland management (e.g. grazing planning, grazing measurements, assessing forage quality, etc.).
- Put into practice tools that can help farmers to identify the critical animal body condition at periods affecting productivity, such as before mating, calving/lambing, and finishing before slaughter.

Research needs

- Develop models to predict grass growth for assisting farmers in managing a fluctuating grass supply. Develop practical tools (robust, simple to use and appealing) taking advantage of the large amount of information already available in farm-related databases and territorial information systems.
- Increase yield through a combination of an extension the grass growing season in areas where the weather allows this, more focussed plant breeding, use of forage mixtures (including legumes and woody vegetation), smart fertilisation, dynamic and flexible stocking systems.
- Develop novel grazing systems (large-scale, high/medium/low productive, highly automated) that are technically and socially feasible, economically viable and environmentally sound.
- Design new strategies to convert grassland management into an attractive activity for young generations.
- Develop the concept and methods for precision grazing which include all components of agroecosystems, particularly plant-animal-product interactions.

3. Benchmarking European grassland production and utilisation at national and regional levels

Innovative actions

- Select measuring tools (visual assessment, plate meter, stick, palatable species height, etc.) to estimate dry matter production adapted to different grassland types.
- Develop national and Europe-wide grassland databases. These databases would be populated with data from commercial farms within Member States.
- Increase measurements of dry matter production, quality and biodiversity across Member States. Integrate these data in a grassland measurement network.

Research needs

- Further investigate the potential of plant species to provide bioactive compounds, biomass production, etc.
- Improve grass growth prediction at regional, national and international levels.
- Integrate the following knowledge into a database for subsequent analyses, development of models and practical tools:
 - Potential dry matter production levels and seasonal distribution that can be achieved in different kinds of PG in Europe.

- Estimation of production cost of grass as a feed and definition of a common methodology for all EU Member States.
- Yield variation between EU Member States, accounting for soil type, climate, grazing animal type, management etc.

4. Increased grassland functionality through diversification of sward composition

Innovative actions

- Develop new methods for introducing legumes and herbs into pasture to enhance productivity, digestibility and herbage intake by grazing animals.
- Select multi-species mixtures with different growth patterns for PG establishment and renovation under different soil and climate conditions and linked to different animal species and breeds.
- Develop and optimise types, density and distribution of trees and shrubs using agroforestry practices (hedges, wooded pasture, multi-purpose woody vegetation).
- Use legumes, forbs and shrubs rich in tannins to maximise protein utilisation, prevent bloat, suppress internal parasites and produce healthier food.
- Optimise and/or develop new forage conservation techniques to avoid nutrient losses, mitigate the risk of forage contamination (e.g. mycotoxins) and minimise the use of maize silage and concentrates.

Research needs

- Optimise the combination of the extension the growing season, plant breeding, use of mixed dynamic stocking systems.
- Breed new forage species better adapted to extreme weather conditions.
- Identify seed mixtures for each soil/climate condition and production system (dairy, meat, cattle, sheep, goats, horses, etc.) by using different functional groups.
- Improve legume management by grazing for better persistence and intake.
- Monitor grassland production by remote sensing.

5. Increased resource efficiency

Innovative actions

- Inform farmers on pasture growth in specific locality: use of the ‘big data’ concept to enable matching grass growth with input utilisation and outputs.
- Improve fertilisation strategies to increase grassland production with less input.
- Develop and promote new systems of mixed grazing (for cleaner grazing with fewer parasite eggs, better use and higher animal and grassland growth rates).
- Improve grazing practices and strategies to reduce the parasite burden, especially on meadows. Look for plants containing condensed tannins or other beneficial animal nutrients associated with legumes, other herbaceous dicotyledons and shrubs.
- Optimise silvo-pastoral practices to promote efficient production of milk, meat, bio-energy, biodiversity etc.
- Reduce labour by using new technology to supervise animals on large areas.

Research needs

- Improve understanding of the association of microorganisms with plants, to promote plant uptake of soil nutrients.
- Find adequate productive and persistent legume and woody species, cultivars and their respective Rhizobia adapted to variable soil and climate conditions.
- Develop knowledge on soil microorganisms, inoculants and processes which, in association with plants, may be able to solubilise P (e.g. *Pseudomonas*) and/or extend the plant rhizosphere (e.g. arbuscular mycorrhiza) and their potential use for improving legume growth and woody vegetation.
- Establish methods or practices to avoid negative interference between extensive production systems and predators to avoid conflicts between farmers-shepherds and other groups (e.g. nature conservationists).
- Identify the main factors preventing farmers from using PG and affecting farm management: current policies, authorities, markets, lack of cooperatives, limited access to credit, extension and technical information, access to slaughter houses, vets, etc. (especially on small farms and marginal areas).

6. Differentiation of grass-based products for higher market value: linking quality traits and management practices

Innovative actions

- Define marketing arguments ensuring valorisation of permanent grassland-based products to consumers (e.g. by promoting local breeds and cultures).
- Develop mobile applications making easy product marketing and delivery from remote PG areas.
- Adapt legislation to control food safety of homemade products, so that they can be implemented in rural conditions.
- Improve communication to increase citizens' awareness about the characteristics and functionalities of this type of products.

Research needs

- Identify a set of markers to allow product identification in relation with management practices and/or origin. Optimise authentication and traceability protocols minimising the bureaucratic effort for farmers. Exploit the potential of ICT-based tools.
- Develop affordable and rapid analytical methods for routine authentication and traceability, including a validation at local level under controlled conditions or on-farm on a large scale.
- Establish ways to help farmers to identify society preferences for their products.
- Refine understanding of the effect of botanically diverse composition of PG on the product biochemical composition, quality and functionality.
- Appraise the relevance of ecosystem services for product improvement. Study and model the trade-offs between product quality traits and other ecosystem services.

7. Life cycle assessment: evaluation of the environmental impacts of grassland-based and livestock systems using Life Cycle Thinking (LCT)

Innovative actions

- Develop user-friendly, inter-operable indicators and tools at farm scale for LCT assessment of PG-based and livestock farms.
- Integrate data sets at local and regional levels by a participatory approach integrating different stakeholder types to provide an accurate dynamic picture to the market.
- Design new strategies and tools to communicate to final consumers LCT assessments of PG systems (i.e. territorial committees of stakeholders where farmers and consumers directly participate, using social media to improve connections between rural and urban life, to form a network of educational grassland-based farms).

Research needs

- Assess the role of PG on soil erosion control, wildfire prevention, carbon sequestration, enhanced biodiversity and products with functional components from LCT perspective.
- Further develop and apply LCT to support scientifically sound methodological choices enabling a harmonised assessment of improvement options for social acceptability of agricultural systems.

IV – Fail factors and solutions

A summary of the identified fail factors of PG systems is presented in Figure 2. It shows the complex interactions among different components of the systems. This complexity is also reflected by the multi-dimensional and multi-level fail factors: *i.e.* PG are not directly marketed but are the main resource for different types of livestock productions and, at the same time, they deliver many important ecosystem services, which are often not properly assessed and rewarded. The more complex the value chain, the more potential failures at different steps.

The first step for designing new solutions is to recognise the need to involve all actors, that their actions have multiple consequences, and that the responsibility for system maintenance and development should be assumed by all. This includes farmers, scientists, advisers, official institutions, enterprises, and consumers.

The Focus Group sought to identify innovative ideas or actions, which would address the different problems within each section of fail factors (Fig. 3). These can be grouped under six generic headings:

1. improved knowledge/information/expertise;
2. enhanced investment in research/education;
3. enhanced resources (actors/tools);
4. reduced bureaucratic and regulatory restrictions;
5. improved marketing infrastructure;
6. enhanced stakeholder communication.

The proposed improvements at different levels in agricultural knowledge and innovation systems should result in numerous innovative actions to improve PG management. However, some other failures directly affecting productivity and sustainability may be difficult to address. For example,

how to stop land abandonment in marginal areas where there are still big problems with social services. There are also more subtle problems linked to socio-economic matters, even cultural issues. For example, young farmers have to follow protocols accepted in their family/community, or fight against values linked to many PG regions. Breaking from these will not be easy. Such fail factors linked to young farmers, should be given priority as they will be responsible for the future. Other actions may need a change of philosophy within community groups. Farmers assuming risks and getting involved as stakeholders, will have to take a more business-like approach to farm management, and should be encouraged to sell their products directly to local markets, thereby helping to maintain a vibrant rural economy and a cohesive rural society. Getting citizens to accept their direct or indirect responsibility for the continued existence of PG is also difficult, given the physical, social and economic differences that often exist between rural and urban communities. However, this issue must be tackled. Likewise it is important that public institutions recognise their role in searching for solutions which take into account all stakeholders, the peculiarities of each situation, and most importantly, which are independent of political scenarios.

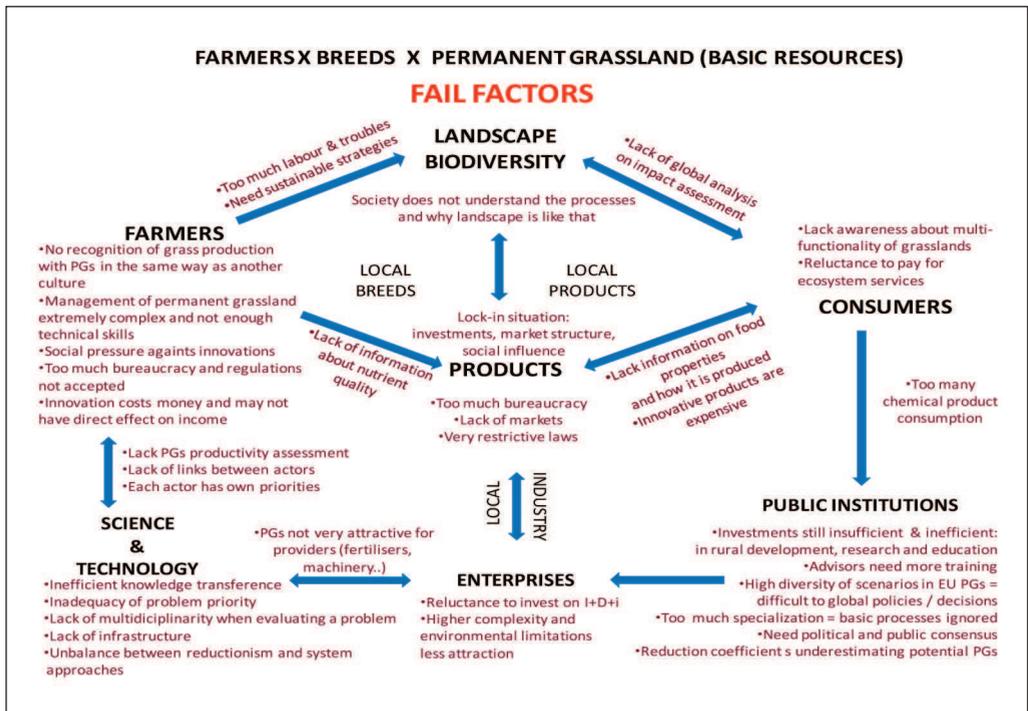


Fig. 2. Summary of fail factors linked to the sustainable development of permanent grasslands.

Development needs

- Share knowledge between farmers, scientists and other stakeholders about the management of PG in a participatory approach (F).
- Use demonstration/pilot farms.
- Manage animal/sward performance to maximise productivity, biodiversity, carbon sequestration and climate change adaptation (F).
- Identify animal/grassland systems adapted to available resources and markets.
- Increase biodiversity in agri-environmental measures (adding product value-labelling).

More efforts in participatory and holistic approaches with farmers are required, with a special focus on the correct use of the different management strategies adapted to local conditions. Ecosystem services which currently have no market value may become valuable also in monetary terms in the future and farmers may also, therefore, seek to maximise ecosystem service values. After two or three decades of research, the contribution of farmers to their provision is still not quantified in practical terms. LCA approaches should be developed to assess PG systems and to fill in this gap.

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