EIP-AGRI Focus Group

Profitability of permanent grassland

FINAL REPORT
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1. Summary

The Focus Group 'Profitability of Permanent Grassland' addressed the challenge of evaluating the current situation of Permanent Grassland (PGs) and the required paths for increasing their productivity in a sustainable way.
The Focus Group (FG) recognised that it is a very broad topic and that PG systems and management strategies in Europe are very diverse. The FG grouped the multiple aspects of enhancing permanent grassland productivity and sustainability into seven key issues:

- Definition of a grassland typology in relation to biodiversity and productivity
- Achieving grassland production and quality that matches animal needs
- Benchmarking grassland dry matter (DM) production and its utilisation at regional and national levels
- Increased grassland functionality through the diversification of sward composition
- Increase resource efficiency to improve profitability and sustainability
- Differentiation of grass-based products for higher market value: linking quality traits and management practices related to ecosystem services
- Life cycle assessment: evaluation of the environmental impacts of grassland-based systems using Life Cycle Thinking (LCT)

These seven issues are seen as operational goals to address the overall aim of enhancing profitability and sustainability of PGs. The main conclusions of each of these seven issues 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 ways to identify and manage better grazing systems (Decision Support Tools, ICT, Big Data)
- Integrate data sets at local level and implement ICT tools for interconnecting advisory services and other stakeholders, and also developing benchmark systems for permanent grassland (for instance for future dairy and beef farms)
- Develop management tools for animal-sward optimisation to maximise productivity and biodiversity (including adapted animals to grassland systems).
- Develop tools to describe services and link permanent grassland to local demands
- Technical and political solutions to capture value of high quality products and ecosystem services to improve farmers' quality of life
- Integration of PG objectives through Life Cycle Assessment: regionalise ecosystem services prior to inclusion in a permanent grassland management framework
- Approach knowledge transfer as a participatory process of Operational Groups (Rural Development Programmes)
- Identify different farmers' incentives for innovation and use this knowledge in development and transfer

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2. Introduction

Permanent grassland (PG) cover more than 60 million hectares across the EU-28 according to Eurostat data for 2012. They account for 34.6% of the total Utilised Agricultural Area (UAA), although there are differences between countries. The highest percentages are found in Ireland (80% of the UAA), the United Kingdom (65%) and Slovenia (65%). In Mediterranean countries such as Spain, Portugal or Greece there are over 12 million ha of PG in total, covering around 44% of their UAA (see Starting Paper in Annex 7).

Nevertheless, the area of PGs in Europe has declined due either to abandonment and afforestation or to intensification, specifically conversion to maize or arable crops. At the beginning of the 21st century, 60% of the newly afforested areas in the EU were formerly permanent pasture or meadows (European Commission, 2008). Abandonment of semi-natural pastures, especially the least accessible ones, in certain areas and concentration of the stock on more productive land are becoming increasingly common, as observed for example in the United Kingdom (McCracken et al., 2011), Spain (Iragui Yoldi et al., 2010) and Sweden (Jordbruksverket, 2010).

These changes affect many livestock production systems which play a role in maintaining natural resources such as local breeds and their products. They also influence the ecosystem services provided by PG: e.g. C sequestration, supporting biodiversity, contribution to cultural heritage, including the contribution to beautiful and living landscapes for residents and for recreation or tourism.

The maintenance of PG then became one of the highlights of the new Common Agricultural Policy (CAP), especially through the establishment of the greening payments which are paid if certain practices which are 'beneficial to environment and climate' are respected and this includes the maintenance of permanent grassland.

All these aspects provided the baseline for the creation of the Focus Group (FG) of 20 experts (Annex 56) to evaluate the status, constraints and possibilities for these habitats and the rural communities linked to them.

Definition of Permanent Grassland

The latest definition of permanent grassland/pastures was included in the Regulation Nº 1307/2013 published 17 December 2013, which defines PGs and permanent pastures in Article 4 as the "*land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or more, it may include other species such as shrubs and/or trees which can be grazed provided that the grasses and other herbaceous forage remain predominant as well as, where Member States so decide, land which can be grazed and which forms part of established local practices where grasses and other herbaceous forage are traditionally not predominant in grazing areas.*"

The definition of PG includes herbaceous and non-herbaceous permanent pastures which provide essential forage in many semi-intensive and extensive livestock systems, especially in more marginal regions. These systems account for multiple key ecosystem services in some of Europe's most bio-diverse habitats (Rigueiro et al., 2009): from heathlands, Montados or Dehesas to mountains grazed by reindeer, and semi-natural pastures such as in Scandinavia or Romania. Maintaining these agroecosystems can help reduce fire risks, and maintain open landscapes with high levels of biodiversity and cultural heritage, generally grazed by local breeds and wildlife.

Within the frame of this Focus Group, "Permanent grassland" will be referred to 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 (more or less herbaceous), the type of animal (cows, sheep, goats, horses, pigs, hens…) or the type of farming system (intensive/extensive; meat/milk, etc.)".

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Diverse functions of grassland

The analysis of the current status and the future perspectives of PG has to consider an extremely wide diversity: from the drier shrub-dominated Mediterranean areas passing through the grassland of the Continental and Atlantic zones up to the extreme and mostly forested Alpine and Boreal regions. This diversity of conditions is associated with a wide variety of management strategies adapted to local characteristics including forage crops, grassland for livestock production, several animal species and breeds with different products (milk, meat, fibre, etc.) and combinations of the these and silvopastoral systems (Mosquera-Losada et al. 2006) (Annex 2).

Grassland provide forage and other key resources for a livestock sector which contributes significantly to European agricultural income. PGs also provide a number of environmental and social benefits and added-value products usually under different geographical indications (PDO, PGI, etc.). The benefits are linked to the territory; production and conservation are frequently associated with sustainable traditional strategies based on the management of different breeds and vegetation types, especially local ones, therefore acting as biodiversity reservoirs. All of these facts are increasingly acknowledged and, therefore, maintaining PG has become a key element in the Greening of the CAP, and for the conservation of rich local cultures and traditions.

Slowing down and reversing the decline of PGs is one of the biggest challenges in order to maintain European biodiversity and wider ecosystem services (Isselstein et al., 2005; Rosa García et al., 2013; Huyghe et al., 2014). It is also vital for the social fabric of some rural areas, especially in many marginal regions, and for maintaining and enhancing location-specific and high quality products based on traditional practices and local breeds. Furthermore, also the more intensively used grassland of Europe serve multifunctional purposes ranging from providing local fodder for animal husbandry (and hence food for citizens) to biodiversity, to maintaining traditional landscapes that European citizens appreciate for recreational purposes.

The large acreage of grassland, the numerous economic and environmental benefits that grassland swards provide and the challenges they face are important reasons to seek innovations in grassland management, regulation and protection. More information about the role and situation of PGs in Europe can be found in the Starting Paper of the FG (Annex 7).

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3. Objectives of the EIP-AGRI Focus Group on Permanent Grassland

The Focus Group discussed how to improve PG management and profitability, while maintaining their biodiversity value and capacity for carbon sequestration. The FG clarified the interrelationships between these functions, looking towards the sustainable management of PGs, while providing high quality products (including PDO, PGI, etc.). The experts combined their personal experience with the available evidence from relevant research projects (Annex 3). They also explored potential innovative actions to overcome the fail factors identified (chapter 5), including ideas for Operational Groups funded through the Rural Development Programmes 2014-2020.

The EIP-AGRI Focus Group on PG had a number of specific tasks:

- Identify and describe the **main farming systems** using permanent grassland.
- Define **practices on PGs to improve efficiency, productivity and profitability** of animal production systems.
- Identify **practices which** improve PG composition to develop **premium and functional products**.
- Identify PG management **practices which enhance animal health and welfare**.
- Define **key traits** that relate PG management with **biodiversity and carbon footprint and find examples of strategies that combine** maintenance or enhancement of biodiversity and low carbon footprint.
- Identify **fail factors that limit the use of the identified techniques/systems** by farmers and summarise how to address these factors.

These tasks were accomplished following this sequence:

a) Identifying good management strategies, practices and techniques to increase productivity for different vegetation, agro and edaphic climatic conditions and livestock cultures in Europe.
b) Evaluate the strategies identified with regards to animal health-product quality, biodiversity and carbon footprint.
c) Identify a list of gaps that may need further research, the development of innovation projects, social initiatives, etc.

Key issues for productivity and sustainability of Permanent Grassland

In order to understand the potential role of PGs in European farms, farmers, advisers, scientists, policy makers and other stakeholders need to identify the crucial factors and associated mechanisms which affect their present and future profitability and sustainability. Unfortunately, most studies have examined the effects and mechanisms of only one or a few influential factors without considering others that may play a relevant role on the system. Nevertheless, permanent grassland and the associated livestock systems are very diverse, and they also influence and are influenced by a broad range of economic, environmental and social factors.

The experts prioritised seven key issues to enhance productivity and sustainability of PGs. These seven issues compiled the most relevant aspects and positive interactions among them for efficiency and productivity, animal health and welfare, biodiversity conservation and carbon footprint reduction as well as provision of premium and functional products. For each issue, the group evaluated the current situation and recommended new practices and innovations based on future perspectives and research according to their productivity, multifunctionality and complexity.

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The present report is therefore structured according to these seven key issues:

- Definition of a grassland typology in relation to biodiversity and productivity
- Achieving grassland production and quality that matches animal needs
- Benchmarking grassland dry matter (DM) production and use at regional and national levels
- Increased grassland functionality through diversification of sward composition.
- Increasing resource efficiency to improve profitability and sustainability
- Differentiation of grass-based products for higher market value: linking quality traits and management practices related to the ecosystem services
- Life cycle assessment: evaluation of the environmental impacts of grassland-based systems using Life Cycle Thinking (LCT)

These seven issues are interrelated (Figure 1). Research, innovation and practice within one of them should therefore consider the inter-relationships in the system to achieve the final objectives from agricultural, environmental and social points of view.

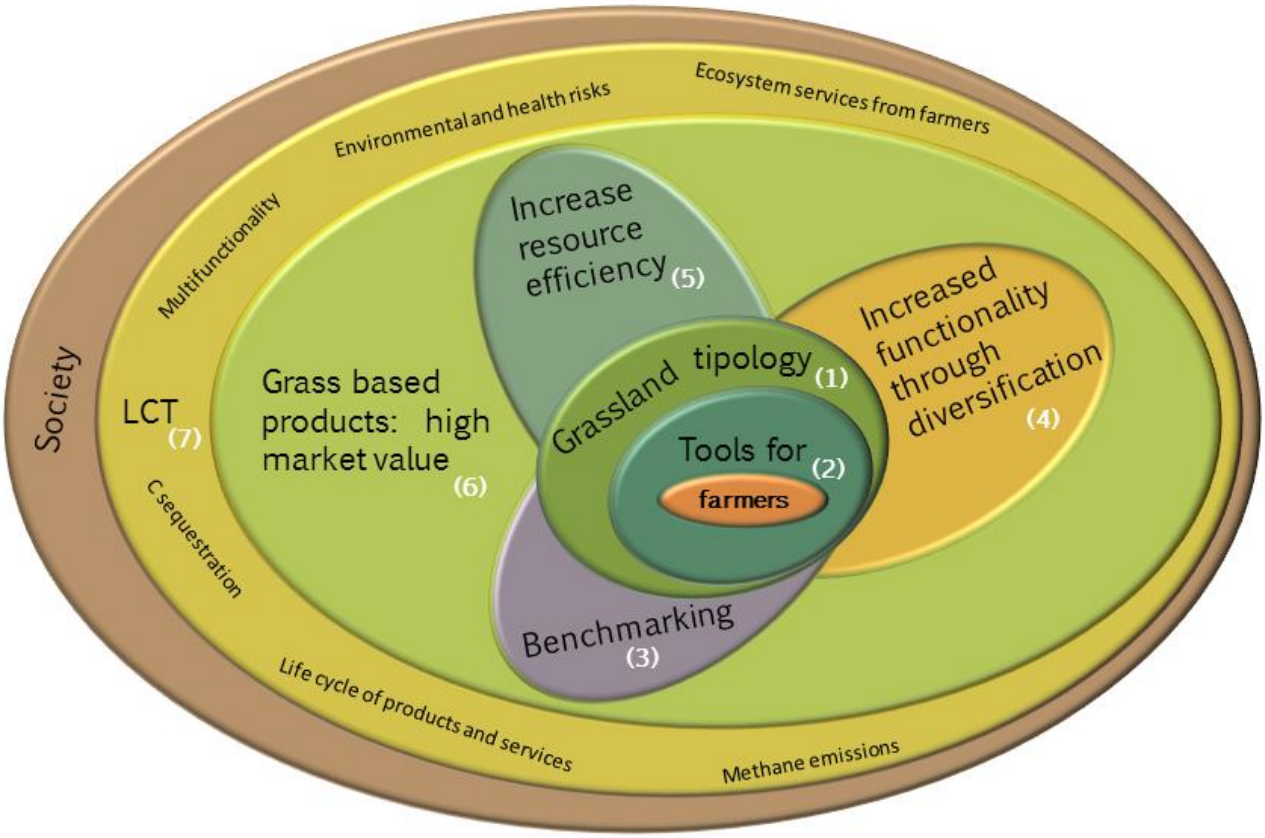

Figure 1. Level of relationship and interaction between the issues identified by the EIP-AGRI Focus Group 'Profitability of Permanent Grassland' (in brackets the issue number)

The seven topics cover important aspects of PGs that are interrelated because PGs are multifunctional (see Figure 1). We explain below the relationship among the topics.

Farmers in Europe deal with very different environmental and socio-economic conditions. For this reason, PGs are not uniform (Peeters et al., 2014) and neither are the associated production systems. Therefore **a proper typology of PGs is needed** (Issue 1) to evaluate their potential productivity from an economic and environmental perspective. By understanding the diversity of scenarios linked to the diversity of PGs,

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we can increase their quality and quantity as well as the efficient use of the available resources. In particular, the FG discussed **which tools and strategies farmers can apply to match animal needs in relation to changing weather conditions and within their different locations** (Issue 2).

Proper data and benchmarks are needed for each site and region to increase profitability (Issue 3). By benchmarking grass dry matter production and establishing the reasons for differences in grass output, botanical composition, grazing season length, ratio of grazing to harvesting, etc., a clearer view of the level of use can be developed. This FG discussed which tools will work at farm level and can be used by farmers to increase their grassland knowledge with reference to the benchmarks of their regions/areas.

The sustainable management of PGs demands a compromise between different factors (Issue 4). The challenge when balancing the 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, chemical composition, oligo-elements, bioactive compounds, nutrient uptake, water needs, etc. Therefore, their relative presence significantly affects animal performance, health and welfare, and also product quality (meat, milk, cheese, fiber, etc.) and environmental performance. Functional benefits of increasing sward diversity can only be appreciated when both productivity and ecosystem processes and services are considered simultaneously.

Another step should aim to **increase proper resource use efficiency (land, vegetation and animal).** This involves considering tradeoffs between profitable use and delivering ecosystem services, only using a minimum level of complementary external inputs which is sufficient to ensure profitability (Issue 5). It also requires that livestock can efficiently convert their feed into profitable output.

Farmers' efforts to obtain products (meat, milk, wool, fibre, etc.), together with environmental services, will allow them to maintain their enterprise in a profitable but also sustainable way. There is also a great potential to add value to products from PGs. The FG explored how to **provide a sound link between premium grassland-based products and their quality** in order to achieve a high market value based on food safety (Issue 6).

Besides, maximising positive ecological impacts is an important factor to improve competitiveness of grassland-based farming through market mechanisms or by public incentives linked to enhanced services to society**. Life Cycle Thinking approaches and evaluation methods will help to accordingly identify, quantify and showcase ecosystem services provided by PG-based farms** (Issue 7). This is particularly important for PGs located on marginal lands or within protected and High Nature Value (HNV) areas as well as taking into account climate change scenarios.

Each of the issues addressed by the FG is summarised in Chapter 4, and more detailed information is provided in the discussion papers included in Annex 8.

The main conclusions include practical recommendations (Annex 2), the identification of relevant fail factors and ideas to overcome them (Chapter 5), and potential innovative and research actions (a summary of priorities is presented in Chapter 6). A summary of previous EU projects which have addressed some of the key issues of PG either completely or partially is included in Annex 3. These projects have provided significant improvement of knowledge, but further research is clearly needed in many areas, from the research itself to the improvement in adoption strategies and in innovation tools (Annex 4).

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4. Main issues for productivity and sustainability of permanent grassland: a summary of FG findings

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

Permanent grassland embrace a complex variety of agricultural habitats with different forage productivity and capacities to produce ecosystem services and goods for society. PG variety results from diverse climates, soils and management strategies at different levels (farm, local and regional). Current ecological typologies do not reflect the diversity and quality of PGs as they usually do not consider the variability caused by management practices. To classify them properly, their ecological value and the management practices should be evaluated. It is essential for farmers to know their type of PG, its productivity and potential to cover animal needs as well as the ecological characteristics.

This key issue is analysed at three levels:

- At farm level. Farmers need information and support on the productivity and ecological value of their PGs to make management decisions regarding productivity, sustainability and profitability.
- At regional level. Evaluate the potential of regional grassland typologies to satisfy animal production needs and to produce differentiated regional products targeting niche or added value markets, identifiable by PDO, PGI, etc.,.
- At European level. There is currently no PG classification linked to productivity and biodiversity values. This could be implemented in Common Agricultural Policy (CAP) land recording mechanisms (e.g. LPIS) to better support the provision of ecosystem services.

Innovative actions

- Creating a typology of PGs according to their multi-functionality (including animal welfare) and their productivity-biodiversity value. The EU global habitat classifications (European Nature Information System, phytosociology, European Grassland Federation) could be adapted for PG classification according to biodiversity/productivity. The framework provided by the Habitats of Annex I of Directive EU 92/43 could be starting point.
- Document easy-to-use indicators for PG identification based on their production potential, farming management and main environmental conditions.
- Develop manuals to clearly define PG types at field level so that farmers, technicians and inspectors use a common language.
- Document ecological relationships among PG types that can be used in management: how to maintain PG types or how to change from one type to another.
- Mapping of PG types. Adapt existing vegetation maps to PG typology and Land Parcel Information System maps. For example, Natura 2000 sites are usually mapped at a useful scale using Annex I of Directive 92/43 as legend.

Research needs

- New methods and tools to evaluate functional biodiversity in the field, including legumes and woody vegetation.
- Develop comparable botanical methods for evaluation depending on the type of vegetation (i.e. herbaceous, woody, mixtures of trees with other vegetation types, etc.)
- Easy implementation at plot and farm level- simplify field indicators while maintaining their precision
- Develop remote sensing based technologies and statistical classification techniques for easy and broad scale classification.
- Development of models to better understand interactions among biodiversity components for the different soil and climate conditions

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2. Achieving grassland production that matches animal needs

For every grassland based livestock farm, the ideal target is that the forage produced matches animal needs. These two variables – forage allowance and feed requirements – are mainly dependent on the stable components of the farm: (a) Animals: breed, species, number and annual/seasonal productivity (milk, meat, fibre); (b) grassland: type, area, botanical composition, annual/seasonal productivity and nutritive quality, but also (c) on the weather and soil characteristics and labour availability. In fact, farmers need to adapt to the short-term variability of PG production generated by changing weather.

To address this issue, we need to answer the following questions:

- How to help farmers to manage their grassland production (quantity and quality) regarding the needs of animals and improving profitability of the farm?
- How to do this for the variety of ecological conditions, types of grassland and livestock systems?
- How can it be approached, considering key aspects such as weather variability and labour availability?

Innovative actions

- Develop methods to measure grass yield in a less time-consuming way
- Develop tools by establishing models to predict grass growth to assist 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; e.g. managing a fluctuating grass supply or assessing forage quality.
- Promoting 'brain storming' and learning processes in mixed groups, where farmers learn from farmers and other stakeholders, and identified challenges and possible solutions could be handled as innovation projects by Operational Groups
- Develop internet/Smartphone applications for grassland management (e.g. grazing planning, grazing measurements, assessing forage quality, etc.). For example, **www.dairynz.co.nz** holds a good number of tools/applications that can serve as an example of what could be made accessible to EU livestock farmers at regional, national or international level (see e.g. **http://pasture-growth-forecaster.dairynz.co.nz/** .
- Put into practice tools that can help famers to identify the critical animal body condition at moments affecting productivity, like before mating, calving/lambing, finishing before slaughter

Research needs

- Increase the potential yield through a combination of extending the grass growing season in areas where the weather allows this, more focussed plant (perennial ryegrass and clover) breeding, use of mixtures of plant species (including legumes and woody vegetation), smart fertilisation and dynamic and flexible stocking systems
- Develop novel grazing systems for farms (large-scale, high/medium/low productive, highly automated) that are: i) technically and socially feasible, ii) economically viable and iii) environmentally sound
- Differences in grazing behaviour, diet selection and energy needs of different species, breeds, mixed flocks and production (milk, meat, fibre, ecosystem services) to search for flexibility with respect to grassland production

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- Determine the fundamental processes of a resilient grazing system, e.g. grass growing curves, senescence and decomposition, proportion of grass consumed by grazing and by harvesting in different seasons and sustainable grass utilisation levels. Accordingly, design essential decision support tools (cutting/grazing/cutting+grazing, etc.) to achieve high levels of grass utilisation which will differ across agroecological regions and livestock production systems (type of flock and type of production (milk, meat, conservation, etc.)
- New strategies to convert grassland management into an attractive activity for younger 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 level

Benchmarks are needed to understand the overall differences between European grassland, why they exist and how to use possibilities for any increase of profitability of PG and to overcome the problems in different environments and regions. There has never been clear benchmarking of national grass dry matter (DM) production within member states.

The aim in this issue is to benchmark grass dry matter production of EU member states and to establish the reasons for differences in grass output, differences in botanical composition, grazing season length, ratio of grazing to forage harvesting. This would provide a clear view of the level of grazing and intensity of use in EU countries. The second objective is to establish benchmarking tools that work at farm level, which can be used by farmers within their region to increase the knowledge of their grassland with a more global perspective (sharing knowledge), and to identify points for improvement.

Innovative actions

- Develop new measuring tools – visual assessment, plate meter, sward stick, palatable species height, GIS, 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 and quality and biodiversity across member states to be integrated in a grassland measurement network. The available data at EU level, might be analysed and discussed within a European Consortium

Research needs

- Further investigate the potential of plant species to provide bioactive compounds, biomass production, etc.
- Integrate and analyse data from different sites (commercial farms, research studies, FAO studies, etc.) from different research groups/centres
- Identify main research gaps and develop quantitative research studies (which are not common in the current literature)
- Grass growth prediction – regional, national and international levels for a given climatic condition
- Integrate the following knowledge into a database for subsequent analyses, development of models, discussion and putting in practice
- Potential dry matter production levels and seasonal distribution that can be achieved in different kinds of PGs in Europe

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- Level of grass utilisation and its breakdown between grazing and harvesting for each agro-and edaphic-climatic region within each EU member state
- The cost of grass as a feed (grazed and/or harvested) and a common methodology for each EU member state for the estimation
- The variation between EU member states, accounting for soil type, climate, grazing animal type, management etc.

4. Increased grassland functionality through diversification of sward composition.

Sward species vary in their morphological characteristics, chemical composition, oligo-elements, bioactive compounds, nutrient uptake, water needs, etc. Therefore, their relative presence significantly affects the grassland functionality. At the same time, depending on climate and soil conditions and management, composition of grassland communities can change significantly between areas and therefore it influences production as well as the quality and quantity of ecosystem services.. Effective practices and techniques are needed to achieve optimal functional levels of grassland taking advantage of balanced sward composition.

Innovative actions

- Develop new effective and ecologically friendly methods to renovate swards (e.g. by using animals as seed dispersers).
- Introduce legumes and herbs into pasture to enhance productivity, sward palatability, quality (digestibility) and herbage intake by grazing animals.
- Promote legumes by inoculation of seeds of specific species with effective *Rhizobium* strains to assure an efficient symbiotic Nitrogen fixation.
- 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, silvo-arable, silvo-pasture, multi-purpose trees woody vegetation).
- Use of legumes, forbs and shrubs rich in tannins to maximise protein utilisation, prevent bloat in grazing ruminants, suppress internal parasites and produce healthier food.
- Develop new efficient and sustainable solutions for targeted mechanical weed control (low labour input) in grassland sward. Removing toxic plants from extensively used flower-rich meadows, e.g. *Colchicum autumnale, Ranunculus sp., Pteridium sp.*, *Enantus crocata* which can affect animal health, or even cause mortality.
- Optimise time of cutting, particularly after first regrowth to maximise the nutritive value and digestibility of herbage.
- Optimise and/or develop new forage conservation techniques to avoid nutrient losses, mitigate the risk of forage contamination (e.g. mycotoxins accumulation in silage or hay) and minimise the use of maize and concentrates.
- Develop user-friendly, low-cost, ICT (Information and Communication Technologies)-based tools to provide information to farmers about potential forage quantity and quality.

Research needs

- Define both the optimum dosage and unavoidable losses of biodiversity when using organic and mineral fertilisers (definition of the efficiency)

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- Optimise the combination of extending the growing season, plant breeding, use of mixed dynamic stocking systems
- Breeding/selection of new grass, legume species and varieties better adapted to climate change, e.g. more winter hardiness or drought tolerance.
- Identify seed mixtures for each soil/climate condition and production system (dairy, meat, cattle, sheep, goats, horses, etc.) by using different functional groups (e.g. legumes for proteins, woody vegetation for its fibre, etc.)
- Evaluate pasture plants for breeding and selection of new genotypes adapted to low farm inputs, marginal conditions, shade conditions (agroforestry), etc.
- Manage legumes under grazing for better persistence and utilisation (intake)
- Enhance N fixation and phosphate availability by improving soil/plant microbiology (inoculants) (particular emphasis on the *Rhizobium*/legume symbiosis and on the plant/arbuscular mycorrhiza /phosphate solubilising bacteria)
- Monitor forage status (productivity) of grassland through remote sensing

5. Increase resource efficiency

Increasing resource efficiency in terms of profitability is essential to the overall objective of the FG. The aim of this issue is to examine aspects of resource use efficiency of PG in the context of profitable utilisation and the trade-offs that need to be considered to enable the functioning of other ecosystem services, particularly C sequestration and biodiversity. The higher the resource efficiency is, the lower the carbon footprint per processed unit is, which is an important goal besides profitability.

Innovative actions

- Develop new ways to increase the presence of well nodulated, diverse legumes in PGs to improve pasture productivity (quantity x quality) and profitability.
- Information for farmers on pasture growth in specific locality: use of the 'big data' concept to enable matching of grass growth with inputs, utilisation and outputs
- Improve fertilisation strategies to increase grassland production with less fertiliser inputs (timing and dose)
- Look for management strategies to reduce poaching in a wetter climates
- Develop and "market" 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 health/nutritional elements associated with legumes and grasses (e.g. *Lotus*, sainfoin) and also shrubs (e.g. heather)
- Optimise silvo-pasture 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 the existing soil nutrients
- Find adequate productive and persistent legume and woody species, cultivars and their respective *Rhizobia* adapted to variable soil and climate conditions
- Knowledge on soil microorganisms 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 legumes growth and woody vegetation in swards

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- Establish methods or practices to avoid negative interference between extensive production systems and predators to avoid conflict situations between farmers-shepherds and other groups (e.g. urban ecologists).
- Better knowledge on what the main factors are preventing farmers from using PG and on how these affect farm management: current policies, authorities, markets, lack of cooperatives, limited access to credit, extension and technical information, access to abattoirs, vets, etc. (i.e. especially on small farms and marginal areas) .

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

Consumers increasingly demand food products with a positive image concerning food safety, nutrition value, healthiness, production practices, animal welfare and the environment where they are produced. PGs carry a potential added value which should be exploited in the form of premium products. These products would contribute to sustain farmers' income or counterbalance the costs of management practices to guarantee the sustainability of the production, or other costs due to constraints (i.e. climatic or topographic, quality of life), especially in less favoured or marginal areas.

The aim of this issue is to review the literature on links between quality traits of products from PG systems and PGs management practices, together with the challenges farmers face to ensure a constant product quality.

Innovative actions

- Provide tools to develop and promote new quality products based on enhancement of grassland-based production systems for PG areas and promote in new ways.
- Define marketing arguments ensuring valorisation of permanent grass-based products, including functional ones, to consumers given special value according their ecosystem services for the society and origin (e.g. using local breeds, and local cultures)
- For grazing systems, synchronisation of feed demand, pasture availability and market demand of products, to increase efficiency, especially of labour
- Establish mobile applications explaining product delivery from sustainable managed areas
- Adapt manufacturing laws 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 (authentication & traceability)

- Optimise authentication and traceability protocols minimising the bureaucratic effort of farmers; exploit the potential of ICT-based tools
- Develop affordable and rapid analytical methods for routine authentication and traceability, including a validation at a local level under controlled conditions or on-farm on a large scale (large number of commercial farms representative of EU farming system and practices)
- Establish ways (e.g. Operational Groups or advisory services) to help farmers to identify society preferences for their products and the link with sustainability
- Optimise a set of markers to allow a good identification of the products based on management practices and/or origin

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Research needs (management practices)

- Define management practices ensuring a stable quality over time
- Refine understanding of the effect of botanically diverse composition of pastures and forage on the product biochemical composition, quality and functionality
- Define management practices to use legumes and woody vegetation which do not negatively affect taste or smell of the milk or meat
- 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 systems using Life Cycle Thinking

Assessing the environmental performance of livestock systems is essential to quantify their complex and multifunctional characters and to allow them to be compared taking into account more than traditional economic indicators. Life Cycle Thinking (LCT) is a useful approach for this. Evaluation results of LCT are of value at different levels:

- Understanding the inter-relationships among the different dimensions of PGs systems: production, carbon footprint, biodiversity, conservation of genetic resources, soil conservation, etc. at farm and territorial level.
- Benchmarking different PGs and non-PGs systems in ruminant production at environmental level
- Providing evidence and sound basis for evaluation of side services of PGs systems and their valorisation through market mechanisms
- Providing relevant criteria for calculations of agri-environmental public support measures (i.e. CAP payments)

Assessing and valuing environmental performance could play a crucial role to improve competitiveness of grassland-based farming, especially in marginal lands or within protected and High Nature Value farmland areas, whose products receive increasing interest.

The aim of this issue is to evaluate the integral analysis of both the primary production (quantitative, qualitative and functional) as well as the environmental impact of the production systems, but also some limiting factors such as predators.

Innovative actions

- Development of user-friendly, inter-operable, indicators and tools at farm scale for LCT assessment of PGs based farms.
- Integrate data sets at local and regional level (based on inter-operable LCT assessment tools) interconnecting producers, extension services and academic and research centres providing to market demand a more timely and accurate dynamic picture, including new scenarios, of the territorial role of PGs
- 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 life and urban life, to form a network of educational grassland-based farms).

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Research needs

- Assess the role of PGs on: i) soil erosion control, ii) wildfire prevention, iii) carbon sequestration, iv) enhance biodiversity and v) products with functional components from LCT perspective considering overall systems complexity
- Develop knowledge to improve data inventory and analysis
- Further development and application of LCT to support scientifically sound methodological choices enabling a harmonised assessment of improvement options for social acceptability of agricultural systems, in particular for PGs

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5. Fail factors to overcome and ideas for doing so

Understanding the factors contributing to the success or failure of adopting new and/or innovative agricultural practices is complex but of vital importance to all sectors concerned. Agricultural projects and innovations may fail or not be adopted because at the design stage, farmers, local ethics, culture and socio-economic conditions are not considered and hence, the technologies developed and promoted are incompatible with the needs or contexts of the target groups.

Admittedly, the agri-environmental systems linked to PGs are complex and hence the reasons for failure at each interconnection level may be multiple (Fig. 2). Nevertheless, the first step is to recognise the need to involve all actors, that their actions have multiple consequences, and that the responsibility for the maintenance of systems must be assumed by all. This includes farmers, scientists, technologists, official institutions, enterprises, and consumers, who may not live in areas where the PGs are, but are nonetheless directly or indirectly linked to their evolution and interactions.

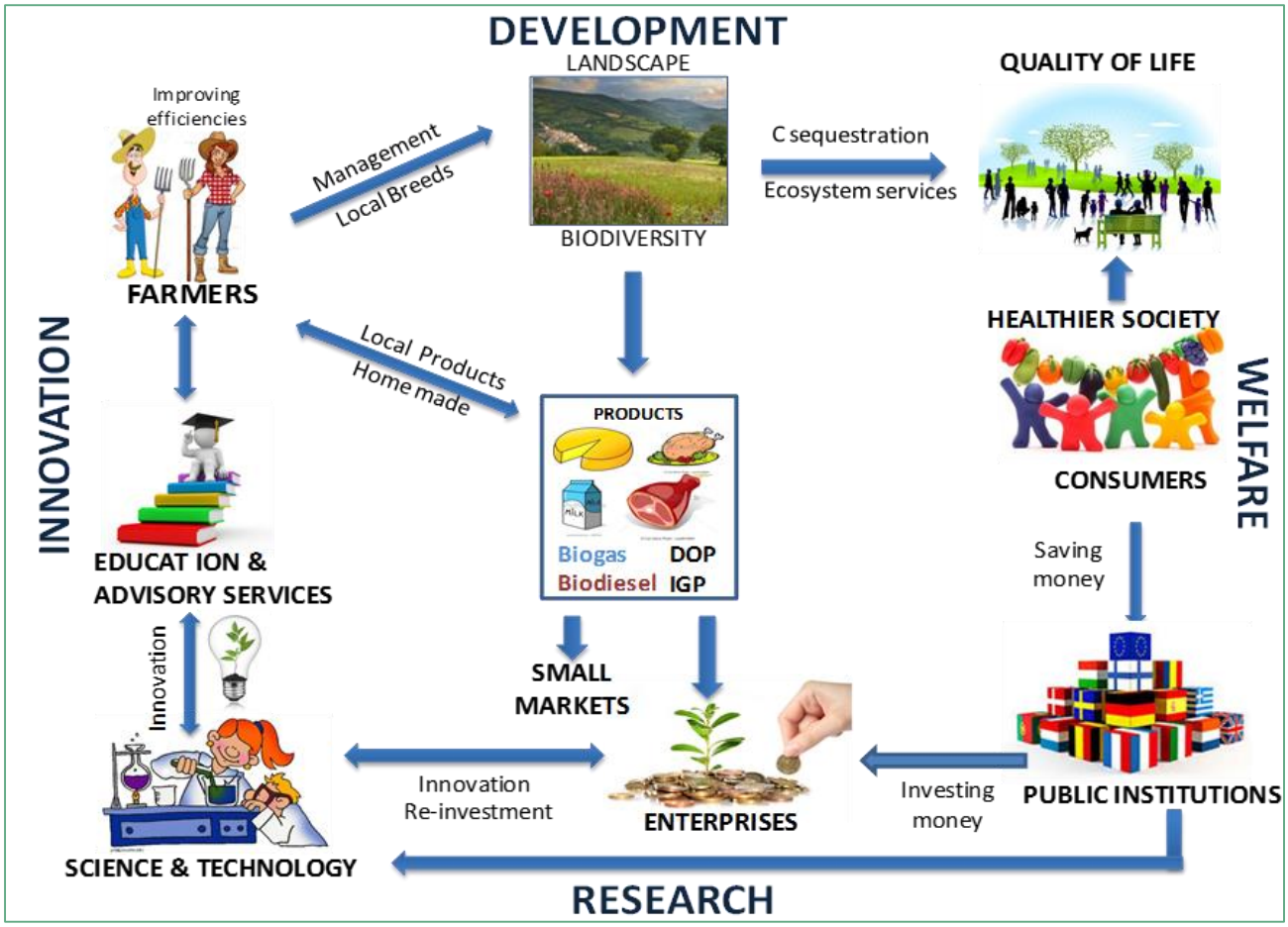

Figure 2. Relationships between the main actors involved in agrarian systems linked to PGs

Using the system innovation approach framework by Klein et al. (2005) the Focus Group identified some of the main fail factors hampering the improvement of the management practices of PGs. This approach distinguishes between different actors (i.e. consumers, farmers, knowledge institutes, etc.) and levels of failures (i.e. infrastructural, institutional, etc.). A detailed matrix elaborated by the group is given in **Annex 5**.

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A summary of the identified fail factors is presented in Figure 3, showing the complex interaction among the different components of PG systems. This complexity is also reflected by the multi-dimensional and multi-level fail factors: i.e. PGs are not directly marketed but are the main resource for different types of livestock production and, at the same time, they deliver many important ecosystem services, which are often not properly assessed. The longer and more complex the value chain, the more potential failures at different steps or links.

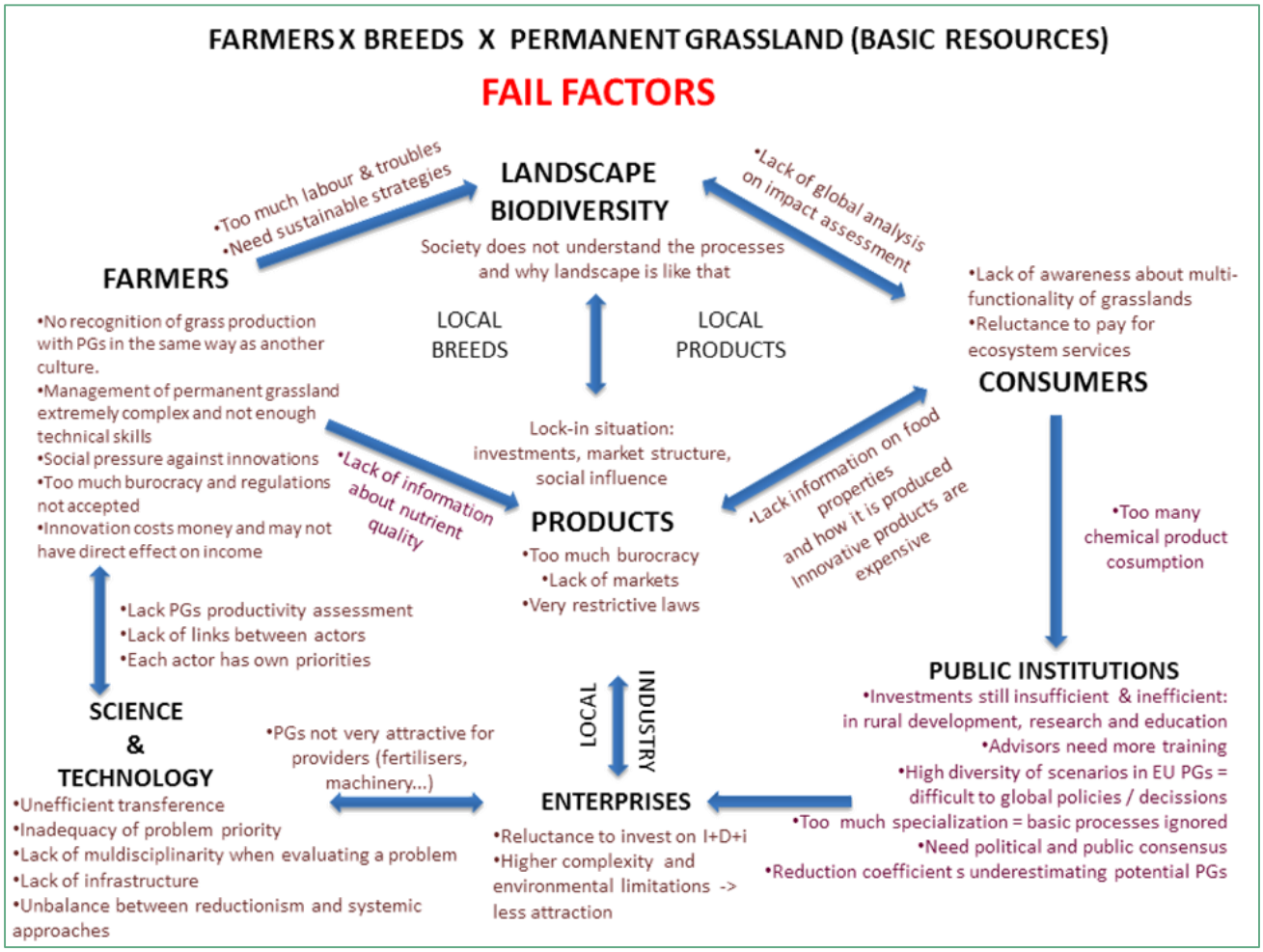

Figure 3. Summary of fail factors linked to the sustainable development of PGs

The Focus Group sought to identify innovative ideas or actions, which would address the different problems within each section of fail factors (Fig. 4). These can likewise 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; and
(6) enhanced stakeholder communication.

The proposed improvement at different levels in agricultural knowledge and innovation systems concerning PGs should result in numerous innovative actions to improve PG management. However, some other failures directly affecting productivity and sustainability of PGs may be difficult to address. For example, how to arrest land abandonment in marginal areas where there are still big problems with communications and education and healthcare provision, this means social services. In such situations, support will be crucial.

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But 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 systems. 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 of PGs. 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 and enterprises thereby helping to maintain a vibrant rural economy and a cohesive rural society.

Getting consumers (society) to accept their direct or indirect responsibility for the continued existence of PGs 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 account of all stakeholders, the peculiarities of each situation, and most importantly, which are independent of political scenarios.

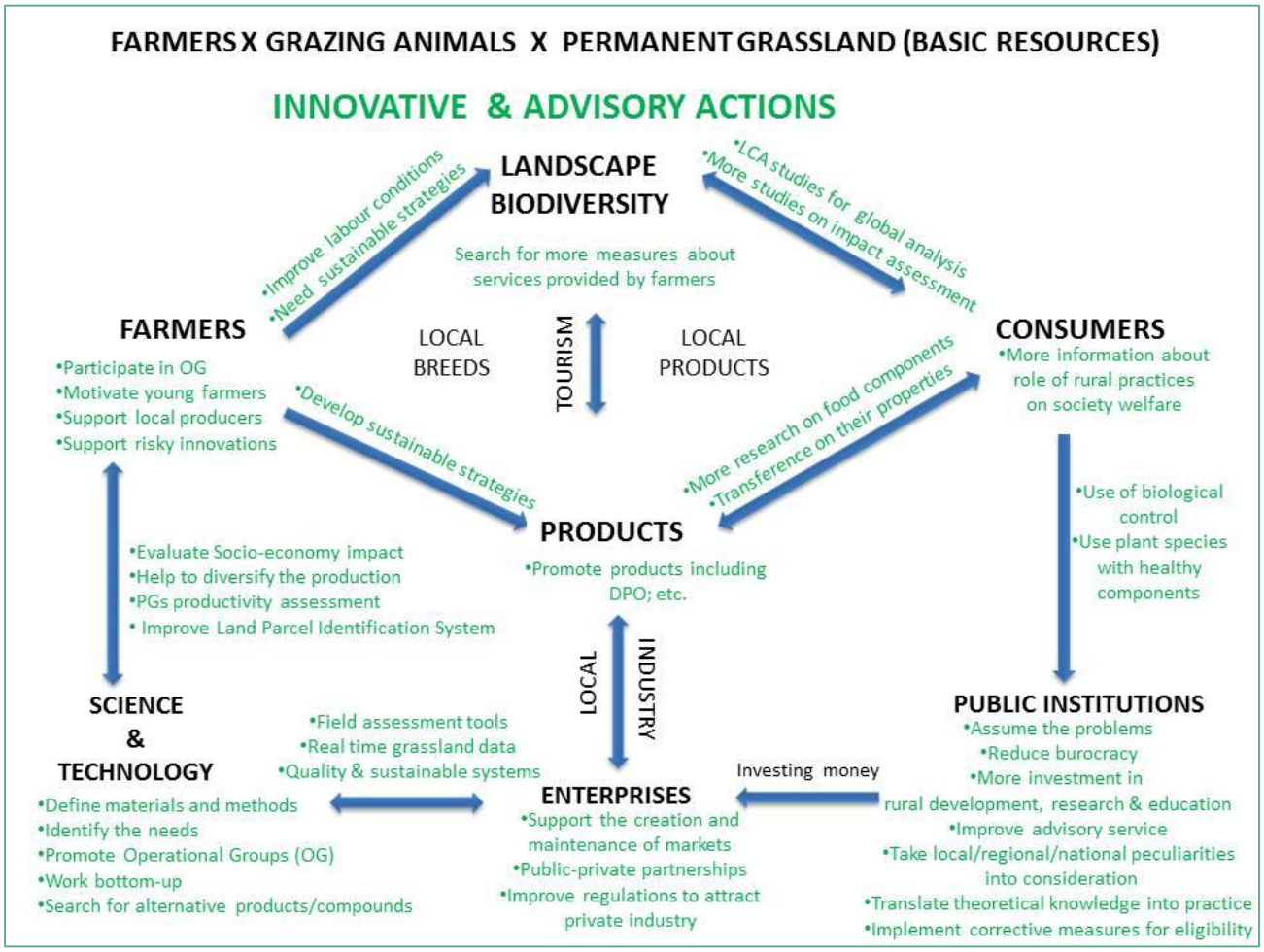

Figure 4. Summary of innovative actions linked to the sustainable development of PGs.

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6. Conclusion: prioritised innovation and research needs from practice

This chapter summarises the main priorities selected by the group concerning innovation opportunities and research and advisory needs coming from the seven topics developed in chapter four. Furthermore the Focus Group paid special attention to the farmers' point of view. Thus, out of all the issues identified by all the experts, a few were further filtered as particularly important from their perspective by the farmers present in the group (marked with "(F)").

Innovation Needs

- Integrate data sets at local level and implement ICT tools to connect advisory services and other stakeholders (Decision Support Systems, DSS)
- Provide technology to farmers to optimise grass production (F)
- Develop tools describing services of PGs to respond to local demand (F)
- Increase yield and quality of PG through management strategies
- Re-think technical and political solutions to improve farmers' livelihoods (by producing quality products) (F)

Research needs

- Develop a benchmark system for future dairy and meat farms (large scale, high product.) integrating productivity, environmental, biodiversity, carbon sequestration and adaptation to climate change (F)
- Increase quantity and quality to improve profitability and sustainability
- Life Cycle Assessment including ecosystem services at regional level prior to inclusion in PG management framework
- Help farmers to identify the best grazing systems using new technologies such as DSS, ICT tools, Big Data (F)
- Research & analyse what motivates different groups of farmers in their strategies for PG management (F)

Adoption needs

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

Farmers have the most direct contact with PGs. The communication between the different sectors involved in PG management should be improved to make sure that available knowledge and technologies are effectively applied at field level. Despite their deep knowledge of their grassland systems and the surrounding environment, there are still many ways in which new technology and updated scientific knowledge can benefit farmers through education, knowledge exchange and interactive participatory innovation, and this could be done by Operational Groups. Researchers and technicians should also gain more awareness of what farmers think, need or want and seek for cooperative learning, taking advantage of their proven know-how. Moreover a balance is needed to reconcile the stress between production and conservation of the PG. The farmer is able to change the landscape and the biodiversity within the proportion of territory he or she manages, but landscape-scale factors such as landscape heterogeneity, habitat fragmentation and habitat connectivity depend on many actors who share the same territory:

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farmers, nature conservation managers, local authorities, road managers, etc. All these actors influence the regional species pool.

Farmers and conservationists have multiple ideas about the usefulness of biodiversity for grassland production, probably as a result of their contrasting experiences. Experiments have often been conducted in experimental grassland plots or newly sown grassland where the vegetation composition is not (yet) in equilibrium with the resources, where management and harvests are rarely comparable with agricultural situations (Wrage et al., 2011). Fortunately, some recent projects have set up long-term experiments looking at the consequences of livestock management on multiple plant and animal groups that interact with each other within a land 'food-web'.

The farmer frequently deals with PGs holding species numbers in dynamic equilibrium with the environment and he/she is engaged in the sometimes difficult task of matching primary production with the needs of the animals. Farmers and breeders usually demand more research to cope with uncertainties attached to future climate scenarios and to make rapid decisions in areas with high weather variability.

We need to search for the ways to improve the balance between the potentials of the territories and the demands in the surrounding areas from different perspectives: alimentary, social, economic and environmental.

Therefore, in conclusion future multidisciplinary investigations on the different types of PGs and plant species components related to the quality and value of livestock products are needed. In certain cases, like Mediterranean grassland, a successful development of well-adapted species and varieties to those habitats is needed. Finally, more efforts in on-farm experimentation and knowledge transfer to farmers are required, with a special focus on the correct use of the different management strategies adapted to the local situations considering site and landscape scales. In addition, new traits in animals and grasses may assist farmers to both mitigate and adapt to climate change (Del Prado et al., 2014).

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 the ecosystem service value. Alternative methods are already suggesting that for products from extensive and, in some cases greener conditions, the emissions should be split according to both market (product price) and non-market (e.g. ecosystem services) values (Ripoll-Bosch et al., 2013). Market products (e.g. milk, cheese, etc.) are already quantified according to their demand, quality, etc. and they already have a market price. The available knowledge about non-market products such as ecosystem services provided by PGs is much more limited. After two 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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Annex 1. Glossary / abbreviations

BIO	Biodiversity
CAP	Common Agricultural Policy
CLA	Conjugated Linoleic Acids
CNR-IBIMET	Institute of Biometeorology of the National Research Council
CNR-ISPAAM	National Research Council - Institute for the Production Environment in the Mediterranean
CO	Carbon footprint
DM	Dry matter
DSS	Decision Support Systems
EIP-AGRI	European Innovation Partnership for Agricultural Productivity and Sustainability
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FG	Focus Group
GIS	Geographic Information System
HNV	High Nature Value
ICT	Information and Communication Technologies
IFEU	Institute for Energy- and Environmental Research Heidelberg GmbH
LCA	Life Cycle Assessment
LCT	Life Cycle Thinking
LPIS	Land Parcel Identification Systems
P&W	Product quality & animal welfare
PDO	Protected Designation of Origin
PG	Permanent grassland
PGI	Protected Geographical Indication
PROD	Productivity
RDP	RDP (Rural Development Program)
SERIDA	Servicio Regional de Investigación y Desarrollo Agroalimentario
UK	United Kingdom
UME	Utilized Metabolic Energy
UMRH INRA	Joint Research Unit associating French National Institute for Agricultural Research (INRA) and Institute of higher education in food science, animal health, agricultural and environmental sciences (VetAgro Sup)
UUA	Utilised Agricultural Area

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Annex 2. Recommendations to practice

The group identified a list of ready to use recommendations to practice. In this section, they are listed and classified by management operation.

1 Grazing management

1.1 Farm planning

- Combine different grassland types for different types of animals: permanent/temporary, mown, grazed, grazed/mown, intensive/extensive/semi-natural/woody to improve resource use, decrease production costs
- Rotation systems to allow rangeland recovery, promote biodiversity and provide ecosystem services (e.g. floral resources for honey bees or appropriate nesting sites for some birds). Nevertheless this management reduces vegetation nutritive quality and therefore animal production.
- Apply grazing patterns which provide a heterogeneous landscape.
- Improve sward flexibility using species well adapted for both grazing and cutting depending to the season and year from establishment (e.g. sulla meadow)
- Integration of Spring rotation planner into grassland management.
- Use of Autumn grass budgeting to ration grass supply in autumn.
- Where possible, cooperation between arable and livestock farmers for manure, crop residues, and forage (hay, haylage or silage) exchange to reduce expenses in energy for transport, environmental costs and optimise nutrient cycling.
- Increasing pasture quality and resilience by using in agroforestry practices by woody vegetation shade and barriers (windbreaks, hedges) which usually reduces the flowering capacity, drought effect, nutrient leaching, causingmitigation and adaptation to climate change.
- Integrate trees establishing silvopastoral practices: e.g. fruit trees, trees for timber and fire wood, fodder trees, hedges e.g. to increase land productivity, enhance biodiversity, diversify productions, provide shelter to livestock, fix carbon.

1.2 Pasture

- Determine grassland production and available standing biomass by different strategies and tools such as farm walks (e.g. with rising plate meters), grazing diaries, web based software to compile measurements, identification of dominant plant functional types and/or forage value tables.
- Optimise grazing management to avoid faeces effects, which lead to grazing losses and thus reduced yield; the negative impact of faeces can be minimised through an abundant presence of dung beetles, which can be enhanced through good practices of pasture establishment and management leading to an increase of soil organic matter and improved soil structure.
- Promote high diversity PG including the integration of nitrogen-fixing legumes to improve fodder quality and woody vegetation to overcome shortage periods and as mechanism to adapt to weather site variability and adapt to climate change.
- In certain areas like Montado/Dehesa, cereals for grain might not be economically practicable as their low yields required difficult and expensive mechanical operations. PG are based on annual selfseeding species so in certain periods cereals produced it the area or imported might be used (LCA has to be considered due to the energy needs to put cereals in the farms).
- Develop tools to start the grazing season adequately on time to improve quantity and quality of pasture in the subsequent regrowing season. Maintain a sward with a range of heights during the growing season, except when the field is closed or shut up for a cut of hay or silage.
- Remove toxic plants from extensively used flower-rich meadows, e.g. *Colchicum autumnale*, *Ranunculus* sp., *Pteridium* sp., *Oenanthe crocata*, which can affect animal and human health or even cause mortality. Control weed proliferation by taking advantage of the diet selection of different livestock species (e.g. goats or horses) to reduce the use of herbicides

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- Diminish leftovers through the use of adequate and flexible grazing pressure along and within the season. That means managing adequate animal species and also production: dairy (high/medium/low production potential), beef, meat, maintenance, etc.).

1.3 Animals

- Select animal species and/or breeds adapted to environmental characteristics and with favourable diet selection and grazing behaviour to the existing or desired vegetation characteristics to maintain favourable performances based on pasture during the longest possible periods to reduce dependence on external inputs which compromise the profitability of the system and may have unexpected negative effects on PG biodiversity.
- Manage mixed, sequential or single flocks attending to pasture characteristics to maximise resource utilisation and minimise health problems (e.g. gastrointestinal parasites), considering diet selections and possible competitions (e.g. cattle and goats show low competitive levels as they are grazers and browsers, respectively). Sequential grazing can be an alternative as well (e.g. use of horses after cattle).
- Promote crop residues intake to reduce overgrazing in PG as they can provide valuable food according to livestock dietary selection, reducing environmental and nutrient costs.
- Use of feed requirement calculators and also to quantify feed supply from available resources.

2 Cutting for hay/silage/haylage

2.1 Farm planning

- Giving priority to herbage feed (e.g. fresh grass, hay, haylage, silage) compared to (food) feed grains (e.g. cereal, pulses, maize), as it provides better grazing system flexibility at farm level and adaptation to interannual and changing weather conditions within the growing season.
- Orient towards self-sufficiency for fodder by using locally or regionally produced forage and feed to limit external fodder in order to avoid an unbalanced nutrient cycle within the farm and/or reduce production costs.
- The different periods of hay and haylage have to be considered. The latter cutting days for hay might require the reinstallation of barn hay drying for better hay qualities.
- Farmers can obtain the best hay feed quality with optimum sugar and mineral content with early hay cut, while maintaining high flora and fauna diversity by cutting other sections later on.
- Development of adequate harvesting program and mowing fields in sections at different dates prolongs the overall flowering season and gives wildlife (e.g. pollinators and birds) a chance to move aside.

2.2 Pasture

- Requirements of conserved forage might be met by purchasing hay/haylage based on nutritive value and weight and dry matter content
- The differences in hay digestibility from different grassland and conservation methods must be taken into account when conserving forages. For example, the digestibility of some hays from neutral grassland is often 10 to 40% lower than forages cut from intensively managed grassland.
- If self seeding annual legumes are components of the PG system, allow them to set seed. If hay harvest occurs after legume seed maturation this favours good legume regeneration. Seeds (from clover and other plant species) from hay bales can contribute to reseed pastures and can even be used to improve marginal areas with low nutrient vegetation components.
- Leave a 1-2 m uncut or ungrazed strip alongside the boundary. Those margins will provide seed sources and over-wintering cover for insects and also some forage for wintering periods

2.3 Animals

- The selection of the livestock breeds and species could aim at providing a heterogeneous sward taking into account its diet selection, grazing behaviour and needs.

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- Use of locally adapted livestock breeds for maximum use of grassland to reduce concentrate feed including commercial feed, which promotes autochthonous breed preservation and also local products.
- Use of double-goal breeds (e.g. Simmental/Fleckvieh) to have both meat and milk production to limit hyper-specialisation of high yielding animals while conserving good income.
- Hyper-specialisation induces health and fertility problems, reduces animal welfare and productive lifetime expectation, and limits the possibilities to use green forage in animal feeding which induces its replacement by concentrates (e.g. food like cereals and soya). Therefore their efficiency to use permanent grassland will be low.
- Where hay is cut annually, the subsequent aftermath can provide grazing for finishing lambs if an adequate sward height (6-7 cm) is maintained.
- Where hay cuts are not routinely practised, cattle are useful grazers of certain grassland, compensating partially for lower quality (digestibility) of these grassland by increasing retention time in the rumen.
- Aftermath grazing, ideally by cattle, is identified as important for maintaining maximum diversity of several grassland types by provisioning regeneration niches in the sward and getting the meadows in a condition suitable for, for example, breeding waders in the following spring (Pinches et al., 2013).

3 Establishment and pasture management

3.1 Seeding and reseeding

- Pre-adjuntment of soil conditions for further plantation
- Breeding/selection of new grass and legume species and varieties better adapted to climate change (e.g. more winter hardiness or drought tolerance) like *Lolium-Festuca* genotypes in temperate humid climates or certain types of *Dactylis* or *Phalaris* in more arid or semi-arid Mediterranan climates. For example to ensure the best adaptation in dry Mediterranean environments, choose varieties like perennial grasses with summer dormancy.
- Breeding/selection also of species and varieties well adapted to continuous intense grazing regimes in mountain, while maintaining acceptable levels of productivity and quality. Explore stoloniferous species with micorrhyzal associations for adequate P uptakes. The seeds of this type of species (e.g. *Agrostis capillaris*) are currently extremely expensive in the market.
- Reseeding when necessary with mixtures of plant species of high nutritive value to maintain livestock performances but also to provide floral resources to pollinator insect communities and therefore simultaneously contribute to increase biodiversity, ecosystem services and the production of added valued products such as honey (e.g. legume *Trifolium* species are very attractive to bees and bumblebees).
- Use of multi-species mixtures for grassland establishment and renovation to increase yield, feeding quality, sward resilience and productivity in comparison to monoculture swards as well as to supply of forage and even higher variety of nutrients like minerals, as well as bioactive compounds, during different growth periods.
- Maximize use of legumes and herbs (optimum proportion legumes-herbs to grasses depending on site characteristics) in PGs to improve protein self-sufficiency, enhance productivity, sward palatability, quality (digestibility) and herbage intake by grazing animal, reduce mineral fertilisation (mainly inorganic) and minimise the amounts of supplementary feed required and nutrient losses with an improvement of carbon footprint.
- Grassland renovation should aim at developing permanent botanical composition of the sward which becomes fine-tuned to the site yield potential (Wachendorf and Goliński, 2006).
- Improved techniques of grassland establishment: i.e. appropriate sowing date, sowing depth, seed inoculation, composition of mixtures considering proportions of functional groups of species even using animals to reseed or planting in ashes after prescribed burning of shrub encroached pastures, reseeding techniques without ploughing.
- Large use of nitrogen fixing legumes in temporary grassland and fodder crops (e.g. green cereal-legume mixtures) to reduce N inputs. Perennial legumes including woody of grassland have a much higher biological nitrogen fixing ability than annual legumes cropped for grain such as pea or faba bean. In Mediterranean biodiverse legume rich PG, annual self-reseeding legumes, contributing to 40-60% of the yields, may fix between 100 and 180 kg of N/ha/year. The incorporation of forage legumes in

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agroecological herbivore farms is thus essential for the productivity of their production system. Proper management is required to exploit the potential of legume forages to replace artificial fertilisation, as it would help also to reduce the need for protein-rich feed (Hopkins, 2008). A controlled expansion of legumes could be achieved while meeting consumer expectations remaining coherent with environmental policy goals (Peeters et al., 2006).

- Use of effective and ecologically friendly methods to increase seeding and reseeding (e.g. over-drilling on organic soils, animal to reseed) to reduce emissions as well as improve fodder yield and quality without negatively affecting the environment.

3.2 Fertilisation

- Pre-assessment of soil needs to calculate the amount and type of fertilisation and minimize use to fertilisers, also considering vegetation characteristics, livestock demands and productivity and environmental targets. For major nutrients, (nitrogen, phosphate and potash), there is an optimum level to maintain maximum species density. Use standard soil analysis representative at plot level and stratified at farm level to accurately determine the content of nutrients in the soil and their evolution with time.
- Adopt a rational plan of soil fertilisation/amendments according to soil and plant nutrients concentration and dynamics to adequately supply nutrient to grassland.
- Reduce nitrogen fertilisation in legume-based pastures to promote natural nitrogen fixation and the dominance of legumes.
- Use of lime fertilisers/amendments (i.e. granular oxide/Ca+Mg carbonate) on specific acidic sites to reduce the Al saturation at levels not toxic for good forage species and that allow legume establishment and persistence in multi-species swards.
- On improved grassland ensure plant requirements for pH and nutrients, particularly phosphate and potash, but also sulphur, sodium and magnesium, are maintained for optimum response to nitrogenous fertilisers.
- Strategic, timely application of N imperative to match climatic conditions and best utilise the optimum effectiveness of N rate and forage production. Timely applications of the adequate type of fertilisers based on their ammonia or nitrate to avoid overdoses or possible contaminations and make inputs more profitable.
- Control use of fertilisers in areas with potential risk for leaching into water bodies (Elsaesser, 1999) and adopt protective practices to avoid damage (i.e. riparian woody vegetation).
- Promote the use of organic fertilisers, considering the levels of mineral and organic N and P they have and the mineralization rates.
- When aiming to maintain species-rich hay meadows, avoid the use of slurry as a source of fertiliszation, or use it at levels that do not affect this high biodiversity levels.

3.3 Irrigation

- Programming irrigation or replacing this technique by adequate grassland mixtures to enhance legume establishment and persist.
- In certain regions (controlled) drainage is an issue/management, also related to CO_2/NO losses and emissions. Soil-water content and temperature not only exert a large effect on the rate of organic matter decomposition but also on N_2O fluxes (Conen et al., 2000; Drury et al., 2003).

3.4 Herbicides/Pesticides use

- Reduce the use to herbicides as much as possible and replace them by mechanical of physical methods. Apply them spot-treat or weed-wipe for the control of injurious weeds (i.e. creeping and spear thistles, curled and broad-leaved docks or common ragwort) or invasive alien species (e.g. Himalayan balsam, rhododendron or Japanese knotweed).

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- Herbicides and insecticides, fertilisers, among others, affect directly the aquatic biota by their toxicity and some act either as toxic compounds or by increasing the growth of algae, thus changing the trophic structure of the environment.

4 Product / Produce

- High quality of products (nutrition, taste) should be promoted by:
- Adopt grass-based productions to decrease total and saturated fats, improve omega3/omega6 fatty acid ratio and conjugated linoleic acids (CLA), in dairy and meat products.
- Favour species-rich vegetation to improve: milk quality, polyphenol content, and livestock and human health.
- Local dairy and meat product processing should be promoted to: reduce transport energy, provide local employment and give value to the rural activities.
- Adoption or development of quality labels (e.g. geographical indications) and trade marks to justify i) the needed higher product prices caused by farm conditions compared with industrial systems while reducing importations and external market dependency, ii) the subsequent high quality and safety food, iii) ecosystem services and iv) socio-cultural benefits.
- Livestock production systems based on PG are much easier to convert to organic production systems than those more based on crops and cereals.
- Short and medium marketing chains to reduce transport costs and energy, to link consumers to the territory use and to justify selling prices and reasonable income.
- Cooperation, collaboration and development of synergies between farmers, between consumers/citizens and farmers (e.g. by signed agreements like those of Community-Supported Agriculture), and between consumers/citizens (e.g. urban agriculture) for increasing and stabilizing farmer's income, for improving access to quality food and decreasing food prices for consumers, for increasing contacts between cities and rural land, for improving contacts of citizens with nature and farming.
- Product diversification to increase economic resilience of farmers, and to reduce dependence on global and national market prices, including 'minor' (niche) productions instead of large-scale productions integrated in global value chains.
- Link product production to other cultural and social activities promoting the diversification of activities (e.g. agri-tourism), which will increase the understanding of the buyers and urban citizens about the important role of rural agriculture on society services.

5 Animal health / welfare

- Efficient use of medicines taking advantage of medicinal properties of natural vegetation when possible to reduce unnecessary extra-costs.
- Reduce the risk of residues of medicines in animal products to avoid undesired allergic reactions and resistances in humans as well as environmental problems (e.g. ivermectines can affect adversely the local insect fauna).
- Include animal health and welfare as a key element of the grazing system to maximize production, reduce use of medicines, reproductive problems and impact on local biodiversity.
- Favour tannin-rich forbs/legumes/woody species (e.g. Heather (*Erica* spp.), *Taraxacum* spp., *Lotus* spp.) characteristic of many PG or essential oil-rich forbs to decrease methane production and improve animal health.
- Favour species-rich vegetation to produce healthier milk and meat quality (high polyphenol content) for livestock and humans.

6 Conservation of biodiversity / carbon footprint / methane emissions

- Increase diversity of livestock species and breeds to increase resilience of the system.
- Maximize livestock intake without surpassing the carrying capacity of the ecosystem and risking its biodiversity. Set stocking rates according to forage quantity and allowance.

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- Apply grazing patterns that promote heterogeneity at different levels, from plots to landscapes. Maintain swards with a range of heights during the growing season, except when the field is closed for a cut of hay or silage.
- Careful use of herbicides, insecticides or other chemicals which might affect directly the aquatic biota by their toxicity and some fertilisers act either as toxic compounds or by increasing the growth of algae, thus changing the trophic structure of the environment.
- Carbon footprint is influenced by the emissions related to concentrate feed use and manure handling as well as the nature of the land used to produce the required feed so: improve feed conversion at the system level, use of feeds that increase soil carbon sequestration versus carbon emission, ensure that the manure produced substitutes synthetic fertiliser, and use manure for bio-energy production when possible. Proper management of manure and urine waste nutrients contribute to avoid possible leaching to groundwater and other risks to livestock, human health and the environment.
- Maintain moderate grazing pressures to contribute to C sequestration. Abandonment of PGs might lead to short-term increased C sequestration but can greatly increase the likelihood of wildfires and C losses.
- Reseeding when necessary with mixtures of plant species of high nutritive value to maintain livestock performances but also to provide floral resources to pollinator insect communities and therefore simultaneously contribute to ecosystem services and contribute to the production of added valued products such as honey (e.g. legume *Trifolium* or *Medicago* species are very attractive to bees and bumblebees) or cheese with higher quality of CLA.
- Improving the efficiency of inputs (water, light, nutrients, forage species, soil, fuel etc). It can ensure that net herbage accumulation is appropriate to the requirements of the farmland situation while also contributing to carbon sequestration and biodiversity.
- Increase the use of managed woody vegetation (agroforestry) as their roots goes deeper and enhances carbon sequestration, while increasing bioidversity providing adaptation and mitigation methods to climate change.
- Rest rotation systems, in which a portion of the pasture is set aside to rest during a whole year, may have similar effects in more unfavourable areas (mountain and semiarid regions).
- For nature conservation objectives (e.g. conservation of some grazed habitats within Annex I of Directive 92/43) use, when existing, contrasted management information based on broad scientific evidence, such as that compiled in the series of Synopses of Conservation Evidence, or the Systematic Reviews of several topics (**http://www.environmentalevidence.org/**).

7 Knowledge transfer

- Establish new strategies to convert grassland management into an attractive activity for younger generations. (already in the section of the mini-paper in innovative actions).
- Improve knowledge transfer to farmers about management options like seed mixtures, fertilisers, amendments, weed control, grazing regime, type and density of trees through agroforestry practices by using innovative information tools that have to be developed and adapted according to local conditions(i.e. SAFE family programs).
- Transfer knowledge to farmers about management focusing on increased functional group diversification by using innovative information tools.

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Annex 3. Relevant research projects related to PGs

Numerous projects which include studies in PGs are currently undergoing or have been carried out over the past few years. A summary of the most relevant ones are included in the following table. They cover one or various of the issues addressed by the FG.

The latest projects tend to be multidisciplinary in coherence with the idea that the sustainability might only be achieved by taking as many factors as possible into consideration to make sure that there is global positive balance for production, conservation, etc.

An increasing interest in search for new seed varieties is observed to provide higher quality fodder without adverse environmental effects. The number of projects dealing with grass-based dairy and beef systems which might take advantage of multiswards is more limited though.

Numerous projects are focusing on dairy systems and in EU regions where sustainable intensification is gaining relevance, whereas there is a limited number of big projects for the Mediterranean areas as well as other areas with semi natural pastures wit high nature and cultural values (e.g. seminatural pastures in Scandinavia or Rumania).

Despite the maintenance of activities in rural areas is encouraged to avoid land abandonment, few projects take place in Less Favoured Areas. In addition, although the future of PGs demands the maintenance of livestock in the field, more and more research focuses on indoor strategies.

The number of research teams working on animal production who can effectively carry out large scale experiments is quite limited in Europe and the budget of the projects cannot support trials with large number of animals and over large areas, so realistic experiments which might be closer to the actual management become very difficult. This situation is especially relevant for research dealing with beef in extensive systems and dairy in intensive systems.

There are several international and European projects on LCA, some are in the field of agriculture, but only a few are concerned on livestock grassland-based systems. There is thus an urgent need of detailed studies on LCA of animal production systems and in general of agricultural systems. Several LCA studies have been conducted on dairy cow production systems in Europe to compare different farming strategies, while very little research has been conducted on the environmental implications of dairy goat and sheep productions (Vagnoni et al., 2014).

Few projects have tested the responses of the ecosystems to the grazing by local breeds in a global way. Most of the projects have either focused on biodiversity conservation or on animal production but they have rarely been analyzed simultaneously.

Integration of socio-economic analyses in the studies should be stimulated because regional and/or local political, historical, etc. factors can play a key role in the regulation of the activities in each area.

In summary, the research projects which have been funded across Europe are covering many gaps of knowledge and increasingly provide alternatives for a sustainable use of the PGs although there are still many aspects to be covered.

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Summary of research projects across EU which confronted one of various of the goals addressed by the EIP-AGRI Focus Group, indicating the countries involved in the projects and the type of system.

TITLE OF THE PROJECT	Typology	Help farmer	Benchmarks	Quality&Quantity	Efficiency	Products	LCA	Country	Dairy/Beef
AGFORWARD		X			X	X	X	17 countries	Agroforestry, ruminants, poultry, pigs
AMAZING GRAZING		X	X	X	X			NL	Dairy
ANIMALCHANGE		X			X		X	10 countries	Ruminants, poultry, pigs. Dairy, beef
ATF- ANIMAL TASK FORCE						X	X	13 countries	Ruminants, poultry, pigs. Dairy, beef
AUTOGRASSMILK		X			X			IE, DK, SE, NL, BE, FR	Dairy
BEEF AND ECOSYSTEM SERVICES		x		x	x	x	x	SE	Beef
ON SEMI-NATURAL PASTURE									
CARBON DAIRY		X					X	FR, IT, UK	Dairy
COST ACTION 852				X				20 countries	Dairy, beef
DYNAMISCH WEIDEN		X	X					NL	Dairy
DAIRYMAN		x		x	x		x	NL, DE, F, UK, IRE, Lu, Be	Dairy
EATING BIODIVERSITY					X	X		FR, IT, UK	Dairy, beef
EUNIS		X						EU	
FEED4FOODURE		X			X	X		NL	Dairy
FORBIOBEN				X	X			UK, DE, IT, FR, ES, BE	Beef
IFEU		X				X	X	DE	Dairy
GRAZELAND		X	X	X	X	X		NO	Dairy
HAGMARKSMISTRA		X	X	X	X	X		SE	Beef,dairy,sheep,horses
LEAP-FAO		X					X		
LEGUME FUTURES					X				
LINK PROJECT LK0638				X				UK	Dairy, beef
LOWINPUTBREEDS						X			Meat, egg
MODELO PUERTO		X			X			ES	Dairy, beef
MULTISWARD	X	X	X	X	X	X	X	EU	Dairy, beef
NITROGEN NUTRITION INDEX		X		X					
ORIGINALP						X		AU, IT	Dairy, Beef, apples
PART-TIME GRAZING 1 AND 2		X	X	X	X	X		SE	Dairy
PASTUREBASE IRELAND		X	X					IE	Dairy, beef
PECUS-CISIA						X	X	IT	Dairy small ruminant
PERMED		X		X				Western Meditteranean	

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PROPARA		X			X		10 countries	Dairy,beef
REKS		X			X	X	DK, NO, SE	Beef, sheep
SFIS				X	X	X	International	
SOLID, FP7						X	EU (25 partners)	Dairy
SUREROOT		X			X		UK	
TRAMPLING RESISTANT SWARDS		X	X	X	X		SE	Dairy
TRUEFOOD						X		Dairy
UNEP/SETAC						X		
VIRTUAL ELECTRIC FENCING								
WEBGRAS		X					IT	Dairy

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Annex 4. List of Research, adoption and innovation needs

Summary of research needs

Topic	Needs
Grassland typology	Tools to classify and describe the main types of permanent grassland for all Europe to support decisions of the European Union.
Help farmers	Increasing the potential yield of grassland through a combination of extending the grass growing season through, plant breeding, use of mixtures of plant species (including trees), smart fertilisation and dynamic and flexible stocking rates or grazing pressures.
	Increasing yields of grazed pastures by reducing the grazing losses (trampling, urine and faeces) ,optimising grazing systems, type of vegetation and smart combinations of animals per ha and breed.
	Developing novel grazing systems for future dairy farms (large-scale, high productive, highly automated) that i) are technically and socially feasible and ii) are economically viable and environmentally sound.
	Establishing the fundamentals of decision supports of a resilient grazing system, i. e pasture growth capacity, levels of pasture utilisation, proportion of pasture consumed by grazing, and designing essential decision support tools using these fundamentals that will underpin high levels of pasture utilisation – these will be different across countries and at different adoptive levels.
Benchmarking	Network for benchmarking and understanding of regional levels of grass dry matter production and their differences will be an important first step.
	Harmonization of criteria.
Increase Qty-Qly through functional diversification	Monitor forage status (productivity) of grassland, classify plant communities and track forage productivity/biomass by remote sensing for a better understanding of the relation to site conditions (weather, soil).
	Develop programmes of plant breeding and selection which should start by characterizing and screening entries of pasture plants coming from existing germoplasm banks (e.g. FAO, ICARDA, nationals) or from new collections or other sources of genetic variability. The evaluation of the plant material will include their characteristics of adaptation to different soil, management and climate conditions.
	Composition of seed mixtures for each soil/climate condition by using functional groups principle (select cvs. of productive and persistent legumes/woody/grasses/others attending at the following characteristics: vegetative and reproductive cycles, perennially and persistency, depth of the root systems, summer or winter dormancy, drought and/or water logging resistance, pest and disease resistance, feed quality and feed intake).
	Develop a program on soil/plant microbiology, with particular emphasis on the *Rhizobium*/legume symbiosis and on the plant/arbuscular *Mycorrhiza* /phosphate solubilizing bacteria, in order to enhance N fixation and phosphate availability for grassland. As a follow up of the above, develop practical and efficient methods of producing and using inoculants.
	Develop research dealing with the use of different types of trees in grassland as a form to reduce the climate change impact, increase growing season, quality and biodiversity.
Resource efficiency	Animal health and welfare issues including carnivore predation, parasites, weight loss.
	Increased use of diverse pastures and silvo-pastures for meat, bioenergy, biodiversity and C sequestration.
	Reduction of labour requirements, new technologies to enable use of underused pastures
	Define management practices ensuring a stable quality over time.

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Differentiation products	Affordable and rapid analytical methods for routine authentication and traceability, including a validation on a large scale, of the products based on management practices and/or origin.
	Modelling and validation on a large scale (large number of commercial farms representative of European farming system and practices) of authentication methods developed at a local scale under controlled conditions or on-farm.
	Optimise authentication and traceability protocols minimising the bureaucratic effort of farmers; exploit the potential of ICT-based tools.
	Refine the understanding of the effect of botanically diverse composition of pastures and forage on the livestock product quality.
	Define management practice enabling to take advantage of the occurrence of legumes and woody vegetation in the pastures without organoleptic negative impacts in the lamb goat kids meat (i.e. too strong flavour arising from skatole and indole production in the rumen).
	Appraisement of the relevance of ecosystem services for product improvement (i.e. improvement of biodiversity of pollinators and plants in order to improve honey yield and honey quality). Study and model the trade-offs between product quality traits and other ecosystem services.
	For grazing animals, synchronisation of feed demand and grass on offer on pastures.
	Novel research on the impact of the presence, absence or reduction of livestock agriculture on local/regional rural communities.
LCA	Progress is needed in order to regionalise ecosystem services prior to their inclusion in an LCA framework.
	The importance of grassland-based livestock farms for biodiversity should be quantified so that effective grazing strategies can be developed.
	Develop easy LCA methods for the whole farm dealing with C and N cycling approach to help farmer to better manage the resources.

Summary of adoption needs

Topic	Needs
Help farmers	Promoting learning processes in groups.
	New strategies to convert grassland management into an attractive activity for younger generations.
Increase Quality-Quantity functional diversification	Knowledge transfer to farmers about management options like seed mixtures, fertilisers, amendments, weed control, grazing regime, type and agroforestry practices (density but also distribution of trees in silvopastoral, silvoarable, hedges, multipurpose trees...) by using innovative information tools that have to be developed and adapted according to local conditions.
	Promote the use of soil analysis to accurately determine the content of nutrients in the soil and their evolution with time, in order to adopt a rational plan of soil fertilisation/soil amendments to adequately supply nutrient to grassland.
	Promote the best methods of forage conservation and utilization of permanent grassland as quality hay, haylage and silage (improved knowledge and extension) in order to embed the seasonal quality attributes of grassland resources.
Resource efficiency	In the past farmers increased N fertilisers (+PKCa) to increase dry matter yield, and/or sowed new species.
	Aim to achieve acceptable output with reduced nutrient use and emissions.
	Increased opportunities for woody vegetation, legumes in range of environments. Also, multi-spp swards, by oversowing etc.
	Balancing seasonal growth with seasonal demand: strategic mowing of surplus pasture, buffer feeding, stockpiling.

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	Managing the trade off between growth and utilisation: compromise between animal performance and sward performance and quality.
	Adjusting stocking rates to herbage availability to avoid both underutilisation (senescence) and overgrazing. Flexible grazing pressures during growing season
	Solving problems of slow growth and non-lactation in livestock: too much UME goes to maintenance reducing efficiency of energy use.
	Dietary improvement: protein from legumes needs high-sugar forage to improve overall efficiency.
	Role for high condensed-tannin spp. and 'terroir' systems linked to particular environments (salt-marsh; mountain pastures, for premium products).
	Livestock improvement to reduce animal mortality, health problems, single-suckler cows, single-lamb ewes, goats; balance of breeding cycles with availability of grass ME, especially grazing.
	Carbon sequestration of PG soils variable .
	Grazing can lead to increased C sequestration (or reduced C seq when heavy enough to lead to reduced plant biomass and C inputs).
	Twin problems of overgrazing and abandonment; latter can increase soil C seq then increased fire risk reduces it.
	Biodiversity: highly important in Mediterranean, also temperate hay meadows, Alpine meadows, wetland, calcareous etc. Measures of agri-environment adding value (products linked to biodiversity).
LCA	Agro-ecology as a mean to replace fossil fuel by ecosystem services.
	Promotion of legume and woody vegetation for reducing energy consumption and protein imports.
	Pasture-based meat & dairy products for reducing impacts on the environment and improving the quantity of functional components in human diet.

Summary of innovation needs

Topic	Needs
Grassland typology	Mediation tools describing services (production & biodiversity) provided by permanent grassland at local scale, in order to answer to local operational demands. For this second purpose, locals typologies based on Phytosociology are very useful as mediation tool.
Help farmers	Implementing models/programs in applications accessible on the internet and/or available for a Smartphone for grazing management
	Measuring grass yield in a less time-consuming way, e.g. by installing suitable equipment on a quad
	Development of practical tools to facilitate grazing on dairy farms, e.g. computer programs, preferably farm-specific or web based programmes that allow farmers to assess farm specific data like feed wedges
	Provide technology and guidance to farmers on how to set up a farm to optimise grass production & utilisation
Benchmarking	Tool needed to be farmer-friendly + true
	Connecting tools from different farms & regions
Increase Qty-Qly functional diversification	Viable, affordable solutions for farms relying only on mechanical weed control, i.e. new devices for targeted mechanical weed control and reducing labour input or promotion of weed wiper, using sponges to wipe out taller growing weeds in pastures and forage crops.
	Management of legumes and woody vegetation under grazing by pasture establishing and maintaining its persistence in both high output and low output systems, i.e. by increasing stocking rate to allow clover to persist or using goats in mixed herds of cattle

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	and goats under moderate grazing pressures or by adapting the grazing-cutting regime in high output systems to allow an adequate proportion of woody/herbaceous in land.
	Increasing the potential yield and quality of grassland through a combination of extending the growing season, plant breeding, use of mixtures of plant species including woody and dynamic and flexible stocking systems.
	Provide adequate and simple tools to fertilise and amend of permanent grassland which are understandable and promote efficient in resource use for farmers and link this practice to high quality products
	Provide farmers adequate combinations of tree and shrub species, density and distribution to enhance pasture production and quality.
	Provide the farmers with information about potential forage quality depending on cutting or grazing time, method of conservation, meteorology and site characteristics by means of user-friendly, low-cost, ICT-based tools.
Resource eff.	Increase use of diverse legumes and woody vegetation to improve productivity and profit (*Rhizobia*, cultivar choice)
	Multi-species swards containing species (*Lotus*, etc) with health and nutrient utilisation properties
	Ensuring P nutrition without reliance on fossil-P.
	Mixed grazing systems and grazing practices to reduce parasites and enhance resource use.
Differentiation products	Providing professionals tools that enable to develop and promote quality products based on enhancement of grassland-based production systems, especially in mountain areas and with associated woody vegetation (enabling the outstanding intrinsic (nutritional and sensory values) and extrinsic (ecosystem services) qualities of their products to be recognised by consumers).
	Support projects and works carried out in this field throughout the territories with the aim to establish recognised operational groups and to participate actively in regional development.
	Define marketing arguments ensuring valorisation of permanent grass-based products to consumers.
LCA	Rethinking the technical and political solutions to improve livelihood of farmers managing low-inputs grassland-based systems.
	New tools based on LCT (LCA of territories) to manage rural areas (e.g. agro-land care extension service) giving scenario analysis of alternative systems to permanent grassland-based meat and milk in terms of their different LCA.
	Territorial management permanent committees of stakeholders (to empower the farmers) where farmers should participate directly to committees.
	Integrate data sets at local level + implement ICT tools for interconnecting extension services to academic and research centres and obtaining more timely and accurate dynamic picture of territorial context.

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Annex 5. Failure matrix

Blue: fail factors // Green: potential actions to tackle fail factors

Failures\Actors (missing actors)		**Demand** **-Consumers** **-Large buyers**	**Producers** **- Farmers** **- Cooperatives** **-** **-…**	**Knowledge institutes** **-Universities and research institutes** **-Technology institutes** **- Advisory services**	**Government** - **Sectoral** - **Other**	**'Third parties'** - **Providers** - **Intermediaries** - **Sectoral organizations** - **NGOs,** - **…**
Infrastructural failure: ICT, roads, land structures…			Absence of market for products Develop cooperative arrangement systems between producers and market place	Lack of infrastructure and clear links between actors Governmental support (money)	No (financial) incentives Lack of strong (medium term) financial support for risky innovations for first introduction EIP-AGRI?	Sellers are the ones that drive markets and therefore production
Institutional failure	**Hard: laws, regulations**		Regulation not accepted by farmers Too much administration Keep working for simplicity	No student in ag. Sciences can graduate/PhD without on farm training Participatory approaches in (i) research&development and (ii) development of rules	Regional-National public policies and bodies are more concentrated on other issues (CAP subsidies, commodity and product prices...) Reinforcing farm competitiveness through innovation not a priority. At EU/national levels, research policies have been highly oriented towards scientific excellence, not promoting enough, at least in the agricultural sector (and more accutely in livestock farms with PG), its real interest to producers. CAP do not focus enough in innovation Difficulties to implement CAP -> no place for innovation Nobody can become a civil servant in agric. Without on farm training Prior to any new rules an in depth analysis of the consequences on economical, ecological, sociological: sustainability	Higher complexity (e.g. grazing) and higher environmental limitations (e.g. Habitat Directive or CAP Regulations) provokes less attraction by private industries.

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					Subsidies need to be focused in efficiency improvements especially in grassland CAP payments only for: Ecosystem services provided farmers // Innovate (but problematic for productivity)	
	Soft: norms, values, behaviours, paradigms	Consumers reluctant to pay for ecosystem services of grassland. Lack of public awareness on multi-functionality of grassland Make the consumers aware of what happens if the farmers aren't there any more (no food, fiber, landscape for recreation and tourism, etc.) Information We need political and public consensus on this = process More communication	What will my neighbour think of the innovation? No sense of urgency No recognition of grass production with permanent grassland in the same way as another culture. Many farmers are not motivated by productivity + CAP highly supports their income = No innovation needs No awareness of farmers: only costs money Be aware of different kind of farmers: early adopters/…/no-farmers -> plan for each group Motivate Young generation of farmers!! Public-private partnerships Promote operational groups A paradigm change in agriculture is needed. Agriculture should feed households not agro-industries. Small-scale, self-sufficient farms processing their products and selling then in short markets.	Not on the agenda of advisors Scientific information is only addressing a solution for a scientific problem, which is often only a small part of a "problem". Farmers like to see new opportunities in the whole picture. Translating theoretical knowledge into practice not there Unbalance between reductionism and systemic approaches. Only systemic approaches can solve complex problems Innovation must improve quality of farmers' life and social integration Promote operational groups Materials and TV shows for farmers promoting the innovation Involvement of the NRN (rural network) in promoting successful innovative projects/ideas Developing systemic and participatory approaches. About the half (50%) of research budgets should be devoted to that.		Work together need all parties to implement for all sector
Interaction failure	**Weak network failure**		The ways in order to send and transfer new knowledge to farmers are not very well reported Lack of common goals and clarity			

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			Need to engage responsibility of involved stakeholders Key persons don't like each other			
	Strong network failure		Farmers only adapting new innovation when it is a (possible) solution to their problem. Who can help the farmer with this innovation? Each actor has own priorities, which may collide with the overall aim (i.e. researchers need to publish, companies may give priority to the profit rather than to the best farmer-oriented solution, extension services may look for a quick approval from the farmer and may not be motivated to go a new way at first sight less appealing for the farmer). Difficult to get innovation from pre-adopters towards the large group	Farmers only adapting new innovation when it is a (possible) solution to their problem. Who can help the farmer with this innovation? Any or low link among research institutions and extension services. Each actor has own priorities, which may collide with the overall aim (idem). Lack of proper channels of knowledge transfer. Technical support on improvement and management of Permanent Grassland by "unbiased" technicians is scarce. Farmers are not asked to work in a participatory way with challenges/needs Advisors unwilling to take responsibility for risk of failure Lack of participatory approaches: need to develop innovations with farmers and scientists together and with other stakeholders No interaction with end user Prioritise communication also fore researchers obligatory Demand driven research Show case farms Advisor and farmer need to develop understanding of risks and how they share responsibility for risks by compromise Improve tools for interconnecting extension services and research institutions -> stakeholders committees	Civil servants are way too far from farming reality Stimulate network among government and farmers Administrative people should be encouraged/forced to work a week a year on a farm	Permanent grassland are not the main objective of important private industries (e.g. fertilisers, seeds, machinery) that are betting strongly on precision agricultural techniques (e.g. use of GPS, drones, etc). Positive support from NGO's: e.g. making consuers pay more money

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Capabilities failure (knowledge, skills, financial..)	Value of ecosystem services not known to consumers Innovative products are expensive on the market Lack of knowledge on which is the minimum amount of grassland that we need Stimulate entrepreneurial skills, attitudes at all levels in society Start the process to know which grassland is needed in ecological and public sense. More information for society: why innovative products are better	Associated risks (what if it doesn't work) Uncertainty due to variability Knowledge is lacking, Lack of enough technical knowledge of farmers Management of permanent grassland is extremely complex because of their inter-plot diversity but also their intra-plot diversity Farmers may not recognise the advantages and the weak points of the techniques/systems. Innovation is too difficult	Associated risks (what if it doesn't work) Uncertainty due to variability Knowledge is lacking Innovation not presented in an interesting way to farmers We should have measurements for field and farm yields. And the site specific reasons for higher or lower yields are also to define / Lack of proper field assessment measures and support There is a need for real time information for farmers on seasonal, locally specific information pasture growth and quality Need for socio-economic information (and socio-economic research to underpin this) to address fail factors Research (reduction of associated risks) Education: high school university life learning	Associated risks (what if it doesn't work) Uncertainty due to variability No money More money ? Better use of money? Subsidies proportional to risks, to benefits for society	Farmers organisations (e.g. Unions) are not seriously involved in I+D+i policies Financial institutions supporting farm business need to have technical advisors who can give evidence-based information on risks and rewards of supporting innovative projects
Mix		Lock-in situation due to investments, market structure, family influence Accompanying farmers (technically and psychologically) who want to escape from locked-in situation Chains. In these farms investments will also be reduced which could leave room for young farmers			

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Annex 6: Members of the Focus Group

Bailey John	Scientist	United Kingdom
Brandsma Jeanet	Farmer	Netherlands
Busqué Juan	Scientist	Spain
Elsaesser Martin	Scientist	Germany
Goliński Piotr	Expert from agriculture organisation, industry or manufacturing; expert from NGO; scientist	Poland
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Lind Vibeke	Scientist	Norway
Mosquera-Losada María Rosa	Farm adviser; expert from NGO; scientist	Spain
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You can contact Focus Group members through the online EIP-AGRI Network.
Only registered users can access this area. If you already have an account, you can log in here
If you want to become part of the EIP-AGRI Network, please register to the website through this link

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Annex 7. Starting paper

Read the starting paper

Annex 8. Discussion papers

You can find the discussion papers in the following links:

- Definition of grassland typology in relation to biodiversity and productivity
- Achieving grassland production and quality that matches animal needs
- Benchmarking grassland dry matter (DM) production and utilisation at regional and national levels
- Sustainable grassland production by increased functional group diversification
- Increase resource efficiency to improve profitability and sustainability
- Differentiation of grass based products for higher market value: linking quality traits and management practices related to the ecosystem services
- Life cycle assessment: evaluation of the environmental impacts of grassland-based systems using Life Cycle Thinking (LCT)

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eip-agri
AGRICULTURE & INNOVATION

The European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts.

The **EIP-AGRI** aims to catalyse the innovation process in the **agricultural and forestry sectors** by bringing **research and practice closer together** – in research and innovation projects as well as *through* the EIP-AGRI network.

EIPs aim to streamline, simplify and better coordinate existing instruments and initiatives and complement them with actions where necessary. Two specific funding sources are particularly important for the EIP-AGRI:

- ✓ the EU Research and Innovation framework, Horizon 2020,
- ✓ the EU Rural Development Policy.

An EIP AGRI Focus Group* is one of several different building blocks of the EIP-AGRI network, which is funded under the EU Rural Development policy. Working on a narrowly defined issue, Focus Groups temporarily bring together around 20 experts (such as farmers, advisers, researchers, up- and downstream businesses and NGOs) to map and develop solutions within their field.

The concrete objectives of a Focus Group are:

- ✓ to take stock of the state of art of practice and research in its field, listing problems and opportunities;
- ✓ to identify needs from practice and propose directions for further research;
- ✓ to propose priorities for innovative actions by suggesting potential projects for Operational Groups working under Rural Development or other project formats to test solutions and opportunities, including ways to disseminate the practical knowledge gathered.

Results are normally published in a report within 12-18 months of the launch of a given Focus Group.

Experts are selected based on an open call for interest. Each expert is appointed based on his or her personal knowledge and experience in the particular field and therefore does not represent an organisation or a Member State.

*More details on EIP-AGRI Focus Group aims and process are given in its charter on:
http://ec.europa.eu/agriculture/eip/focus-groups/charter_en.pdf

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