Study on feeding strategies to diversify the protein sources used in different livestock production systems in the EU

Executive summary

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1 INTRODUCTION

The '**Study on feeding strategies to diversify the protein sources used in different livestock production systems in the EU**' aimed to analyse the opportunities and limitations for diversifying animal feed sources, with a focus on protein feeds that could be produced in the EU to limit EU dependency on imports. This study focused on the main types of livestock production systems at EU level. As such, the study had to meet several objectives: 1) describe the composition of feed rations for different types of livestock in the EU by identifying feeds produced in the EU and imported feeds, 2) identify the most representative livestock systems in the EU, 3) identify import dependencies and identify alternatives to imported feed, 4) identify ways to improve the resilience of the EU production chains of the sector, 5) collect best practices that could be implemented in the EU livestock sector, and 6) identify policy measures to enable diversification of protein feed sources in the EU and develop the EU self-sufficiency.

The study is structured into four main steps: a descriptive part, an analytical part, a case studies step, and a conclusion chapter. The descriptive part provides a description of the functioning and current structure of livestock farms and manufacturers in the EU. The analytical part is based on 12 study questions analysing different alternative scenarios and assessing their impact on arable crop producers, livestock producers, feed manufacturers, the economy of the sector and the environment. An in-depth literature review, numerous interviews at EU level, three surveys, 10 case studies on 10 different livestock types and two modelling scenarios per case study have been carried out, with repetition in three Member States by case study[1]. The case studies were focused on the collection of stakeholders' opinions on possible alternatives to imports, the setting up of scenarios to be studied by livestock type and their reaction to the scenarios modelled. The modelling scenarios made it possible to obtain detailed data on the different alternatives studied and on their economic and/or technical feasibility at cluster[2] or Member State level depending on the case studies.

All the material collected made it possible to make in-depth analyses, which are presented in the analytical part. Finally, based on the descriptive part, the case studies, the surveys, the modelling results, and the answer to the study questions, the final chapter provides conclusions and recommendations on the potential for and limitations to diversifying protein sources in the EU.

The main limitations of this study are related to the following:

- Case studies have been carried out only in some Member States and for some livestock clusters[3], limiting the possibility to extrapolate all results at EU level for all sectors.
- Modelling[4] and the use of the FADN present some limitations (detailed in the methodological chapter and study question 6).
- There is a lack of precise data on prices, yields, margins, and contractual agreements, etc., in most of the case studies.

[1] Meaning in 13 different Member States, 28 different groups of stakeholders (subclusters) met two times: one time for the description of the concerned sector, the issues at stake in terms of protein crop imports, and the scenarios to be modelled, and a second time to react to the results of the modelled scenarios.

[2] Livestock of the same animal species on the scale of several Member States (between two and four), which share common features, such as livestock production system.

[3] The studied clusters were: conventional intensive pigmeat in Germany, Denmark and France; non-conventional pigmeat (organic livestock, non-GM fed livestock and PDO/PGI) in Spain and Italy; conventional – intensive and extensive dairy cattle in France, Czech Republic, and Poland; non-conventional dairy cattle in Germany and Austria; organic laying hens in France, Germany, Denmark, and Sweden; conventional – intensive and semi-intensive broilers in Poland, France, and Romania; conventional – heifer fattening and yearling male fattening in France, Belgium, and the Netherlands; non-conventional beef fattening in Italy and Spain; conventional – intensive and semi-intensive dairy goats in France, the Netherlands, and Spain; and, finally, conventional – extensive and semi-extensive sheep meat, in Spain, France, and Greece.

[4] Carried out by using the EU-level model *FeedMod* except for French sub-clusters, where the French *Prospective Aliment (P.A.)* model provided more precise results.

2 MAIN CONCLUSIONS OF THE STUDY

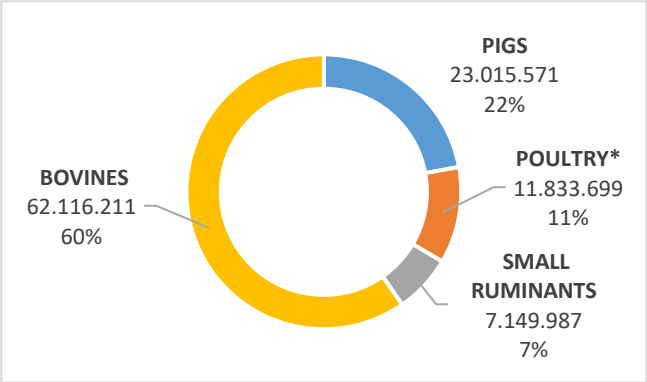
2.1 DEMAND AND SUPPLY FOR PLANT PROTEINS DEDICATED TO LIVESTOCK SECTOR IN THE EU

The volume of the EU crude protein demand for feed in the 2021/2022 campaign was 72 million tonnes. 55 million tonnes of crude proteins came from the EU, **representing around 77% of protein autonomy**. **The EU feed market is self-sufficient in roughage. In addition, 90 % of cereals feed is produced in the EU. Nevertheless, only 37% of co-products (e.g. protein meals) are produced in the EU. The self-sufficiency ratio for oilseed meals is 23% and 3% for soya bean meals.** Soya bean meal is mainly imported from the Americas for the conventional sector, and from Africa or Asia for the organic sector. Imports of soya beans, rapeseeds and sunflower seeds and their meals reached 14.46 million tonnes of crude proteins (49.5 million tonnes of raw product) in 2021/2022, requiring roughly 18 million hectares of land, taking into account the average yield for each crop. This 'offshore' surface represents approximately 13% of the 135 million hectares devoted in the EU to crops potentially consumable by animals[5].

The EU Member States represent a complex mosaic in terms of soil, climate, resources and geographical location (e.g. seafront or landlocked). The type of livestock raised in each Member State reflects these various specificities as well as historical habits and economic opportunities and constraints. For example, Belgium, the Netherlands, and Spain produce far more animals than their 'intrinsic' resources allow, thanks to imports of oilseeds and/or oil meals, as well as cereals.

In 2021, total EU livestock amounted to more than 104 million livestock units (LU[6]). Bovine animals are the most numerous, as they represent more than half of the total herd, with more than 62 million LU. Pigs come second with 23 million LU, representing 22%. Laying hens and broilers are less numerous, and the small ruminants (sheep and goats) are the least numerous, representing 7% of total livestock in LU.

Figure 1: Breakdown of LU in the EU (2021=104 115 468)



Source: CEREOPA, based on available data (Eurostat, FEFAC)
*hens 2021 and broilers 2016

The nutritional requirements of ruminant and monogastric animals are very different. Ruminants rely mostly on forages, while monogastrics rely mostly on concentrates (e.g. cereals, oil meals, etc.). Due to the differences in composition of these diets and to the level of availability of feed components, **monogastric farming (for conventional and non-conventional systems) tends to be more dependent on imports than is ruminant farming**, even though the dairy cow sector is the second-biggest user of soya meals.

Throughout the EU, feeding strategies are mainly driven by **economic reasons and more precisely by price ratios**: price ratio of the on-farm produced crops vs purchased feed for livestock farmers; of EU produced crops vs imported soya bean for suppliers, including arable crop producers; and nutritional quality/price for farmers and feed manufacturers.

[5] Roughly: arable land plus permanent grassland, excluding crops intended exclusively for human consumption (root crops, fibre crop, fresh vegetables, permanent crops, and others), according to CEREOPA data.
[6] Livestock units are used here, as it is difficult to compare animals with very different sizes (e.g. cow vs chicken), and in addition the cycles of the species over the year are very different (e.g. poultry produce several generations a year). Hence, to make comparisons in feed consumption, it was preferrable to work in LU.

Farmers are also influenced by **contractual arrangements**, **legislative requirements**[7] and **traditional practices**[8]. The behaviour of **raw material suppliers** is also economically driven but is dependent on **regulatory requirements** and **other markets**, since there is competition with other sectors for some raw materials (e.g. pet food, human consumption, industrial use, bioenergy, etc.). **Feed manufacturers** then have to strike the right balance between **nutritional quality, availability,** and **prices**.

Finally, it is all about the **needs of each type of animal** (species, age, certification, etc.). Among the three main components of feed, all proteins are not equal (particularly in terms of amino acid profile, energy supply is just as essential, and fibre is more or less necessary[9]). In addition, the protein ingestion capacity of animals, particularly ruminants, can also be a limiting factor. **The range of solutions can therefore be different for each category of operators and even for each livestock production context (e.g. cluster), which means that there are multiple solutions.**

Nevertheless, and even though this study is based on in-depth analysis of 10 different clusters in 13 Members States, most of the analysis and recommendations apply to all the studied clusters, with the following caveats:

- There are, of course, differences between monogastrics and ruminants: the feed of the latter relies mostly on grass/forage/roughage grown in the EU and most of the time at farm level.
- There are slight differences between conventional and non-conventional (organic, non-GM and PDO/PGI) clusters, apart from some restrictions due to regulation and standards (see below).

Hence, in the following executive summary, we treat mainly ruminants and monogastrics, rarely mentioning a given cluster, as explanations could quickly become highly confusing. For example, the systemic modelling of all the clusters at national level shows that **a lever can have winners and losers when one cluster is able to pay more for one diversification lever than another**[10]. These differences are presented in detail in the full study report.

2.2 THE DIVERSIFICATION LEVERS ARE KNOWN

2.2.1 Crops already grown in the EU

Most of the identified alternative raw materials intended for livestock feed are already produced in the EU and used in most Member States. Among the most important levers that were analysed in this study, the most relevant are the following:

- Increase in **the quality and/or the share of proteins in the forage/roughage ration of ruminants** through several possible strategies: integration of fodder legumes (dried alfalfa), improved pastures and grassland management (balanced

[7] E.g. in organic farming the minimum percentage of feed coming from the farm.
[8] Practices usually carried out on the farm or in the region in the long term, implying a fear of change.
[9] Ruminants need more fibres than monogastric species.
[10] In the modelling work, we have tried to identify which species would benefit from the introduction of a new solution in a global system where species/formulas are in competition to capture the cheapest, most suitable raw materials to fill their needs. Our systemic approach depicts the existing fact that when several formulas are in competition for the same (and limited) resource, formulas with the highest constraints will often come first and use it as much as they can. More versatile formulas, which can put several types of raw materials to good use and can easily switch from one to another, are more likely to use the remaining raw materials. In cases where we introduced a new raw material with high protein density, good amino acid composition and digestibility, and high energy level, the formulas that would benefit the most from it are calculated through its shadow price (which is, for each formula, the highest possible price of this raw material to enter this formula, entirely based on its nutritional composition). For protein and amino acid, species that require the densest raw materials are chickens and turkeys (due to their fast-paced growth, with high energy and amino acid requirements). That often makes them the first to capture new raw materials such as the ones we tested. At the other end of species' competition, more versatile species are able to put most of the raw materials to good use, and with limited nutrient requirements: e.g. ruminants, swine, and gestating sows. These formulas are less likely to access new raw materials if volumes are limited, as the first tonnage will be dedicated to the most competitive formulas (broilers especially).

grass and legumes mixtures), or meslins (i.e. mixture of cereals and grain legumes).
- Increase in the production of **soya bean, sunflower, rapeseed and of pulses** in the EU.
- **Replacement of soya meals by the development of improved meals** from sunflower or rapeseed (high protein (HiPro) sunflower[11] or rapeseed[12] meals) or from legume crops (e.g. shelled beans) cultivated in the EU.

But, of course, increasing the production of these crops/grasslands implies reducing others and particularly cereals, which can have an incidence on the EU market and also on exports of these products (see Section 3.2.2).

2.2.2 Various complementary strategies for diversification

The livestock sectors are not equivalent in terms of import needs. It is clearly the conventional pig and poultry meat sectors that are the most dependent on soya meals imports. Ruminants rely more on fodder even if some concentrates are supplied. All non-conventional livestock sectors (i.e. non-GM, organic and PD/PGI) are usually less dependent on imports.

Apart from diversifying diets with EU-grown raw materials, there are many other strategies to diversify feed composition or at least reduce the need for protein-rich materials (imported or not). Some strategies have already been implemented by operators in some sectors and some Member States:

- **Better characterisation of livestock needs (at least by age) to avoid an excessive supply of certain nutrients** while guaranteeing a good yield.
- Better characterisation of the nutritional values (e.g. amino acid profile, content in starch, fibre, etc.) **of the raw materials** used in the ration and in particular of forages.
- **Selection of new crop varieties less rich in anti-nutritional factors (ANF), or richer in specific amino acids** (e.g. fava beans).
- Selection of **crops providing stable and higher yields** (e.g. HiPro rapeseed), better adapted to various pedoclimatic regions of the EU (e.g. soya beans varieties[13]).
- **Selection of more robust animal species (especially monogastric species), less sensitive to ANF and more adapted to diversified diets.**

Some others are more in the experimental phase and cannot be developed without changes in the regulatory framework such as:

- The introduction of **insects that is relevant in terms of nutritional values** and complementary to raw materials grown in the EU[14].
- A **circular economy approach** that could help keep nutrients in the feed system, for example by recovering Processed Animal Proteins **(PAPs)** and **former foodstuffs[15]**.
- Contributions of **amino acids[16] or enzymes in rations** in order to optimise the use of nutrients from raw materials or to reduce the need for some raw materials

[11] HiPro sunflower meal is produced into factories which concentrate their protein content.
[12] HiPro meal is produced from a variety of rapeseed having a higher protein content.
[13] Able to grow in Northern areas than presently.
[14] This lever must nevertheless be nuanced: the study revealed widespread skepticism about the potential of insect meal for animal feed in the supply chains of interest, due to a number of technical and economic limitations, as well as low perceived acceptance by end consumers and retailers.
[15] For these sources, however, the animal feed sector suffers from competition from other outlets (e.g. pet food, biogas production) and some regulatory and technical barriers still need to be overcome. For PAPs, consumer acceptance is still low; however, other actors in the supply chain are more open to their use than in the past (e.g. retailers), especially for monogastric species.
[16] Amino acids are widely seen as a solution to include in the diets of EU-produced raw materials, which have a sub-optimal amino acid profile compared to soya products.

such as soya bean meal. However, the heavy dependence of the EU livestock sector on imports of amino acids, particularly from China, remains of concern.

2.2.3 Constraints and advantages of 'non-conventional' markets

The levers identified for organic farming, Protected Designation of Origin (PDO) Protected Geographical Indication (PGI) and non-Genetically Modified (GM free) sectors are globally similar to the levers of the conventional segments, with a few exceptions:

- Non-conventional sectors are governed by regulations and specifications (organic, PDO/PGI standards, non-GM regulations). Therefore, not all of the alternatives mentioned can be used in all sectors if they do not meet the requirements of these regulations and specifications. For example, **synthetic amino acids are prohibited by organic regulations.**
- The outlets of co/byproducts can be a limiting factor. For example, HiPro[17] sunflower meals and shelled beans are processes that increase the protein content of these raw materials. **But the market for co/byproducts** (e.g. oil for human consumption), **must also exist at the same time and also be profitable** for the sector to develop, which is not always the case[18].

2.2.4 Several combinations of levers: the only diversification solution

The advantages and technical obstacles of these alternatives are known and documented in the various literature dealing with the subject. The stakeholders interviewed during the study are also informed of all the advantages and limitations. In the opinion of the operators and experts met during the study, there is not one single solution that would be applicable to all production systems, all livestock, and all regions of all Member States. **The challenge of diversification is to implement different combinations of levers adapted to the needs and conditions of the agricultural sectors and adapted to the various EU regions and to the various types of farms** (e.g. intensive vs extensive, small vs large, growing ruminants or monogastrics, etc.)**.**

Results of the scenarios modelled demonstrated the relevance of some levers compared to others. It is obvious that the major lever for **diversifying the diet of ruminants consists in increasing the share of proteins ingested via an increase of grass or roughage/forage in the ration and by integration of fodder legumes** (e.g. dried alfalfa), **as well as improved pasture and grassland management**. This can nevertheless be limited for some sectors where production is very intensive (e.g. conventional milking cows) or in systems lacking available land (e.g. small farms).

Increasing the production of protein crops[19] and oilseeds, as well as developing varieties and processes to improve their nutritional profile and limit their yields variation, is systematically emerging as another relevant lever. Presently, one of the major constraints to their use is their low overall availability due to variable yields, low profitability for some of them[20] and lower competitiveness in terms of nutritive profile compared to imported soya bean/soya meal[21]. They also sometimes have fluctuating nutritional values, requiring a regular adaptation of feed mix to variable raw materials. All these barriers are avenues for research programmes.

2.3 Competitiveness (and complexity) are the core challenges

The first main reason why these alternatives have not yet been sufficiently deployed is the **competitiveness of the related crops compared to imported soya bean, as well as**

[17] High protein (content).
[18] For organic sunflower HiPro for example, meals must be produced at a competitive price, but the oil produced in the process also has to find a market in the organic sector (in quantity and quality), which is not always possible.
[19] In the context of this study, **protein crops** correspond to legumes (including mixtures of legumes and grasses), and soya bean.
[20] Particularly compared to main crops in rotation, such as wheat and maize.
[21] They also have an energy and protein content not sufficiently concentrated compared to their competitors, which makes them less versatile in their uses.

vs cereal crops in competition in crop rotation. But this is not the only reason, and the issues are too complex to be reduced to a single consideration of relative competitiveness.

The advantages and technical obstacles of the alternatives depend on many factors: the pedoclimatic situation of the regions, the production systems and the various associated regulations, the production capacities, the staff implications, etc. **This study was able to identify a number of significant drivers that influence stakeholders' decisions to use more EU-produced feed sources**. They are of various categories in economic, technical, organisation and political.

Economic factors are the most important determinant in the choice of raw materials for arable crop farmers and feed manufacturers. The two key factors are: the **relative price/yield and availability** (i.e. satisfactory availability of protein sources produced in the EU – in terms of quantity and quality in terms of nutritional composition and amino acid profile). For both key factors, **volatility and risk** are also significant drivers/constraints, in particular for arable crop producers.

The grass lever for animal breeders is slightly different from the other diversification levers from an economic point of view, as there are many other specific indirect costs influencing livestock farming. Hence, the economic factors (price and availability) can be less central for some of them. **Land availability, working time, agronomic expertise, zootechnical knowledge and yield variability are also crucial factors besides economy that induce livestock breeders to increase the proportion of grass in the ration or not** (due to a lack of available land, for example)**.**

2.3.1 Feed price: top priority of the operators concerned

The diversification crop (whether rapeseed, sunflower, soya bean or other protein crop) must first be economically attractive[22] to produce for **arable crop farmers.** The study compared the average gross margins of crops for farms specialising in crops that could be alternatives either to wheat or maize.

Some examples of these comparisons are given below.

- **Rapeseed is generally competitive compared to wheat** in most Member States[23].
- **For protein crops[24] and sunflower, it is hard to compete with maize[25] across the whole EU:** in all Member States surveyed, the gross margin of maize crop is significantly higher than those of soya bean and sunflower.
- It is **more difficult to draw conclusions for the protein crops traditionally produced in the EU[26]**, as they depend on the protein crop species and on the region considered[27].

The manufacturer includes an alternative raw material in its formulation only when it is available on a long run, in sufficient volume, with a required quality and at an attractive price. If this is not the case, the manufacturer should be able to increase its selling price, but this is often not possible due to competition from other manufacturers that use cheaper raw materials. **Incorporation can be forced** (e.g. if requested by standards) **or incentivised through regulation, contractualisation initiatives[28] or consumer demand for a niche product, etc.**

[22] Some farmers or advisers also work on rotation margin, which is generally more favourable to protein crops.
[23] Except most of the Mediterranean zone.
[24] soya, peas, beans, faba bean, etc.
[25] Both for grain and silage purposes.
[26] I.e. all protein crops (peas, beans, faba beans, etc), except soya.
[27] For example, in Romania, the gross margin of farmers cultivating soya bean is significantly higher than that of wheat.
[28] Thanks, for example, to the use of operational programmes for producers' organisations of the new CAP.

Pricing mechanisms are central to the contractual arrangements between feed manufacturers and their raw material suppliers, in particular when the dynamics of EU prices are influenced by world prices, which is the case for the three main oilseeds, in particular soya bean. For these crops, the pricing mechanisms tend to be adjusted more frequently. The price could be determined by a fixed component and a variable component, which may be linked to the futures markets (when they exist and are sufficiently liquid)[29], which will limit the volatility of prices. But these mechanisms are less developed in the EU than in the US.

Animal breeders face other challenges. The ambition to increase feed autonomy may lead them to develop production of protein crops for self-consumption[30]. The notion of competitiveness of the produced crop could be combined with other issues at stake (as there is not systematically the objective of selling the products on the market); however, when there is a limited availability of or access to land[31], the production of alternative crops also competes with more profitable cereal crops. The farmer's choice is then whether the self-sufficiency provided by the crop compensates for the loss guaranteed by a saleable crop (e.g. maize or wheat), which depends on a comparison of their related opportunity costs. Furthermore, as grass production is much more variable than silage maize, silage maize can be seen by farmers as an insurance against risk, and they may wish to keep it in their ration.

Nevertheless, although core issues, the competitiveness of each raw material and its relative prices are not the only decision-making factor, as explained below.

2.3.2 Increasing the availability of proteins from EU-grown raw materials: a question of relative competitiveness, but not just that…

In addition to the purely financial aspects, the choice of the crop for the raw material producer **also depends on other aspects** such as availability of land, crop adaptation to local pedoclimatic conditions, crop management, crop protection (including availability of phytosanitary products for this crop), production costs, knowledge of the crop, equipment needed, etc. Profitability remains central to develop protein production in the EU.

Nevertheless, increase in diversification of production in the EU (grass, pasture, oilseeds, protein crops) requires, at EU level, available agricultural land suitable for the crops of interest. At farm level, the study shows that farmers are not equal in terms of land availability (particularly for small intensive farms) and that in most cases land availability in the EU is limited.

Indeed, an increase of the availability of protein from raw materials grown in the EU, would be done at the expense of crops already in rotation. Rapeseed and some protein crops will compete mainly with wheat and soya, and sunflower mainly with maize. As described earlier, **maize has higher gross margins overall**. For wheat, the situation is more mixed, and other drivers are likely to hinder the development of alternative crops.

At the EU aggregated level, the target of 50% replacement of imported soya bean by local protein-rich plants would have significant economic impacts**. Replacing 50 % of soya bean-equivalent imports** (19 in 21/22) would mean swapping 6.6 million ha of other crops, i.e. around 4% of the EU 27's UAA. Leaving forage crops (excluding silage maize) and vegetable crops untouched, this would mean converting almost 9.5% of the remaining area, i.e. roughly 3.6 million hectares of wheat, 1.4 million hectares of maize, 1 million ha of barley and 0.7 million ha of sunflowers. The land-use change needed at the expense of cereals **would thus have significant impacts on EU external trade and on exporting Member States**. Such significant economic impacts make it **very unlikely**

[29] The linking of pricing formulas with the futures markets also allows for the application of hedging techniques by operators with the necessary expertise, which mainly concerns big players.
[30] The stakeholders interviewed during the study relativise this fact, as feed self-sufficiency would not be the priority for most animal breeders.
[31] For dairy cows, access to grassland is less easy when the there is a pre-set milking facility, which represents the majority of cases.

that significant changes occur in livestock production systems at EU level in the short term. The diversification of protein sources will instead require the implementation of different combinations of levers, depending on the specific contexts, and pathways for change for the medium/long term.

In terms of EU land use, the change related to scenarios was generally not significant for monogastrics. In the case of ruminants, it was not possible to obtain quantitative figures for all clusters. But available results suggest that **scenarios based on increased availability of local oilseeds require greater land area in the EU than the baseline situation** (HiPro rapeseed meal for dairy cattle, HiPro sunflower meal for conventional beef and dairy cattle). This is **also the case for scenarios based on a higher share of roughage in the ration** (e.g. about a 15 % increase in land area for French conventional dairy cattle and goats), although less land is needed in the EU to produce manufactured feed.

The impact on the organisation of farm activities as a whole also has to be taken into account. For example, the indirect agronomic impacts after the introduction of a new crop in rotation, in terms of working time generated, transport time between potentially scattered plots, available plots and size, or even the tools and equipment needed, are examples of factors that each farmer will integrate in his/her reasoning before deciding to include a new crop in his/her rotation or to expand some of them (e.g. pasture). The lack of experience and knowledge regarding a new production also influences the farmer's choice.

Finally, the existing outlets and the organisation of the sector constitute a major constraint to the introduction of alternative crops, in particular the existence of outlets for co/byproducts and structured logistics networks, tools, machinery, and equipment (e.g. collection, sorting, and storage capacity).

Farmers are also aware of the **regulatory requirements on crop production**. Regulations on irrigation, fertilisers and available pesticides for a given crop, or private standards, etc., influence the choice of crop production/rotation. In this respect, the regulations on climate and environmental protection are changing rapidly since the publication of the Green Deal, and recent regulations could still change the context of European production (concerning imports of fertilisers and soya beans in particular).

2.3.3 Quality and nutritional requirements throughout the chain

Technically, for both animal breeders and feed manufacturers, product characteristics and quality parameters (e.g. crude protein content, organic, non-GM, etc.) are major factors to consider. Above all, the feed must be nutritionally adapted to the needs of the animals at a given age and in a given sector or cluster (e.g. private standards). **The nutritional requirements set by processors and/or distribution chains in their supply methods can have a greater or lesser influence on feeding strategies.** In general, the more stringent the requirements are in terms of (i) permitted raw materials, (ii) minimum/maximum inclusion rates of specific raw materials in the manufactured feed diets/formulae and (iii) raw material quality parameters, the greater the influence. The use of synthetic amino acids enables a ration to be better balanced from a nutritional point of view. This lever, already well established in some livestock sectors (mostly monogastric) and some Member States, has been recently applied to ruminants, but up to now, to a still limited extent in almost all Member States.

Nutritional requirements (mostly sourcing of the raw material and method of production) set by EU legislation[32] are also a key element that determine the choice of manufactured feed for organic farming, non-GM production and in the specifications set for PDO and PGI products (especially for PDO). Sectors that have chosen to develop in such specific segments have thus facilitated the development of alternative crops in their territories. For example, Austria has significantly increased its

[32] https://agriculture.ec.europa.eu/farming/organic-farming/legislation_en

soya bean production since the introduction of incentives (by public authorities) to produce animal products without GMO feed. Germany has developed soya bean production to meet the needs of the non-GMO poultry and milk sectors.

2.3.4 Impacts on the organisation of the supply chain

The scenarios on supply chains identified only a few impacts[33] concerning the **'soft' elements of the organisation of the supply chain,** such as the internal organisation / the operational procedures of the operators, the vertical coordination/integration, contractual arrangements, process/quality, and requirements, standards, etc.

With regard to the **organisation of the feed supply chain**, including the **associated regulatory mechanisms**, two main areas for potential improvement were identified by the stakeholders consulted:

1. Organisational solutions[34] to promote **an increased supply of alternative raw materials and/or the commercial production of innovative raw materials**. Ideas for improvement included increasing coordination along the chain (e.g. deciding investment in partnership, establishing contractual arrangements in the medium term, and developing process/product specifications, setting up private standards, etc.).
2. Organisational solutions aimed at **promoting increased use of alternative raw materials** and/or enabling the use of **innovative raw materials**.

As for the **organisation of the animal product sectors**, two main areas for improvement were identified by the stakeholders consulted:

1. Development of **solutions to improve the competitiveness** of animal product supply chains, with a view of ensuring the economic conditions that would allow the (increased) use of more expensive alternative/innovative, such as, EU-grown raw materials (e.g. establish private standards and communicate on the EU origin of the feed through outreach campaigns for these products, etc.).
2. **Revision of nutrition-related requirements** in product/process specifications and existing quality standards for end products (e.g. PDO/PGI), to allow for increased use of alternative raw materials and/or for the use of 'innovative' raw materials (e.g. PAPs).

2.4 THE IMPACT OF ALTERNATIVES STUDIED ON THE ENVIRONMENT

Overall, the literature shows a global positive effect for the environment of grassland and protein crops. However, **these impacts cannot be made widespread because they are highly dependent on the cropping methods used by farmers and even on the crop itself**[35]. In addition, environmental impacts will depend on the area and the geographical context concerned by changes in land use. Given the diversity of possible levers, context, and management strategies, it was possible to quantify only some of the environmental impacts of the alternative strategies. Additional literature review made it possible to add some additional points. It is with these limits in mind that the following chapter must be read.

A majority of scenarios reduce the pressure on the environment compared to the reference situation and show the following:

- **An overall positive impact on biodiversity, soil, and water quality,** mainly due to the introduction of legumes into the cropping system in most scenarios, which can reduce the need for nitrogen fertilisers. Pasture-based scenarios also

[33] In this respect, it should be considered that the feed manufacturers interviewed attach rather limited importance to the contractualisation of the supply of agricultural raw materials as a driver for the increased use of raw materials grown in the EU (see SQ3).
[34] The possibility in the new CAP to use operational programmes of producers' organisations, which applies to all sectors, should be explored by the different value chains aiming at developing this type of diversification.
[35] Rapeseed, for example, requires more treatments than soya or sunflower.

have positive environmental impacts. In contrast, scenarios based on rapeseed development could increase negative pressures on the environment[36].

- **Some positive air quality effects can be expected** for scenarios with enzymes or amino acid optimisation, which tend to increase the ratio of protein retention to intake, thus allowing for reduced nutrient excretion and the associated ammonia release.
- **An overall decrease in GHG emissions for a majority of scenarios.** However, in the beef scenarios, the proportion of grass in the ration should be increased due to the extension of the fattening period, which could lead to increased enteric methane emissions.
- **With regard to the efficient use of natural resources, the effects are generally positive, depending on the growing methods [37].** Indeed, most of the scenarios benefit from a lower nitrogen supply requirement, due to the introduction of legumes. However, as regards monogastrics, several scenarios are based on energy-intensive industrial processes leading to increased GHG emissions. In addition, several alternatives proposed for ruminants appear unsuited to certain local contexts in terms of water availability, particularly in the current context of climate change. This is for example the case for alfalfa and rapeseed in the EU southern Member States.

Apart from a number of issues to be considered, and provided that growing methods do not result in increased use of PPPs or N losses into the environment, or loss on biodiversity in agricultural land, the **diversification of protein sources should, with variations in function of the crop and growing methods, have a positive impact on the environment.**

Moreover, as explained above, the strategies will not rely on a single solution, but on several combinations of levers adapted to the local context. The considerations on the combination of levers (to be carried out by territory according to specific situations) will therefore have to take into account environmental issues to propose a mix of solutions that is as positive as possible for the environment. This means, for example, avoiding solutions based on the use of monocultures (such as soya or rapeseed) and **favouring levers based on grasses, protein crops and fodder legumes.**

The impact on global deforestation by replacing imported soya with EU-grown proteins would be rather limited: deforestation is increasingly driven by demand from other countries, and the potential deforested area corresponding to EU imports is estimated at 7 % of the Brazilian total area at risk of deforestation and should decrease to 0 % by 2025 due to the EU ban.

2.5 POLICY INSTRUMENTS FOR DIVERSIFICATION

Enhancing domestic protein crops to reduce import dependency requires an organised and balanced implementation of all the alternatives described in this study. This can be done at different levels, from the EU to Member States and regions, and even sectors or clusters within these sectors.

One of the most essential conditions for this development is the competitiveness of each envisaged alternative. But it is not the only one: the alternatives must also be available over a longer period of time (as they almost always imply significant investments along the whole value chain), meet the nutritional needs of animals (meaning with performance able to compete with the imported products), and be reasonably priced.

[36] Rapeseed is more dependent on pesticides, especially insecticides. But this highly depends on the local context in terms of usual cropping patterns and the rapeseed growing season, since the environmental impact of oilseed rape is improved when grown during winter, thanks to the ground cover and its ability to make the best use of soil nutrients and water.

[37] It can be mentioned that, in general, animals can be efficient protein producers, i.e. producing more protein in milk and meat than the protein they consume edible protein sources. This is particularly true for grassland-based ruminants (European Commission 2020. Peyraud J.-L., MacLeod M.). Furthermore, grasslands are central in the EU climate strategy and the implementation of the LULUCF Regulation.

They must also be known and handled by all the operators in the cluster, so that they can be developed in partnership and used appropriately. Public policies can indeed support such a development at EU level through the design of the CAP instruments, public research programmes, etc., but further partnership with the private sector is also required in developing for example new varieties or breeds, treatment products more adapted to proteins crops, etc. because substantial resources[38] and commitment will be needed to succeed[39].

To improve competitiveness, research and innovation are also key sectors that could overcome many obstacles and bring innovations that make alternatives more competitive. Many projects are already supported and funded, but efforts need to be intensified.

At farm level, the study has shown that crop diversification rules in **the past regulatory framework – particularly the conditionality or greening measures for direct support – and the financial support currently available under the CAP (e.g. coupled payments) have not significantly modified the situation prevailing for decades**. Hence, to significantly change this situation, this study argues **for a substantial increase in the existing coupled income support for the crops/productions concerned**[40] (provided that this is not in breach of any international agreement), to provide a real incentive for farmers.

The **EU coupled income support to oilseeds (soya, rapeseed, and sunflower) could theoretically be extended in the EU up to 7.8 million ha**, i.e. the maximum limit under the Blair House Agreement, compared to only 1 million ha presently supported. In this way, the EU could provide support to an area equivalent to roughly[41] half of the present importations, which would be already very significant. Furthermore, some of these crops could also grow in the most suitable regions, without any support from the CAP, meaning that this ceiling has little chance to be reached[42]. Given that these crops are grown intensively, it would be important to remain vigilant that growth does not result in increased use of PPPs or N losses to the environment, or on loss of biodiversity in agriculture land.

Such coupled support could be rounded out by **better-tailored harvest insurance**, focusing on protein crops, to reduce the risk for farmers cultivating these plants. This tool is too little used in the EU.

The **lack of investment to support diversification** is true for all the operators of the value chains (e.g. farmers, collectors, processors, etc.), as the investments made in the EU to support diversification (e.g. storage facilities[43], processing machinery, etc.) are still lacking in some regions/value chains to help provide local solutions and develop protein crops or improved fodders[44]. Significant room for manoeuvre exists here to support the equipping of the concerned value chains.

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[38] Additional to public ones.

[39] Such programmes mixing public and private initiatives have already been implemented in different countries (e.g. grass development in New Zealand, canola development in Canada, etc.) to reach common strategic goals.

[40] Article 33 of the new CAP regulation includes, in the list of products/sectors eligible for coupled income support, oilseeds (excluding confectionary sunflower seeds) and protein crops, including legumes and mixtures of legumes and grasses, provided that legumes remain predominant in the mixture.

[41] And depending on the crops concerned.

[42] Beyond the use of coupled support, it could be conceivable - from a pure theoretical point of view - to raise the import tariff for a good such as soya bean under the procedure of GATT Art. XXVIII, but this option would probably be extremely costly politically. Actually, such a decision would also require granting adequate compensations for exporters, generally in the form of a tariff rate quota equivalent to the level of EU imports before the increase of the tariff. Hence, there is little chance for that to happen.

[43] Adding a new crop in the region where it is not produced requires investment at least in additional storage capacity.

[44] Most of the big factories to treat (e.g. to crush) protein crop seeds are located in port cities, but it could be useful to have some in EU production basins to support some local value chains.

The new CAP **Strategic Plan Regulation** (SPR) in CAP 2023/27 (Regulation (EU) 2021/2115)[45] has extended the support of operational programmes of producers' organisations beyond the historical 'fruit and vegetable' sector. This means that arable crop producers and livestock producers organisations can now apply for this instrument that can finance both material (e.g. equipment) and immaterial expenses (e.g. studies, advice, etc.). These new possibilities have then to be explored.

National policies can also have a great influence on the protein crop sector. This is for example the case in the Netherlands, on the limitation of their herd, but also in the Members States which developed 'proteins plans' such as Belgium, Denmark, Finland, France, Germany, and the Netherlands. These policies could also favour a priority access to irrigation water for these crops in the event of competition with maize, for example.

Public policies should also promote training, support and advice on a large scale to ensure the upgrading of the skills of most of the operators in these sectors, including on sustainability[46]. Traditions are deeply rooted in the choice of production methods and feed strategies. Resources must therefore be ambitious and accessible to all because **the increase in skills must be rapid and global.** The **technical gap between research and training should also be supported to bring concrete solutions** to farmers, but also the other operators of the chains. Technical institutes have a great role to play in this regard.

On a wider scope, in terms of EU policy, as suggested in the **Parliament protein strategy**[47] adopted this autumn, some improvements could be done in some regulations such as: *'a feed additive regulation that enables stability and innovations in feed additives[48]; a novel food legislation that simplifies and speeds up authorisation processes; a directive on waste that enlarges the types of* ***biodegradable waste to be considered as feed[49]****; a renewable energy directive that allows for* ***long-term stable regulation for biofuel production[50]****; a* ***regulation on new genomic techniques****; a combination of CAP rules that provide incentives for production of protein-rich crops, grassland and legumes*'.

Examples from abroad are also interesting to observe. **The social food security** which is part of the US farm bill would also be interesting to study, if the support to families could be directed to animal products grown with feed produced in the EU.

Finally, it would be necessary to **keep looking for the differences in regulation between production in the EU and imported production**. Some current examples are the import of GMO products, (whose cultivation is not allowed in the EU), and the differences in environmental standards between countries. These examples show that attention should be paid to all these differences that can favour imported products to the detriment of EU ones.

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[45] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02021R2115-20220422

[46] This is possible through the CAP, with notably the operational groups in EIP-AGRI and other Farm Advisory Service (FAS) related funding.

[47] European protein strategy, European Parliament resolution of 19 October 2023 (2023/2015(INI)) - P9_TA(2023)0375.

[48] In terms of amino acids, EU industry is in a poor position due to Chinese competition. There could be a 'sovereignty exemption' on the energy prices of this type of company if the EU wants to keep this type of industry. Regarding additives, it could be emphasised that their authorisation in organic feed could resolve certain obstacles (notably deficiencies which impact animal welfare and performance) and would limit the use of imported soya.

[49] Here it is mainly about supplying insects with material other than bran and spent grain previously allocated to livestock. This would undoubtedly be a way to reduce costs (but apparently not well suited to the very precise nutrition of insects, with too much variability in raw materials such as fruit and vegetable waste). In addition the present factories in operation, are not on this model, which would change part of their carbon footprint as they are mostly presently adjacent to starch factories (meaning with no transport costs).

[50] This is particularly true for rapeseed value, whose meals come from oil plants. Reducing the consumption of biofuel would indubitably reduce the production of these meals and hence the EU production.

3 RECOMMENDATIONS

The present dependence of the EU on significant imports of protein-rich products is partly linked to historical reasons (post-Second World War agreements and the WTO agreements of the 1990s) but also to pedoclimatic and structural reasons (e.g. average size of holdings, available land on the continent, cost of production, etc.) that make the EU less competitive in producing these crops than other parts of the world. At the same time, the choice to develop cereals within the EU has led to significant research efforts on them and has resulted in a gradual increase in their yields and consequently improved their competitiveness compared with rich protein plants (e.g. sunflower, peas, beans and to a lesser extent rapeseed).

Nevertheless, even with strong political will, the shift (if even possible) from the present situation to 'zero importation of protein-rich products' would necessarily take decades. Hence, our first recommendation is to start a process of reducing imports, even significantly, and then to adopt new measures once the first import reductions are in place.

Another complementary strategy would be to diversify and secure protein sources with close partners (e.g. Ukraine[51]) for protein crops, soya beans and HP sunflower meals, which would be favoured and protected[52]. This would not reduce the EU dependency in imported plant proteins (except if Ukraine enters the EU) but would limit the risk of a too limited number of suppliers and disruption of international transport.

Among the following recommendations, some are relatively simple to put in place and could be implemented quickly. At the opposite some would require a long-term perspective. They are presented by category, from those applying to all sectors to those that are more specific.

3.1 GENERIC RECOMMENDATIONS

Some recommendations apply to almost all sectors. These are presented below.

Improve the competitiveness of proteins sources within the EU by:

- **Developing a significant research plan associating public and private research** to, among other objectives, **increase protein crops yields and protein content, limit their variability, and reduce limiting factors** (e.g. antinutritional contents), **develop innovative raw materials,** etc. Over the past decades, protein crops and oil seeds have not benefited from the same level of research as their cereal competitors (mainly wheat and maize). Consequently, their competitiveness has progressively decreased, making it difficult now to reverse the situation. The only solution is thus to start a long-term approach to make all these crops, which were historically cultivated in the EU, competitive again compared with cereals. Research plan should additionally cover the production and the use of innovative raw materials. The main fields in which to intensify research could be:
    - variety selection to improve yield, yield regularity and protein content, as protein/leguminous crops and grassland have suffered from a lack of research in comparison to dominant crops such as cereals;
    - development of innovative raw materials (e.g. algae);
    - improvement of the ability of livestock to valorise less rich plant proteins as well as innovative raw materials/feed through genetic improvement of livestock;
    - selection of protein crops that have a lower antinutritional factor content and that are more disease-resistant;
    - life cycle analysis of these crops[53]; and

[51] Which is a candidate to join the EU.
[52] To take the case of HiPro sunflower meal, global export supplies are presently all being taken by Russia.
[53] There is a clear lack of references for tomorrow's formulation of local eco-environmental foods.

  - products to protect the concerned crops[54].
- **Temporarily (and in compliance with WTO rules), increase[55] support to plant protein cultivation in the EU** to enable an increase in production and a shift (which will take time) of value chains to more EU-grown plant proteins. There are many examples of supported crops in the EU in the past, and they have proved to be effective when sufficiently supported[56]. Even if some unsuccessful examples led to overproduction, we are far from this risk for these crops. Hence, the **coupled income support of the CAP** could be used to cover the gap identified in this study between the relative main price of interest[57] of feed manufacturers for a given production and livestock cluster, and the relative price allowing farmers to obtain a sufficient margin[58] compared to other crops in competition.
- **Support the value chains and farmers for the necessary investments linked to the development of all the alternatives**. The investments supported by the second pillar[59] offer possibilities that could be explored along those lines, as do other structural funds for the industry. Many investments could then support the development of the alternatives studied. This could cover the following levels:
  - The farm or local cooperative/producer organisation level, in which simple equipment could support farm self-sufficiency, e.g. by financing toasters to enable farmers to use soya or fava seeds directly on-farm, or solar driers for fodder, etc.
  - The collector level, in which sorting and storage facilities, for example, could help develop the variety of the collected products.
  - The processor and feed manufacturer level, by supporting new processes to be developed, such as the equipment needed for HiPro sunflower meal, or by developing new plants in areas far from the big crushing factories often located in maritime harbours.
  - The whole value chain, by incentivising a long-term biofuel supply, to enable the related production of oilseed meal.
- **Increase support through the harvest insurance included in the CAP.** One of the limiting factors behind the development of protein crops is the farmer's fear of risk. Setting up specific rules for this instrument, dedicated to protein crops (e.g. increase of the ceiling of support[60], reduction of the 'excess' [61] part, cancelation of historical reference for yields, etc.). Developing this possibility would certainly incentivise farmers to come back to these crops, with which almost all of them are familiar.

[54] The lack of research concerning these plants compared to cereals has also concerned treatment products, and now very few products are available for their cultivation.
[55] From 7 to 10 years to secure private investments.
[56] In the only evaluation made on the agri-environment and climate measures (Oréade-Brèche 2005), it was shown that the payment of the income foregone and uncured costs were not sufficient for the farmer to decide its uptake. An incentive part is still necessary. This is also true for coupled income support that has to compensate sufficiently the loss of margin between the crops in competition in order to make the production of the targeted crops worthwhile for the farmers.
[57] i.e. the price at which the first tonne of an alternative feed material is used by a manufacturer without changes in the cost of the final product. This means that, to be introduced in the composition of manufactured feed, the market price of the alternative feed material must match the price of interest.
[58] Some examples of capture of the margin by the downstream sector have existed with such support, but mechanisms could be tested to avoid these practices and make the increase of margin available for the farmer.
[59] By Rural Development Programmes or by Sectoral Interventions of operational programmes of producer's organisations in the 'other' sectors.
[60] There are two CAP schemes available for harvest insurance for arable crops: RD (Art 76 SP Regulation) and a sectoral operation programme for other sectors (Article 68(1) SPR). Presently, a maximum 50 % of the expense is covered by the EU.
[61] An 'excess' is the first amount payable by the person insured in the event of a loss and is the uninsured proportion of the loss.

Through support to operational programmes of producers organisations[62], incentivise, in the value chains, a system of negotiation to guarantee the long-term availability of products and the price paid to producers, by linking the selling price of the concerned crops to the crop it is in competition with (e.g. soya beans vs maize), with ratios adapted to the Member States' conditions. With the same instrument, **an attempt should be made to better organise the sector(s) and the supply chains at EU level** (e.g. support the development of platforms for connecting fodder producers (alfalfa) and breeders and/or breeders with too much fodder with other breeders (anti-waste), or the development of regional allotment centres[63]).

This would strengthen the concerned value chains and make the production of protein crops for diversification less risky all along the value chain. Hence, integrated sectoral strategies that combine the different/complementary CAP intervention systems above and beyond these operational programmes of producer organisations and that include the environmental tools related to crop rotation could now be developed. Extension of such support to interbranch organisations would also help to develop bigger and more integrated initiatives to reduce the EU protein dependency[64].

As proposed by the EU Parliament, **improve and simplify some EU regulations** on feed additives, food legislation, wastes and biofuels, for a broader support to the production of protein-rich crops, grassland and legumes.

Mitigate the situation by which currently – and for decades – most monogastrics and dairy cows have been mostly produced in proximity to large harbours, thereby giving a competitive advantage to imported protein sources compared to inland EU production that must be shipped to these zones. To this effect, develop intra-EU infrastructure (e.g. trains, canals and river equipment) to reduce transport costs in the long term and bring the protein sources from the production zones to the consumption zones.

Ensure the long term development of the whole profession in the field of protein feeds and alternative techniques, by providing the following:

- Funding for training and support plans dedicated to the whole profession, and without delay to all those who work in technical advice and monitoring of farming practices with farmers.
- Financial support to farmers who wish to benefit from support and technical advice and monitoring.

Encourage Member States to set up national policies in line with the objectives of an EU protein policy, and that support a transition to sustainable food systems, for example, by:

- Include measures in their CAP SP to ensure that the expansion of certain protein crops does not result in adverse environmental effects (increased use of PPPs, increased losses of N to the environment, loss of biodiversity in agricultural land), and support sustainable growth of these crops.
- Setting up a system of payment for environmental services, in complement to eco-schemes and agri-environment and climate measures, to take into account the numerous environmental services provided by some plant proteins and grasslands when grown sustainably.
- Defining ceilings of animals by available land (e.g. like in the Netherlands) which will de facto reduce the import of protein crops from outside the EU and at the same

[62] Including the RD support for the setting-up of PGs, and POs (Art. 77(8)(b) SPR). This may lead to a better concentration of supply, a benefit for farmers from operational programmes' implementations, and a higher value of marketed production which triggers higher revenues for farmers members of a PG/PO.
[63] As is done in the USA.
[64] Support to the industry is not the goal of the CAP, but they can be covered by other EU instruments such as the European Regional Development Fund (ERDF).

time reduce the environmental issues related to high density of animals in a given place.
- Implementing the standards of good agricultural and environmental conditions of land (GAEC) with the view of further promoting the development of protein crops and grassland[65].
- Developing rules that favour the concerned crops compared with the cereals in competition (e.g. preference for irrigation water for these crops in the case of competition mainly with maize).

Retailers and consumers can also play a significant role in reaching the objectives of an EU protein policy. Hence, outreach campaigns incentivising consumers to buy animal products fed with EU-produced feed that is free of deforestation[66], non-GM[67], organic, etc., could also help in developing EU production of protein crops and grass.

Would the EU protein plan be a success, **some international agreements could limit its full deployment**. This is particularly the case for the **Blair House Agreement limiting support to oilseed in the EU at 7.8 million ha**. However, while presently about 1 million ha of oilseed are supported, to replace the imported grains, around 13 million ha would be necessary for production if the EU goal is to cover 100 % of the present importations. Even if this is unlikely to happen, it should be taken into account in the political agenda.

It is also necessary to continue identifying the **differences in regulation between EU production and imported production**. Some examples are the import of GMO products, whose cultivation is not allowed in the EU[68], or the differences in environmental standards between countries. These examples show that deep attention should be paid to all these differences that can favour imported products at the expense of the EU ones.

Finally, at EU level, it would also significantly help if **price observatories of these crops** could exist at all levels (between farms, collectors and processors), to monitor the exchanges properly in each value chain and to consequently adapt the support to these crops.

Above all, long-term commitments are crucial in the agricultural sector. Hence, policies must remain in place for a long time[69], avoiding the too frequent changes to which all sectors often have difficulty adapting.

3.2 SECTORAL RECOMMENDATIONS

3.2.1 Ruminants and forages

Work on forages concerns almost exclusively ruminants, but these represent two thirds of the livestock units to be fed in the EU. It is definitely recommended, where possible and relevant, to increase the proportion of forages in the rations of cattle and small ruminants, and to increase the protein content of the forages[70] (via varietal selection, drying and storage). It should be noted that, for cattle, this should reduce the use of maize silage but be accompanied by greater use of wheat. It also would enable the rest of the ration to be

[65] When implementing GAECs, Member States should keep in mind that the development of protein crops and grassland is important and that the GAECs can be a mean to develop them.
[66] From 2025 all soya marketed in the EU, be it produced domestically or imported, should be deforestation-free.
[67] The example of German mass distribution, in which all poultry is now non-GM, shows that shifts are possible if all the operators of a chain work together.
[68] It could also be possible to open an EU-wide debate on the appropriateness of maintaining domestic bans on cultivation of GM soya and/or reaping the opportunities of a possible future authorisation of New Genomic Techniques (NGTs).
[69] Even if some instruments can be temporary, such as coupled income support.
[70] In this case some equipment to easily measure the nutritional value of forages would be necessary.

deconcentrated and should encourage the use of so-called secondary cakes (rapeseed and sunflower).

Dried alfalfa is a good candidate to support diversifying strategies. Produced on the farm, it represents an advantageous source of ration diversification, as well as possibilities for rotation. But production zones are not always the same as consumption zones. A great deal of work is needed to organise flows and match supply and demand. This solution is the quickest to implement, but only concerns ruminants.

Hence, the recommendations for these animals are:

- Significantly but temporarily[71] increasing production aid to make temporary grassland and mixtures of legumes and grasses more competitive than more profitable crops (like, maize and wheat). Coupled income support of the CAP could be used for this purpose [72].
- Support farmers in producing high-protein grass by increasing support for local R&D projects on grassland management, species to sow, mowing periods, drying and conservation methods.
- Support farmers in accessing equipment to better appraise the nutritive value of their forages and, as mentioned above, to directly process on-farm production (see the example of toasters and driers above).
- Supporting grassland management aiming at grazing by multiple livestock species.

3.2.2 Amino acids

The EU is extremely dependent on synthetic amino acids in animal feed. However, with some of the solutions proposed (in particular the use of protein crops), animals will need increased use of amino acid supplements in order to reduce soya in their diet; otherwise, the zootechnical performance of the animals and/or their well-being will decline.

This industrial sector needs to be strengthened within the European Union, especially as we have the necessary resources for lysine fermentation (beet) to improve the environmental balance of this product compared to its Chinese competitor. The future of this solution will depend on the willingness of institutions to support this industrial sector. It would help avoid falling from one dependency to another and would enable the use more EU-grown material.

3.2.3 Soya bean development

Soya bean production in the EU is limited by less favourable soil and climate conditions than in South and North America, and by an uncompetitive effect of scale (plot size). Importations represent the equivalent of 14 million hectares, and in 2020 the EU produced 2.6 million tonnes from 1 million hectares. Doubling the surface area would already be a good objective and would reduce soya bean meal imports by 2.2 million tonnes (less than 9% of the current consumption of 30 million tonnes).

The main obstacles remain genetic and economic. For the genetic issue, it would be necessary to invest massively in varietal research (orphan crops), in order to develop varieties adapted to climate change[73] and, earlier, to conquer new territories. For the economic issue, one of the solutions to develop the crop would be in the value chain, by indexing its price to that of maize[74] in the contracts.

[71] From 7 to 10 years to secure private investments.
[72] For now, only mixtures between legumes and grasses are eligible, with the predominant criteria on legumes, which are not easy to define/control over time.
[73] Besides adaptation to drought, the selection of varieties with better resistance to pests is becoming an urgent need. For example, in Southwest France, in the Sojadoc value chain, the cycles of the soya bean borer (Etiella zinckenella) have shifted from one cycle a year some years ago to up to three cycles in recent years, seriously threatening production.
[74] In Western France, for example, a soya bean/maize ratio of 2.5 would be necessary to offer farmers a remunerative and attractive price and to protect the value chains of an abandonment of soya bean cultivation.

3.2.4 Protein-enriched rapeseed

Protein-enriched rapeseed is an ongoing varietal innovation[75] which would enable sales of a high-protein rapeseed meal on a commercial scale within five to seven years. This solution is all the more promising because it will be available at no additional cost compared to standard rapeseed and will be versatile enough to compete with soya bean meal. It requires no adaptation of crushing equipment. However, transformation plants are not necessarily located close to production areas. Infrastructure development to support intra-European flows is an avenue worth investigating for this particular case.

This solution could be deployed in the EU over the next 10 years. The versatility of the proposed meal means it can meet the needs of all species.

3.2.5 Sunflower

The EU imports the equivalent of 5 to 7 million tonnes of sunflower seeds annually, which corresponds to around 2.5 to 3.5 million hectares. The sunflower meal most in demand is shelled sunflower meal, which has a protein and fibre content more likely to compete with soya bean meal. To increase its competitive potential, the idea is to lower the product's fibre content, which also increases its protein content and makes it more digestible. The industrial process (sifting) is available but increases the selling price of oil meal, while at the same time making it necessary to add value to the fibre fraction.

The aim here would be to reduce or cover these additional industrial costs and to ensure a level of crop production that will reduce the need for imports. In the case of oilseeds, the difficulty arises from the importance of the oil market in crushers' margins. The price of oilcake is often an adjustment variable.

3.2.6 Peas, field beans, lupins

The production of peas, field beans, lupins (around 3.5 million tonnes) is struggling to take off despite successive protein plans. These products have an intermediate nutritional composition in terms of energy compared with cereals and of protein compared with oilcakes. They therefore lack versatility, an essential quality for manufacturers that do not have unlimited storage capacity. Although very interesting from an environmental point of view, they struggle to find their place in crop rotations, especially since their yields are highly volatile.

It is therefore necessary to take action at many levels in the supply chain to develop these crops. For example, storage and transport costs are higher for 'small atomised sectors' than for cereals[76]. In addition, lower fertiliser requirements for the following crop are rarely taken into account when calculating the legumes' margin, leading to underestimation of their economic interest and environmental benefits. This calls for a change in accounting rules.

Producing peas, field beans, lupins for animal feed requires good yields and prices. Numerous forms of support need to be developed at every level in the supply chain[77].[78]

3.2.7 Renumerating positive externalities of protein crops and grassland

The 'additionality' of funding is essential to integrate virtuous crops into rotations. Farmers need to be better remunerated in order to enhance the value of their profession. It would

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[75] See the 'Decoproze' project, winner of the France 2030 award (https://www.gouvernement.fr/sites/default/files/contenu/piece-jointe/2023/03/20230306_-_dp_115_laureats_agriculture_alimentation_de_france2030.pdf).

[76] Ceresco - Rapport final étude freins et leviers logistiques légumineuses- Nov. 2021.

[77] According to the director of the agricultural group IN VIVO (T. Blandinières. June 2021, OPINION seminar), the risk associated with the transition (integration of legumes into rotations in particular) is estimated at EUR 150/200/ha in France. 1/3 could be remunerated via agricultural added value, 1/3 via the carbon market and 1/3 via public policies.

[78] The setting up of a pea futures market could also be interesting. The main problem to start it would be the liquidity, as the available quantities are insufficient. But if the protein policy leads to an increase in quantity, this interesting tool would help in securing volumes.

be then necessary to move away from simply supporting agriculture (through coupled income support, eco-scheme measures or, agri-environment and climate measures for example[79]) and consider farmers as entrepreneurs who also produce environmental services (e.g. food, water, carbon, biodiversity, etc.). Protein crops (depending on the cropping system and even the crop) and grassland have numerous additional benefits than simple production of raw material, and these benefits are not currently remunerated by the market. Hence, one of the conditions to increase their share in EU production – and to thereby reduce imports of meals in particular – is to set up such additional funding systems (e.g. **payment for environmental services[80]**) and among them consider favouring the crops concerned by this study, i.e. protein-rich crops (at least, soya, sunflower and pulses) and all forms of grassland.

[79] CAP instruments that have been developed by some Member States (e.g. on crop rotation/diversification including legumes as well as on grassland/grazing).

[80] At the present price, carbon credits seem not remunerative enough for farmers in the face of expensive audit costs, which could explain the very slow development.

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