

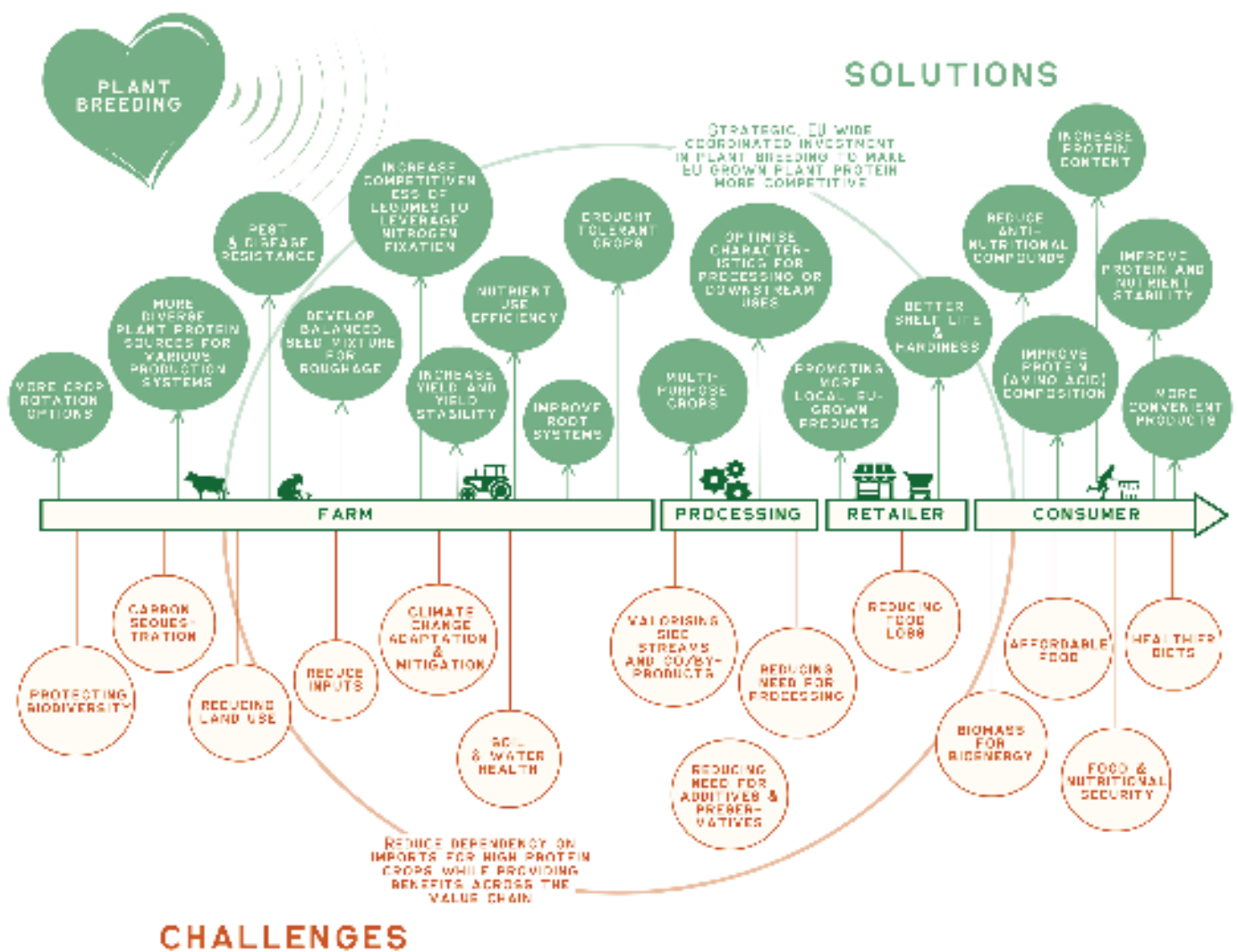
An Implementation Strategy for Increasing European Plant Protein Production and Uptake

by Plants for the future ETP



Executive Summary

The European Union (EU)'s reliance on imports of plant protein for the livestock feed sector has been a long standing challenge. Despite the EU currently producing ~76% of the plant protein it requires to feed its livestock sector, there is a significant deficit for high plant protein sources (i.e., oilseed meals), for which the EU only produces ~27% of its requirements¹. In the past decades, many policy initiatives have aimed to address the EU plant protein deficit^{2,3,4}, with little success. Many barriers exist at multiple levels of agrifood systems, with the main ones being: **(1) the lack of long term policy commitments** needed to encourage stakeholders across value and supply chains to invest in increasing and scaling up EU plant protein production over several decades; **(2) the current biological limitations of EU plant protein crops**, requiring at least 10-20 years of research, development and innovation before more competitive varieties would be ready for the EU market; and **(3) the need to establish and/or adapt infrastructures and value chains**, particularly for crops that are not already widely grown in the EU.



1 EU Commission (May 2024) [EU feed protein balance sheet](#)

2 European Parliament resolution of 17 April 2018 on a [European strategy for the promotion of protein crops](#)

3 EU Commission (2018) [Report: Development of plant proteins in the European Union](#)

4 European Economic and Social Committee (2022) [Opinion: Towards a sustainable plant protein and plant oil strategy for the EU](#)

The main drivers determining the success of an implementation strategy for increasing EU plant protein production, are the **plant protein crops** and the **value and supply chain uptake**. In this implementation strategy, we outline the bottlenecks for each stakeholder across the value chain, and highlight some opportunities to leverage the benefits plant proteins can offer, for example in terms of sustainability and resilience. Potential quick wins are described alongside the need for long term financial and policy commitments, which together are needed to build momentum. However, a balance must be kept between providing initial (public) investments, to help establish the market, and creating a market pull that should ideally promote additional investments and ensure a steadily growing demand. Attention should also be paid to the differences between the food and feed markets, as well as between crops and cropping systems that are already widely adopted in the EU, compared to those that are less so. Each market and situation present different challenges and opportunities, with no one solution fitting all. **Coordination at EU level will be essential to ensure synergies between different national and regional strategies and build the momentum necessary for scaling up.**

The following short, medium and long term policy recommendations are identified as being crucial to the success of the implementation strategy for increasing EU plant protein production:

Short term policy recommendations:
Promote and valorise EU plant protein production

- Create a better overview of **EU Plant Biomass** that covers all sectors utilising plant biomass, as well as their resulting side streams, by- and co-products.
- **Optimise the management of grasslands and permanent pastures** by allowing regular reseed-ing where possible.
- Leverage the ongoing updates, developments or implementations of relevant legislations to create an enabling environment for increasing EU plant protein production
 - » **The Renewable Energy Directive III (RED III)**: promote the growth and use of oilseed crops for both renewable energy and high protein feed
 - » **The legislation on Plant Reproductive Materials (PRM)**: enable the registration of crop varieties with traits such as increased protein levels or nutritional composition
 - » **The legislation for plants obtained by New Genomic Techniques (NGTs)**, enable the use of NGTs in EU breeding programmes, by quickly adopting and implementing a new legislation for NGT plants.
- **Setup incentive schemes, subsidies and/or other funding mechanisms** to trigger the initial involvement of stakeholders across the value chain.

Medium term policy recommendations: Promote research informing science-based decision-making

- **Ensure science-based policymaking and policy coherence** by closely monitoring and learning from successes and failures.
- Fund **research and innovation (R&I)** to
 - » develop new and innovative solutions and technologies for **effective weed management**
 - » conduct **multi-year studies on the impact of legumes and other plant protein crops** in crop rotations to assess environmental and socio-economic benefits at farm level
 - » **optimise processing technologies** to increase the use of products and by/co-products from plant biomass processing for food, feed and/or for the wider bioeconomy.

**Long term policy recommendations:
Establish long term EU-wide coordinated and strategic investment in plant breeding**

Long term EU-wide coordinated and strategic investment in plant breeding will be essential to develop a wide range of diverse and resilient plant protein crops for diverse purposes (food, feed and raw biobased materials), regions and production systems. **An EU public-private partnership on plant breeding** would enable collaborations between the public and private sectors to streamline breeding efforts for plant protein crops from basic research on biological processes, to breeding a wide range of new and better adapted plant varieties for the needs of the EU market.

About

This Implementation Strategy was prepared by members of Plants for the Future (Plant ETP)'s working group on Sustainable Agriculture with valuable input from external experts, including representatives of the European Feed Manufacturers' Federation (FEFAC), Terres Inovia, GIE Peabost, DLF Seeds A/S, Sofiproteol, the VALPRO Path project, Cargill, the Federation of European Vegetable Oil and Protein meal Industry (FEDIOL), and the European Association of trade in cereals, oilseeds, rice, pulses, olive oil, oils and fats, animal feed and agrosupply (COCERAL).

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Background and mission of the Working Group Sustainable Agriculture

[Plants for the Future \(Plant ETP\)](#) supports the transition of agricultural value chains to more sustainable and innovative systems that remain within planetary boundaries. To actively contribute to this transition, Plant ETP established a multistakeholder working group on Sustainable Agriculture in 2019, which consists of experts from academia, the seed and breeding sector, agricultural service providers, and the farming community. The aim of this working group is to consider, from a plant sector perspective, the challenges, and opportunities of agricultural value chains in a holistic way, while developing a vision for future systems spanning food, feed, and biobased raw materials.

Disclaimer: Views and information expressed in this document do not necessarily reflect the opinions of any single participant, member or their organisation.

Introduction

Setting the Scene

Agrifood systems worldwide are facing ever increasing challenges, including from the impact of climate change (e.g., weather volatility, pests migration), biodiversity loss and geopolitical shifts. At the same time, it is essential to safeguard the production of food, feed and biobased raw materials, to ensure food and nutritional security for a growing population, while providing alternative carbon sources for the wider bioeconomy. It is therefore necessary to maintain or increase agrifood production, while reducing negative environmental impacts. This will require a careful balance between optimising farm management practices and the use of inputs (e.g., plant varieties, fertilisers and plant protection solutions (PPS)).

In the last years, resilience to shocks from environmental, health and geopolitical crises has proven to be essential, with the vulnerabilities of the EU's agrifood systems being laid bare. One such vulnerability is the dependence of the EU livestock sector on a small number of countries and sources for high protein plant-based materials for feed. The EU currently produces ~77% of the feed protein it requires, ~76% of which is from plants⁵. However, there is a significant deficit for high plant protein (High Pro) feed sources (i.e., oilseed meals), for which the EU only produces ~27% of its requirements (according to the forecast for 2023/24, updated May 2024)¹.

Due to its combined high protein content and high-quality amino acid profile⁶, soy is widely used for boosting the protein content and improving the nutritional quality of compound

	Protein Category (Low to Super)	EU total feed use (Million tonnes of crude protein)	Feed use of EU ori- gin (Million tonnes of crude protein)	% feed use of EU origin	% of total feed use
CROPS		16.62	14.24	86%	23%
Cereals	Low Pro	15.17	13.00	86%	21%
Oilseeds	Low-High Pro	0.46	0.46	100%	1%
Pulses	Medium-High Pro	0.99	0.77	78%	1%
CO-PRODUCTS		23.84	9.33	39%	33%
Oilseed Meals		19.36	5.15	27%	27%
Soya Bean Meals	High-Super Pro	11.76	0.46	4%	17%
Rapeseed Meals	High Pro	4.60	3.29	72%	6%
Sunflower Meals	High Pro	2.49	1.32	53%	3%
Other Oilseed Meals	Medium-High Pro	0.52	0.08	15%	1%
OTHER CO-PRODUCTS	Low-Super Pro	4.48	4.18	93%	6%
ROUGHAGE	Low-High Pro	29	29	100%	41%
TOTAL (plant-based)		71	54	76%	

Low-Pro = Less than 15% protein content; Medium-Pro = 15-30% protein content; High-Pro = 30-50% protein content; Super-Pro = More than 50% protein content

5 EU Commission (May 2024) [EU Feed Protein Balance Sheet](#)

6 Kudelka et al. (2021) [Quality of Soybean Products in Terms of Essential Amino Acids Composition](#)

feed. The large majority of EU's soy imports come from Brazil, Argentina and the US, both as meal and bean⁷. This leaves the EU exposed to risks related to global market fluctuations, trade disruptions or geopolitical shifts. A current example is the situation since Russia invaded Ukraine in 2022: in 2018, Russia provided the EU with ~1.5% of its required soy meal and ~13% of its required sunflower and rapeseed meal and grain combined. At the same time, Ukraine provided the EU with ~44% of its sunflower and rapeseed meal and grain requirements⁸. The invasion of Ukraine led to supply disruptions resulting in severe shortages of raw materials, including high protein materials for EU agrifood chains. At the same time, soaring energy prices affected many aspects of agrifood systems, most notably driving fertiliser prices up and making them inaccessible to many farmers. All this contributed to the high levels of food inflation since 2022, and a reduction of global food and nutritional security.

These developments have highlighted the need to increase the resilience of EU agrifood systems. With this in mind, plant protein sources must also be diversified both in nature (e.g., crop species) and in source (e.g., producing countries). This aligns with the aim to increase the EU's self-sufficiency for plant protein, so as to reduce the EU's environmental footprint, as well as the increasing demand for non-GM soy (~80% of soy imported in the EU is Genetical-

Opportunities

Increasing plant protein production in the EU comes with many challenges, but also brings many opportunities for EU agrifood systems. The long-standing feed protein deficit in the EU, caused by many decades of

over-reliance on imports from third countries, has resulted in EU-grown plant protein being substantially less competitive. To overcome this major challenge, it is essential to better valorise EU-grown plant protein, to create a demand for such products that will attract investment and to scale up production and value chains.

One way to better valorise EU-grown plant protein is to leverage its contribution to the transition towards more sustainable agrifood systems. For example, high protein crops such as legumes are known to interact with nitrogen (N)-fixing bacteria in the soil, thereby requiring little to no N input, while at the same time leaving the soil replenished for the next crop. This contributes to reducing the use of fertilisers, thereby reducing costs for

Increasing the production of plant protein in the EU will also lead to a more diversified panel of agricultural crops, providing new/alternative options for crop rotations. This can help break pest and weed cycles, thereby contributing to integrated pest management (IPM) and reducing the need for PPS.

At the same time, this increase in agrobiodiversity can contribute to increasing biodiversity at large, by reducing the use of inputs and providing nourishment for a broader range of pollinators. This in turn could reduce on-farm costs and open up avenues for new business models and opportunities at EU,

Increasing the production of plant protein in the EU will not only provide EU-grown alternatives to meet the needs of the feed sector, it will also provide a wider choice of protein sources for consumers, thereby ensuring access to healthy and balanced di-

7 European Soy Monitor (2021) [Insights on European Uptake of Certified, Responsible, Deforestation and Conversion-free Soy in 2021](#)

8 EU Commission (2018) [Market Developments and Policy Evaluation Aspects of the Plant Protein Sector in the EU - Final Report](#)

EU Plant Protein for Feed and Food

When setting up an EU implementation strategy for plant protein, it is important to consider separately two distinct, though closely interrelated, markets: feed for the livestock sector and food for human consumption. The purpose of the end product will determine the preferred approach, such as what is grown (crop species, varieties, desired traits), how (under which farm management practices) and which quality requirements need to be fulfilled (e.g., plant proteins for food require a higher harvest quality than for feed). In this context, an implementation strategy for EU plant protein needs to consider both markets.

The majority of plant protein imported into the EU is used in the feed sector. Therefore, to reduce EU dependency on imports, there is a need to increase EU-grown plant protein for feed. Fortunately, the scale of the demand for the feed sector ensures a sizeable potential market for EU-grown plant protein. In addition, an increase in the demand for non-GM soy, including from the organic sector, and soy that is not at risk of contributing to deforestation, provides a potential opening for EU-grown soy and GM-free supply, that could help overcome currently lower competitiveness, compared to imported soy.

However, feed is considered a commodity, meaning it is often traded as an ingredient. Therefore, plant protein destined for feed fetches a lower price than that destined for food. In the EU, legumes like soy tend to provide a lower physical yield with a higher susceptibility to disease than typical commodity crops, like

wheat or maize. However, due to their better nutritional value, they fetch a higher price. When choosing whether to grow high protein crops, farmers have to weigh the lower yield and increased risks, versus the higher price. Therefore, access to a reliable market and stable prices, are essential to provide certainty and encourage the increase of plant protein production at farm level.

While the feed sector provides a large potential market for EU-grown plant protein, the market for human consumption is much smaller. Nevertheless, it is a high-value market, with a possibility to apply premiums through branding. While the demand for plant protein for food is relatively small compared to that for feed, it is a fast growing market, driven by increasing societal concern for animal welfare, the environment and shifts to more balanced and healthy diets. Although high protein crops, particularly legumes, are often the focus of outlook reports and research activities, it is important to consider other sources of proteins, such as roughage, or the products of side streams from food and drink processing. In the case of the latter, side streams, also known as by- or co-products, are the residual products remaining after processing and can originate from plant (e.g., distilled dry grains) or animal (e.g., whey powder) sources. Valorising these by/co-products contributes to increasing food security and a more sustainable and circular bioeconomy, while improving the nutritional quality of compound feed and reducing food waste.

Why has it not happened yet?

Despite many past policy initiatives^{9, 10, 11},

9 European Parliament Resolution of 17 April 2018 on a [European Strategy for the Promotion of Protein Crops](#)

10 EU Commission (2018) [Report: Development of Plant Proteins in the European Union](#)

11 European Economic and Social Committee (2022) [Opinion: Towards a Sustainable Plant Protein and Plant Oil Strategy for the EU](#)

including a recent study from the EU Commission¹² and an initiative by specific Member states¹³, little progress has been made. Many barriers exist at multiple levels of agri-

Lack of long term policy commitments

EU-wide long term policy commitments are needed to encourage players across agrifood value chains to invest and engage in increasing EU plant protein production. Several past initiatives have invested substantial funding in research and innovation (R&I), value chain creation and incentivising production of EU-grown plant protein at farm level (notably through the Common Agricultural Policy (CAP)). However, these efforts have not led to wide-scale, competitive and self-sustaining supply chains for EU plant protein for food or feed, but rather to scattered, small-scale, regional supply chains serving niche and/or premium markets. This can mostly be explained by the lack of EU-wide coordination and the fact that previous policy initiatives have been linked to policy cycles and were therefore limited to a relatively short period of time i.e., five years. This short time is insufficient to provide the long term support that would be needed to encourage impactful investment from the private sector.

Biological limitations of EU plant protein crops

Due to the high level of soy imports over many decades, the EU seed and breeding sector has had little incentive to invest into breeding programmes for soy, legumes, or other high protein crops. In the case of soy, the majority of the genetic material available is genetically modified and therefore not suitable for cultivation in the EU. The current genetic material available for breeding high protein crops for the EU mar-

ket is not very advanced and would require 10-20 years of R&D before truly competitive varieties would be ready for the market. In addition, apart from soy, the EU markets are very small and region-specific. This would require developing a large number of crop species and varieties adapted for different regions. So far, due to the lack of clear long term policies supporting an increase in EU plant protein, most of the seed and breeding sector has had little reason to invest.

Need to establish and/or adapt infrastructures and value chains

Increasing EU plant protein production, particularly for crops that are not already widely grown in the EU for this purpose, requires putting in place the necessary infrastructures and value chains, including developing new and/or adapting existing technologies, equipment and practices. This includes farm management practices and adapted equipment for harvesting, storage, etc... It also includes the development of new value chains around specific plant protein sources. Scaling up the necessary infrastructures and value chains will be essential for success, and will require substantial long term financial and political commitment.

Success Story

Rapeseed (or oilseed rape) is an oilseed and high protein crop of great importance in the EU. It can be used for a variety of purposes, with the seeds being the most valuable part of the plant, from which oil and proteins can be extracted. The oil is used for human consumption, industrial purposes or bioenergy, while the proteins in the meal or cakes are mostly utilised for animal feed. By having multiple potential uses and markets, rape-

12 EU Commission website - [Reducing the Plant Protein Deficit of the European Union 2024](#)

13 AOB for the Meeting of the "Agriculture and Fisheries" Council on 18 November 2024: [Putting Forward an EU Protein Strategy](#)

seed has become an ideal example of a success story for a multipurpose protein crop in the EU.

In the mid-20th century, rapeseed was primarily grown for its industrial uses, such as lubricants and biofuels, due to its high oil content. Its potential as a food crop was limited due to high levels of erucic acid and glucosinolates, which are anti-nutritional compounds that are harmful to human and animal health. Recognising the potential of rapeseed as a source of food and feed, researchers in the late 1950s and early 1960s, embarked on a breeding program to develop varieties with significantly reduced levels of these undesirable compounds. Through extensive selection and breeding, scientists successfully developed low erucic acid and low glucosinolate varieties of rapeseed¹⁴. This breakthrough made rapeseed suitable for human and animal consumption, opening up new markets and opportunities for farmers.

Story to Learn From

Fava bean (or faba bean) is a legume that is adapted to colder European climates (as opposed to soy) and is a promising high protein crop for the EU. Much research is being conducted to improve the traits of the crop (e.g., yield, disease resistance), as well as attempts at setting up value chains at regional level¹⁵. Setting up such value chains takes substantial effort over many years, and they are unfortunately extremely sensitive to shocks. For example, the production of fava bean in France has been fluctuating over the last decades, partly due to recurring limitations in the use of certain plant protection solutions (PPS). As a result, infections by the fava bean weevil, a pest that reduces yield and

seed quality, have been difficult to manage. The inconsistent yield and quality have resulted in loss of markets for French fava bean^{16,17}. In light of this, it is important to recognise that PPS are an essential part of IPM and care should be taken to fully assess the impact on all crops and value chains, in addition to the environment, before imposing limitations on their use, especially when no efficient alternatives exist.

In this document, we put forward an implementation strategy to increase EU plant protein production for feed and food, considering the drivers for different players across the value chain, and suggesting solutions and recommendations.

14 Canola Council [History of Canola Seed Development](#)

15 [NUTRIS, FAVE-TRADING](#)

16 Simmen (2020) [La Filière Féverole à la Loupe : Une Culture en Mutation](#)

17 Garrabos, Bouttet et Hémet (2007) [Contre la Bruche, Intervenir au Bon Moment](#)

Main drivers

Plant Protein Crops

To increase EU plant protein production in a resilient and sustainable way, it is essential to source plant protein from a diversity of crop species. For that, how to optimise the crops making up the main feed sources, according to the EU Feed Protein Balance Sheet, will be discussed. It should be noted that the breeding goals outlined in this section are the most relevant and specific to increase EU plant protein production. They do not represent an exhaustive list of all important breeding

such as overall yield or disease resistance.

- **Optimise the protein (amino acid) composition** to improve nutritional quality and reduce the need to balance compound feed with other sources (e.g., from soy) or synthetic amino acids.
- **Improve disease resistance**, so as to maintain yield and quality under lower input conditions. A special eye should be kept on possible trade-offs in disease resistance breeding, which sometimes results in lower protein content.
- **Improve nutrient use efficiency**, in order to maintain protein content under low N fertilisation.
- **Improve root systems** be more robust and perform better in winter and summer cereals.



Cereals

Cereals, such as wheat, barley, maize, oat and rye are important and versatile sources of plant protein for food and feed. In the case of feed, these are supplemented with high protein meals, to increase the protein content of compound feed, particularly of essential amino acids, and ensure nutritional quality for livestock. Since cereals are already widely grown in the EU, improving their nutritional quality and protein content would reduce the amount of high protein meals needed to supplement com-

In the case of most cereals, criteria for variety testing and registration prioritise disease resistance and yield as part of the Value for Cultivation and Use (VCU). **To encourage the development of improved protein content/ quality traits, methodologies to assess variety performance on protein could be developed as part of the new Value for Sustainable Cultivation and Use (VSCU), according to the Commission proposal on Plant**

The development of the following traits should be encouraged as part of an EU Protein

- **Increase protein content**, to improve nutritional quality and to reduce the need to supplement compound feed with high protein meals. Or, alternatively, **maintain protein content**, as it can sometime decrease when breeding for other traits,

In addition to these breeding goals, **it is important that essential PPS remain available as part of the IPM approach.**



Developing new and improved varieties of soy, tailored for different EU regions, could reduce EU imports for feed. However, due to the current

lack of competitiveness of EU-grown versus imported soy, we recommend focusing, for the moment, on breeding this crop for niche markets, such as local, organic or GM-free, and/or intended for human consumption. By targeting a higher-value market, the business case for breeders and farmers becomes more attractive.

The main challenge for EU farmers to grow soy for human consumption is the need to reach a high level of quality for the harvested product. If this is not the case, the harvest will go to the feed sector and result in a lower return on investment for the farmer.

The development of the following traits should be encouraged as part of an EU Protein Strategy:

- **Increase yield and yield stability.** Higher and more stable yields will make the crop more competitive and desirable for EU farmers to grow.
- **Increase drought tolerance.** Soy is mostly grown in the south of the EU, where temperatures are high. However, soy is very sensitive to drought. Developing drought tolerant soy will be key to ensure continued soy production in these regions.
- **Increase disease resistance.** EU soy varieties are highly susceptible to a wide range of diseases, thereby threatening the quality of the harvested product.

In addition to these breeding goals, weed management must be addressed. **Weed management is a major challenge when growing soy, therefore new and innovative solutions and technologies must be developed** to enable farmers to manage weeds without reliance on herbicides, especially for no tillage

production systems.

Another challenge for soy breeders is the lack of enforcement related to reuse of protected soybean seeds. Soy breeders have little incentive to develop new varieties, as their return on investment is greatly reduced by the illegal reuse of harvested seeds¹⁹ for soybean. It also results in farmers not making use of the newest varieties, despite their higher performance and disease resistance. **Efforts should be made at Member State level to inform farmers and combat this practice.** This will have the added effect of increasing soy production and quality through the use of newer and better performing soy varieties, without the need to increase agricultural land.

Sunflower & Rapeseed

Sunflower and rapeseed are already widely grown in the EU for a range of uses including food, feed, bioenergy and industrial purposes. The meal resulting from the crushing has a high protein content, which is of particular interest for the feed sector. Since the use of parts of the plant in one sector does not necessarily prevent further use in another sector, these crops are by definition multipurpose crops. While the use of rapeseed is more widespread, the use of sunflower is slowly catching up. It is particularly thanks to the use of their oil as renewable bioenergy, that their co-products are being produced and used in the feed sector. This dualpurpose not only bolsters their uptake, but also generates an additional stream of income for farmers, effectively maximising their returns by harnessing several products from a single crop.

However, their success is currently threatened by several factors, including a push to cease their use in bioenergy, as well as a loss of essential PPS, with no or few effective alternatives currently

19 Council Regulation (EC) No 2100/94 of 27 July 1994 on Community Plant Variety Rights

available. Investment in breeding programmes for these crops should be increased to ensure they remain a competitive source of plant protein in the EU.

To address these challenges, it is essential that the development of the following traits be encouraged as

- **Increase protein content** to improve nutritional quality and to reduce the need to supplement compound feed with high protein meals.
- **Optimise the protein (amino acid) composition** to improve nutritional quality and reduce the need to supplement compound feed with synthetic amino acids.
- **Increase disease resistance**. This is constantly done, but must be increased in light of a reduction of available PPS.

In addition, it is also crucial that the **Bioenergy Policy, which enables the use of rapeseed and sunflower oil for bioenergy, is maintained**. This is not only to ensure the

in the last decade, the agricultural land used for producing legumes in the EU remains low.

Legumes face similar challenges as soy, to becoming more competitive for EU production (e.g., low yield, disease susceptibility) with the additional challenge that demand in the EU is very fragmented with region-specific preferences for select species and varieties. Breeding programmes for most legumes are even less advanced than for soy, and therefore require more substantial long term investment and breeding efforts, with little return on investment foreseen.

We, therefore, recommend focussing on increasing their uptake for food, by developing varieties tailored to specific regions and uses. While small, these markets are high-value, with many varieties already linked to specific geographical origins²⁰. Accessing such markets could

The main breeding goals for legumes (excluding soy) for any EU Protein Strategy should therefore aim to improve competitiveness and uptake for human consumption:

- **Increase yield and yield stability**. This will be essential to make the crops more competitive and ensure a predictable income for farmers.
- **Increase disease resistance** to ensure high quality for the premium market under low input conditions.
- **Increase drought tolerance**. As droughts become more frequent and widespread in the EU, drought tolerance should be a priority trait to develop.

Legumes (other than soy)

Legume crops, or legumes, such as beans, peas, lupins, chickpeas, peanuts and lentils, can fix N directly, with the help of specific bacteria. Therefore, they require little to no N fertiliser during their production, while at the same time reducing the need for N fertiliser for the next crop, and improving soil health. Despite their clear

to improve the uptake of nutrients during consumption, thereby increasing nutritional quality and improving digestibility.

- **Improve food processing characteristics** to optimise processing, while maintaining high nutritional quality and stability.

Breeding legumes will require close collaboration with the public sector for acquiring knowledge on basic biological processes, and for pre-competitive breeding²¹. In order to create momentum and better coordinate efforts, as a first step, it would be desirable to select two or three legume species per region (e.g., northern Europe, southern Europe) with similar pedo-climatic conditions. This will focus the research and breeding efforts, thereby optimising and speeding up the process. It will also be essential to assess what knowledge gathered on one legume species could be applicable to other legumes.

Roughage

While some efforts are currently underway to optimise processing of some sources of roughage for human consumption²², this section will focus on feed. Grass, silage maize, fodder legumes and dried fodder, are the main sources of roughage identified in the Feed Protein Balance Sheet²³, with the entirety being produced in the EU. Roughage plays an important role in livestock feed, making up ~40% of all feed used in the EU, despite only being consumed by ruminants. In addition, roughage is mostly produced and used on-farm, fostering self-sufficiency and minimising transport. However, the decentralised nature of production may present challenges in accurately monitoring yields and utilisation.

Roughage mostly comes from grasslands and permanent pastures. Ruminants will directly graze or will be fed the mowed (dry or ensilaged) roughage. These practices are often associated with extensive production systems using traditional and/or conservationist approaches, but they are also used in more intensive and high-tech production systems. Grasslands and permanent pastures are known to act as efficient carbon sinks and help promote biodiversity²⁴.

The challenge is to optimise and, in some cases, modernise the management of grasslands and permanent pastures, to ensure high yields with high protein content and nutritional quality, while maintaining soil health. **This includes regular reseeding, in order to maintain a good source of roughage.**

It is important to note that initiatives are underway to process roughage, so as to obtain high protein powder or dry pellets, which is easily digested by monogastric animals such as pigs and poultry. The protein (amino acid) composition of roughage-based protein is of similar quality to soy, and in this regard constitutes a viable substitute. There are currently two commercial setups operating in Denmark and more is planned in other countries. The economic success of this new business area relates to an efficient use of the roughage pulp generated as a side stream of the protein extraction process. Ensilaged, this pulp has been shown to have even better digestibility and to give better milk yield in ruminants, compared to silage from fresh grass. While companies are already offering grass-based protein as a sustainable and more climate-friendly alternative to imported soy, there are still a number of challenges that need to be addressed.

21 Examples of public-private collaborations in legume breeding: [BELIS](#) and [Legume Generation](#)

22 [BioRefine Fra frø til græs til grønt protein](#)

23 EU Commission (May 2024) [EU Feed Protein Balance Sheet](#)

24 Norderhaug, A., Clemmensen, K.E., Kardol, P. et al. (2023) [Carbon sequestration potential and the multiple functions of Nordic grasslands](#)

For this, the development of the following traits should be promoted in an EU Plant Protein Strategy:

- **Increase protein content** to provide higher nutritional value and reduce the need to supplement with high protein meals.
- **Develop balanced seed mixtures** in order to ensure high nutritional quality for feed, while maintaining or improving soil nutrient content.
- **Increase drought tolerance.** Drought stress can significantly reduce the nutritional quality of roughage.
- **Increase protein and nutrient stability** to enable longer storage of harvested material while maintaining nutritional quality, thereby allowing transport and the scaling up of the drying or pelleting process for a wider application.

In addition to these breeding goals, **the improvement of management practices for grasslands and permanent pastures within the CAP, will be essential to optimise and better**

By and co-products (other than meals)

The use of side stream, or by/co-products, for food or feed, following processing of a diverse range of biobased materials for the food, drink or industrial sectors, currently represent only a small percentage of plant protein sources for feed in the EU (~6%)²⁵. While such practices are now more deliberate towards a circular bioeconomy, their initial purpose was to valorise side streams for additional income and/or to reduce costs.

Due to high food safety standards in the EU, the use of by/co-products as a source of plant protein is more adapted for the feed sector. The use of compound feed to reach specific nutritional compositions also enables a more pragmatic use of by/co-products, which might vary in their composition from batch to batch.

While by/co-products have an important role to play in increasing EU plant protein sufficiency, their use in the food and feed sectors faces several challenges. The biggest challenge is the lack of a clear overview of the volumes and flows of by/co-products as a result of food, drink and other processing (e.g., industrial, pharmaceuticals). **Establishing a better overview of all plant biomass utilisation within the EU, could play a key role in identifying possible (new) sources of plant protein and optimise their valorisation.** This would have the added benefit of increasing food security and circularity, and reducing waste, while providing additional income streams for stakeholders. Moreover, it would support more informed policy decisions.

Another major challenge, is the competition for by/co-products with the wider bioeconomy. As the EU transitions away from fossil fuels, the demand for biobased materials for nonfood or feed sectors is expected to increase. It is therefore essential to guarantee a balanced distribution of by/co-products between sectors, thereby ensuring that the feed sector is not priced out of accessing valuable ingredients for compound feed.

Since by/co-products can be a wide range of products, it is not possible to put forward specific traits for breeding efforts. However, as we move towards a more resilient, competitive and sustainable bioeconomy,

it is crucial to avoid competition between food, feed and other sectors. Therefore, the development of multipurpose crops, pro-

Value and Supply Chain Uptake

The following section will assess the drivers at value chain level, considering the bottlenecks faced by different players and suggesting some solutions.



The Breeding Sector

The challenges and solutions of the seed and breeding sector are already outlined in the previous section, in the context of priority traits to be developed in specific crop groups. In this section, we focus on the need for more knowledge on biological processes and technological development. It should be noted that most points are not specific of plant protein crops and can be extended to all crops.

Increasing the speed of plant breeding

In the context of climate change, resulting in, amongst other challenges, weather volatility and increased pest and disease pressure, it is essential to speed up plant breeding. This will be required to become more dynamic and better meet the needs of farmers and the rest of the value chains, including consumers.

The development of innovative techniques enabling the speeding up of plant breeding programmes, such as genome editing, should be promoted and, when necessary, legislation should be adapted to enable its use.

More basic and applied research on the interaction between genotype, environment and management (GxExM)

As part of the transition towards more resilient, competitive and sustainable agrifood production systems, it is essential to gather new/more knowledge on the interaction between genotype (i.e., genetics, crop specy and variety), environment and farm management practices (GxExM), to feed into and adapt future breeding programmes.

This should ideally be done in close collaboration with the public sector, through public-private partnerships, and would enable better informed breeding programmes aimed at developing a wide range of more tailored and resilient multipurpose crops for diverse production systems.

Impact of legumes on crops in the next rotations

The impact of introducing legume species into crop rotations should be assessed from a multi-year perspective. The aim should be to determine not only the environmental benefits during its growth, but also for the next crops in rotations, as well as in mixed cropping. This will be essential for breeding programmes to develop plant varieties that can complement each other and the soil material, over multi-year rotations and in mixed cropping systems.



The Farming Sector

Every growing season, farmers select the most suitable crop species and varieties for planting, considering different factors, such as the composition of the soils; expected weather conditions; expected pest and disease pressures; previous and future crops in the rotation; available equipment and storage infrastructure; and market demands and access to those markets. In order to promote an increase in

EU-grown plant protein, different strategies should be explored, as the challenges at farm level will vary depending on the type of crop.

Common European Data Spaces focussed on agricultural data are currently being rolled out and could play an important role in this, as they aim to leverage big agri-data to support farmers by boosting their performance and stimulating data-driven innovations and solutions²⁶.

Widespread crops and cropping systems

Crops such as cereals, rapeseed, sunflower and some sources of roughage, are already widely grown in the EU, usually as stand-alone cultures to optimise efficiency. Increasing the protein content of such crops would enable farmers to grow more plant protein, without requiring a substantial investment in new equipment, or changes in farm management practices. This low entry barrier would enable quick uptake, which would result in a considerable increase in EU plant protein production.

However, if varieties with increased protein content present trade-offs, such as lower pest or disease resistance, or lower yields, it would be essential to ensure a return on investment for farmers. This could be done by providing a premium for higher protein grains or oilseeds, such as provided by premium markets, or through the CAP.

Less widespread crops and cropping systems

In the case of crops that are less widespread in the EU, such as legumes, some sources of roughage and mixtures, farmers face a higher entry barrier for uptake. The three main challenges are: the

return on investment for farmers and for risk management.

Farm management practices

Introducing new crops into a rotation requires careful considerations of the impact of the crops on other crops in the rotation, particularly how they will affect each other's performance. Other considerations include the expected impact on soil health and composition, and potential pest or disease cycles and impact on IPM.

For this, overall farm management practices must be adapted to optimise and fully benefit from the new crop. For example, introducing a new crop to a rotation could enable an extended growth season, by harvesting the previous crop earlier to enable the addition of a growth cycle, thereby using the soil to its full capacity and ensuring year-round cover. Another example would be the growth of mixtures, e.g., grasslegume mixtures for roughage, or wheat mixtures, destined for the feed sector. This would provide more balanced and nutritious compound feed, while at the same time increasing agrobiodiversity.

Weed, pest and disease management will be essential to ensure success and long term uptake of new crops at farm level. Precision farming could play an important role, particularly in weed management, to compensate for the reduction of PPS, while the uptake of legumes could help compensate for reduced fertiliser use, and to improve soil health.

Knowledge and capacity building

In order to explore new and alternative farm

26 EU Commission Website - [Common European Data Spaces](#)

management practices, farmers will need access to new knowledge and capacity building opportunities. Knowledge exchange through networks such as AKIS (Agricultural Knowledge and Innovation Systems), will play an important role in providing a network and community for farmers, farm advisors and other relevant stakeholders, to exchange on best practices and innovative solutions to face challenges. Opportunities to exchange and discuss the outcomes of relevant research projects and living labs should also be enabled. Knowledge exchange and capacity building should include entrepreneurial capacity, to enable farmers to explore new

Return on investment and risk management

To ensure a stable and long-term increase in the production of plant protein in the EU, it is necessary to ensure return on investment for farmers. Access to (new) markets and transparency of value and price, will be crucial to incentivise farmers to invest in necessary equipment and infrastructure.

In addition, the introduction of new crops to rotations should reduce risks from recurring pests and, in the case of legumes, reduce costs linked to N fertiliser. This in turn will improve soil quality and health, for which farmers should be rewarded.

To encourage widespread uptake, it is essential that risks are minimised by ensuring long term policy promoting a stable market, driven by demand. Decisions to remove specific PPS from the market, should also consider the impact on minor crops, such as legumes, to avoid situations as described above (see *Story to learn from*).

Major challenges linked to yield instability and the risk of not reaching food grade quality, may

eventually be solved through breeding efforts, but until then, it is necessary to put in place support mechanisms to incentivise uptake of these crops at farm level.



The Agricultural Trade and Wholesale Distribution

and

Diversifying plant protein sources

Trade, wholesale and distribution play a vital role in global agrifood systems, as well as within the EU. The EU currently produces ~75% of the plant protein used in its feed sector, and is dependent on imports for the remaining ~25%, much of which is provided by a handful of countries. It is therefore essential to diversify plant protein sources, both by favouring more EU-grown proteins, but also by sourcing from a broader range of countries. This will provide more open strategic autonomy²⁷ and enable the EU to better weather shocks from environmental, health, geopolitical or other crises. In line with this, the EU is already encouraging Ukraine to “*think about restructuring its agricultural production, focusing on oilseeds and protein crops, as the European Union has and will probably continue to have a deficit in these products*.”²⁸

Increasing the competitiveness of EU-grown plant proteins

To promote increased production and sourcing of plant protein within the EU, it is essential to increase the competitiveness of EU-grown plant protein. For that, technology and innovation (e.g., breeding, PPS, post-harvest processing) should be leveraged to increase plant protein production, quality, and use ratio. In this way, EU-grown plant protein will become financially more desirable, thereby enabling their other benefits, such as sustainability contribution,

²⁷ Spanish Presidency (2023) [Open Strategic Autonomy for a Competitive and Resilient EU](#)

²⁸ Address by Mr Janusz Wojciechowski at the International Summit on Food Security, Kyiv – November 2024

shorter supply chains and local sourcing.



Sourcing more EU-grown plant protein will have the added benefit of alleviating some of the trading challenges related to misalignments of rules between the EU and its trading partners e.g., the use of PPS banned in the EU and the upcoming implementation of the EU Regulation on Deforestation-free Products²⁹.

As by/co-products are also an important source of EU plant protein, particularly for the feed sector, promoting reduced exports of raw agricultural materials and higher exports of processed products, could further increase circularity through a higher use ratio of EU plant protein sources. Such a shift could play an important part in safeguarding food and nutritional security, while supporting more resilient, competitive and sustainable EU agrifood systems.

Scaling up

While the EU currently imports plant protein, such as soy, in the range of millions of tons, the production in the EU will most likely be much smaller and scattered across Europe. Wholesale distributors could play an important role in supporting the scaling up of EU plant protein production by gathering products from across the EU, and making them available to the food and feed sector.

This scaling up should be balanced with local and/or short value

The EU feed sector requires ~72 million tonnes of crude protein per year³⁰. In addition to the amount of protein, the composition of the protein must also meet a certain nutritional standard, to ensure the quality of the compound feed. To promote the uptake of EU-grown plant protein in the feed sector, the following two avenues should be explored jointly: increasing valorisation of by/co-products in compound feed; and promoting the use of EU-grown plant proteins in the feed sector.

Increasing Valorisation of EU by/co-products

By/co-products have a huge potential to provide a stable source of high content and high quality (plant) protein for the feed sector, while increasing circularity and reducing potential land use competition between feed and food. Currently, only 6% of EU feed use originates from plant by/co-products other than oilseed meals, while another 2% originates from nonplant sources (e.g., whey powder or fish meal)³¹.

Research and innovation (R&I) in feed processing technology will be needed to further explore and optimise the use of raw materials and by/co-products, coming to and from the feed sector, to the utmost of their potential, while maintaining high nutritional value and feed safety.

To promote the use of by/co-products for feed, establishing a better overview of EU Plant Biomass would be extremely beneficial.

Promoting the use of EU-grown plant protein in the feed sector

29 EU Commission website - [Regulation on Deforestation-free Products](#)

30 EU Commission (May 2024) [EU Feed Protein Balance Sheet](#)

31 EU Commission (May 2024) [EU Feed Protein Balance Sheet](#)

plant protein, in particular soy, it is expected that the transition towards animal diets based on a higher proportion of ingredients of EU origin, will come at an increased cost, thereby requiring considerable investments from the feed sector. It is therefore essential to support and incentivise players, by ensuring ready access to high quality EU plant protein, both from raw materials and by/co-products.

EU policies promoting more sustainable practices, such as corporate sustainability and responsibility, could be leveraged to support the transition towards sourcing more EU-grown plant protein for the feed sector. This could level the playing field for EU producers, while at the same time supporting a market for EU-grown plant protein.

GM-free markets, such as the organic livestock sector, also present a potential market for EU-grown plant protein, which should be further explored.



The Food and Drink Sector

EU plant protein production for food is a fast-growing and high-value market. In addition, the by/co-products of food and drink processing are ideally placed to be incorporated into compound feed to improve their protein content and/or nutritional value. This would reduce the environmental impact of both end-products, while promoting circularity and food security. To encourage the uptake of EU-grown plant protein for the food and drink sector, the following areas should be considered: synergies between the food and feed sectors; risk-sharing between primary producers and the food and drink sectors; and promoting the use of EU-grown plant protein.

Synergies between the food and feed sectors

While discussions on plant protein are often

limited to plant-based alternatives to animal products, it is essential to realise that both sectors are highly interdependent, with the by/co-products of plant-based alternatives often used by the feed sector (e.g., pressed oats, resulting from the production of oat drink as a dairy alternative, are used for feed), and the manure from livestock providing a valuable source of organic fertiliser for crop production. **Rather than a focus on displacing one protein source with another, a view towards identifying synergies and enabling the valorisation and flow of by/co-products between the food and feed sectors, should be promoted.**

While new processing infrastructures will need to be developed, repurposing of existing infrastructures should also be explored to minimise costs. One example is the use of dairy protein extraction plants to extract plant protein during their off-peak time.

Food-grade EU-grown plant protein

The food and drink sector faces similar challenges as the feed sector, for sourcing competitive EU-grown plant protein. In addition, since end-products are for human consumption, more stringent food safety standards, together with the need to ensure desirable flavours and organoleptic characteristics, create an even higher entry barrier for primary producers. However, due to the higher market value, EU farmers producing food-grade plant protein, can benefit from a higher price than when producing similar products for feed. **Consistent and transparent communication about market demands and prices, for example through pre-determined contracts, would enable risk sharing and encourage farm level uptake of plant protein for the food and drink sector.**

With the goal of scaling up, the food and drink sector should aim to develop processing capabilities and recipes that are flex-

ible in terms of the source of plant protein (e.g., any oilseeds, or any cereals). This would enable the diversification of plant protein sources, and reduce market volatility.

Promoting the use of EU-grown plant protein

In the same way as for the feed sector, policies promoting more sustainable practices should be leveraged to increase the uptake of EU-grown plant protein.



The Retail Sector

To ensure any increase in EU-grown plant protein will be aligned with an increase in demand, it is essential that the retail sector be involved in the implementation of this strategy. Retailers play an important role in creating food environments and can be instrumental in promoting the uptake of specific product types.

In the absence of official standardised labelling, retailers are key to communicating the use of EU-grown plant protein in the development of food products. By leveraging their Corporate Social Responsibility, retailers should be encouraged to promote responsible sourcing of plant protein, and fair distribution of revenue across the supply chain, rewarding key players, like farmers, for their efforts. Retailers can help level the playing field between EU-grown and imported plant protein, by working directly with local farmers and processors, thereby setting up new, short, value chains.



Consumers and Citizens

Consumers are the last link in the value chain and also the most important, as consumer uptake determines demand. In order to successfully increase EU plant protein production in a reliable and sustainable way, it is crucial that it is demand-driven. After a first initially invest-

additional investments and ensure a steadily growing demand.

At the same time consumers are also citizens, with concerns about climate change and the impact of agrifood systems and their food habits on the environment. The willingness to pay for more sustainable “EU-grown” products, could be leveraged through awareness-raising and communication through labelling or other methods. However, recent increases in food prices and inflation, have demonstrated that premium food products are less attractive during crises. It would therefore be essential to ensure that prices remain accessible to the wider population and, if

Policy Recommendations

In the previous sections of this implementation strategy, the main challenges for increasing EU plant protein production were outlined, with recommended solutions for implementation. **In this part we focus on key policy recommendations that will be fundamental for the success of such a strategy.**

A crucial requirement will be a long term policy commitment implemented through timed initiatives in the short (< 5 years), medium (5-15 years) and long term (> 15 years). **A long term commitment will be essential and will provide a clear signal for relevant stakeholders to encourage investment by reducing risk.**

Short term policy recommendations: Promote and valorise EU plant protein

- **Establish a better overview of EU Plant Biomass**, covering all sectors utilising plant biomass, as well as their resulting side streams, by/co-products. This will help identify possible (new) sources of plant protein and optimise their valorisation. It will also have the added benefit of increasing circularity and food security, reducing waste, while providing additional income streams for stakeholders.
- **Optimise the management of grasslands and permanent pastures**, to ensure high yields with high protein content and nutritional quality, while maintaining soil health. This includes allowing regular reseeded, in order to maintain a good quality of roughage.
- **Improve enforcement of existing plant variety protection legislation** to ensure a return on investment for breeders and incentivise the sector to further develop and use new, higher performing, soy varieties for the EU market. Such an initiative will have an immediate positive effect on the production of soy in the EU, through the switch to newer and better performing varieties, in places where soy is already being cultivated, without requiring additional land use change.
- Leverage the ongoing update, development or implementation of relevant legislations to create an enabling environment for increasing EU plant protein production
 - » **The Renewable Energy Directive III (RED III)**: promote the growth and use of oilseed crops providing both renewable energy and high protein feed for the livestock sector.
 - » **The legislation on Plant Reproductive Materials (PRM)**: enable the registration of better adapted crop varieties with traits such as increased protein levels or nutritional composition, despite lower performance for yield or disease resistance.
 - » **The legislation for plants obtained by New Genomic Techniques (NGTs)**: enable the use of innovative breeding methods for speeding up breeding, by quickly adopting and implementing a new legislation for NGT plants.

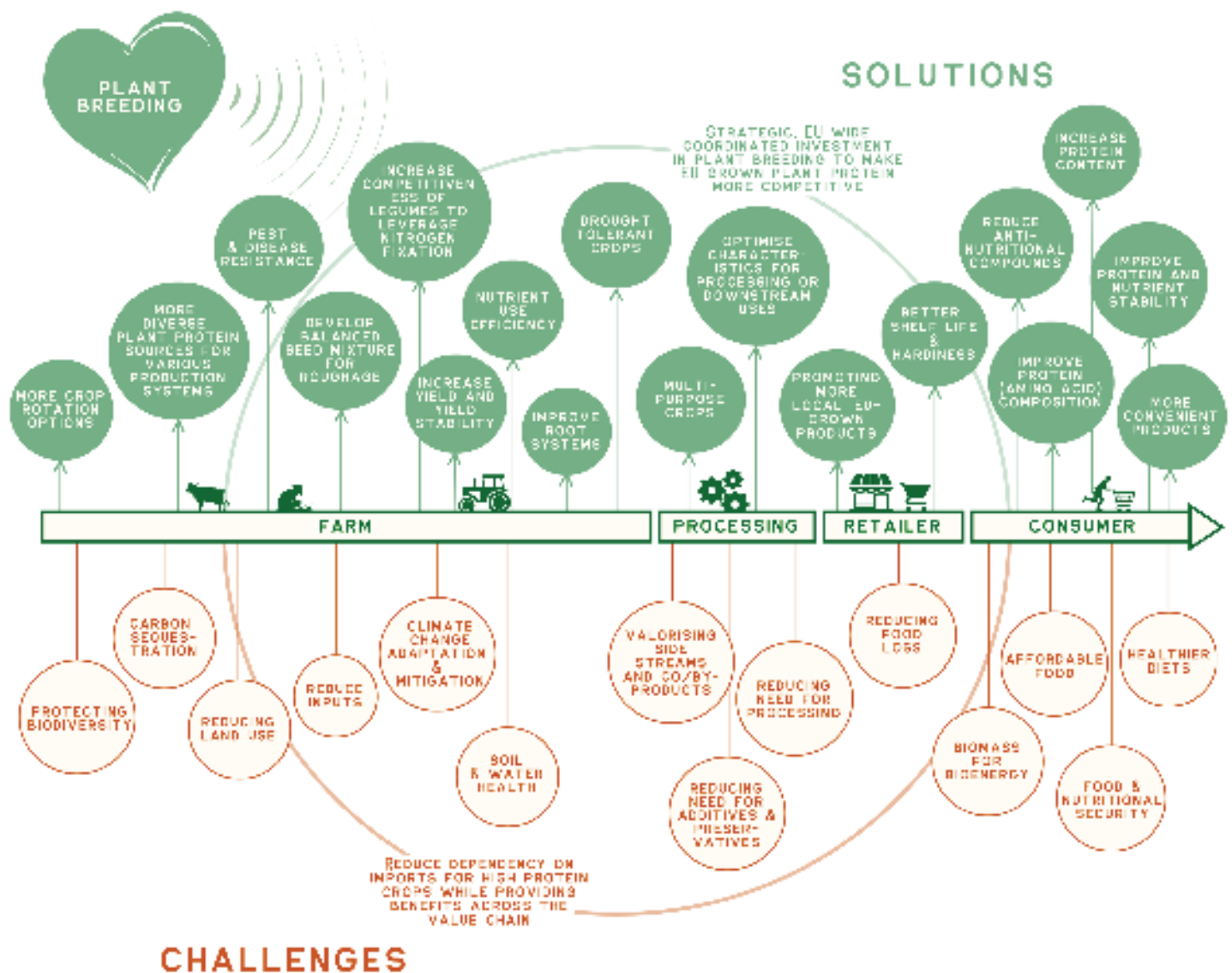
- **Establish and support networks such as AKIS to facilitate knowledge exchange and capacity building** among farmers, advisors, and researchers.
- **Invest in the establishment and/or repurposing of infrastructure and scaling up** successful value chains around EU plant protein crops.
- **Setup incentive schemes, subsidies and/or other funding mechanisms** to trigger the initial involvement of stakeholders across the value chain i.e., rewarding uptake by farmers through the CAP and supporting the creation of new value chains and/or repurposing of existing chains; incentivising the food and feed sectors to prioritise EU-grown plant protein sources; and enabling the establishment of necessary infrastructures.

Medium term policy recommendations: Promote research informing science-based decision-making

- Ensure science-based policymaking and policy coherence by monitoring and learning from successes and failures.
- **Fund R&I to**
 - » **develop new and innovative solutions and technologies for effective weed management**, especially for no- or low-till production systems.
 - » **conduct multi-year studies on the impact of legumes and other plant protein crops in crop rotations** to assess environmental and socio-economic benefits at farm level.
 - » **optimise processing technologies to increase the use of products** and by/co-products from plant biomass processing for food, feed and/or for the wider bioeconomy.

Long term policy recommendations: Establish long term EU-wide coordinated strategic investment in plant breeding

Long term EU-wide coordinate strategic investment in plant breeding will be essential to develop a wide range of diverse and resilient plant protein crops for diverse purposes (food, feed and raw biobased materials), regions and production systems. An **EU public-private partnership on plant breeding** would enable collaborations between the public and private sectors to streamline breeding efforts for plant protein crops from basic research on biological processes, to breeding a wide range of more resilient and competitive plant varieties for the needs of the EU market.



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