

Transition pathways for European legume-based value chains



FOUR SCENARIOS FOR A MORE
AUTONOMOUS LEGUME PRODUCTION
IN 2040, AND HOW TO GET THERE

Public summary

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This study is part of the large EU project LegValue. This focuses on the protein transition, specifically on increasing the share of legumes in European crop rotations. LegValue is run by a consortium of 24 European agricultural research and education institutes. As one of them, Wageningen University & Research has taken on this study of exploring possible transition pathways, in close cooperation with the other consortium partners.

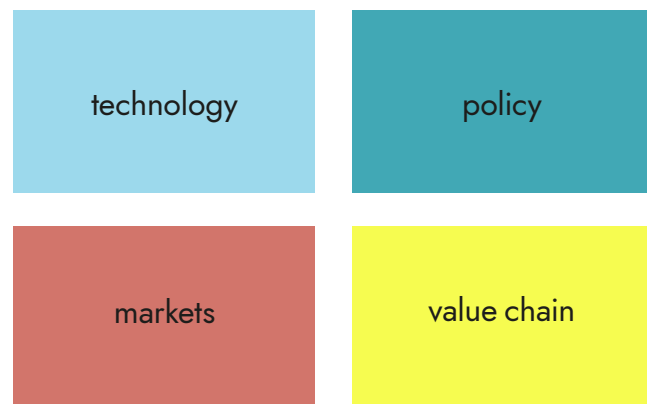
Introduction

How can European agriculture develop into a more sustainable system? And what role do legumes play in the protein transition? In this document, Wageningen University & Research explores four possible transition pathways for European legume value chains. We start by describing four future scenarios in which legume value chains will have developed around 2040. We call these future scenarios:

We call these future scenarios:

- Tribal Paradise
- Multinational Paradise
- Citizens' Paradise
- Consumers' Paradise

Then we decide which transition pathway is most fitting leading up to these scenarios. Each transition pathway is constructed from four building blocks:



For each scenario, we describe all four building blocks. These transition pathways can help strategic planning by the different stakeholders: technology providers, farmers, legume processors, governments and NGOs. We would like to stress that the scenarios and pathways are not predictions of the future, but rather possible courses of action, to illustrate the influence of societal macro developments and stakeholders.

The role of legumes

Legumes play a key role in the protein transition. With the help of bacteria in their root nodules, legumes are capable of nitrogen fixation. As a result, they can provide protein without the need for nitrogen fertiliser. Legumes can be used for human food products as a plant-based source of protein, but also as animal feed or as a cover crop to improve soil fertility.

The best-known legume is probably soy. But there are many other legumes usable for food or feed. Clover in grassland is one example, but there are also peas and broad beans for canned goods, or lupine and alfalfa as cover crops or animal feed, to name but a few.

Legume-based value chains: why and how?



The starting point of LegValue and this study is that the EU wishes to become more autonomous in plant-based protein. The protein transition has an environmental aspect (fewer inputs and imports of nitrogen), but protein autonomy is also of strategic importance in light of global affairs.

Of course, there is not one way for European agriculture to materialise into a system with more legumes in the crop rotation. There are many variables that influence the process and the end result. During our exploration, we found two key driving forces: the economy and the degree of cohesion within the EU.

These result in two dimensions:

- **the economy dimension:** ranging from inclusive growth (with a strong focus on sustainability) to maximum short-term profit (with no focus on sustainability)
- **the EU cohesion dimension:** ranging from nationalism (with a focus on local economy and trade barriers) to an integrated EU (with a focus on liberalism, global economy and free trade)

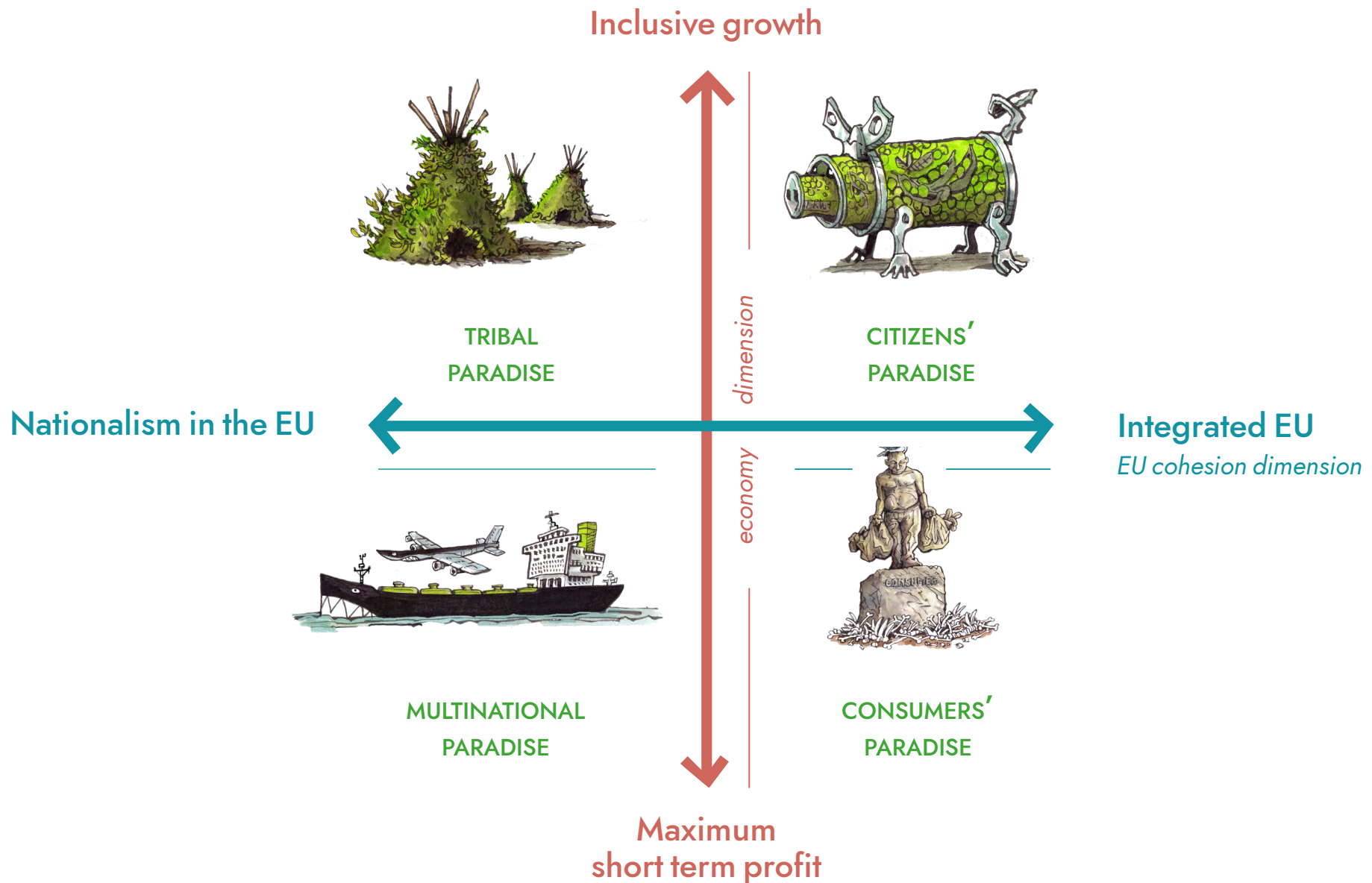
In a two by two grid, these dimensions result in our four future scenarios (illustrated on the next page):

- **1 & 2:** The nationalistic scenarios will focus on national protein independence, while the integration scenarios aim at independence on a European scale.
- **3 & 4:** The nationalistic scenarios will focus on national protein independence, while the integration scenarios aim at independence on a European scale.

The four pathways give insight into how current decisions can influence the future of legume value chains in Europe based on macro developments. The transition pathways inform thinking and strategic planning of technology providers, agronomists, processors, policymakers, NGOs and other stakeholders about the future of legume value chains in Europe. Stakeholders can identify and act on the different implications of each pathway: what do these developments mean for me/my business/my organisation in terms of tools to use and timing of those tools? Hopefully, this will help the EU to successfully become more autonomous in its legume production.

For stakeholders it would be interesting to see where in this grid their agricultural system currently stands, where it seems to lead, and what can be done to influence that.

Future scenarios

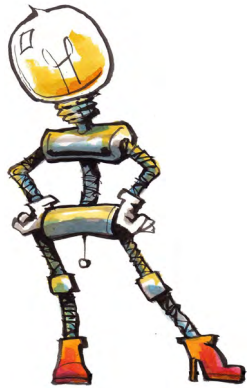


The building blocks

Every scenario is constructed out of four building blocks.
Each building block comes with its own question:

TECHNOLOGY

What are the main technological and agronomical trends related to legume-based value chains in Europe?



Within the EU, legumes cover less than 10% of the arable land. Trials with legumes are more often for cash crops than cover crops. The European market of legume products is currently dominated by soy products. In the EU soy innovations have stagnated, while innovations concerning other legumes are growing, though still a niche market. To increase legume yield, more knowledge is necessary: information exchange, knowledge sharing, building up networks and investing in/learning about technical equipment (farm trials).

MARKETS

What are important market and consumer trends related to legume-based value chains in Europe?



The EU legume market is currently characterised by foreign trade that strongly varies depending on the legume types. In the south and south-east of the EU, soybeans are grown, mainly used for animal feed or biofuel (with the remaining cake used as feed), but the food market for soy and other legumes is increasing. In the north-east of the EU, dry pea, broad bean and lupine are grown for feed. The EU market for plant-based meat and dairy replacements is growing steadily, resulting in a growing demand for processing to protein concentrates. Fresh peas and beans are cultivated in the EU for (canned) food. More information on current drivers and barriers for supply and demand of legumes in Europe can be found on page 14.

POLICY

Which EU and national policies facilitate or hinder the development of legume-based value chains in Europe?



The policy environment encompasses a mix of regulatory, advisory and incentive interventions at a regional, national or European level. Constructive policy measures can be subsidies to stimulate legume cultivation, and support to areas, for example through demo-projects or green deals between stakeholders. An overview of relevant EU policies can be found on page 13. Most farmers receive some form of support (regional, national or EU).

VALUE CHAINS

What are the main characteristics of legume-based value chains in Europe?



Value chains encompass the whole range of activities needed to create a legume product, ranging from 'upstream' stakeholders such as seed producers to 'downstream' stakeholders, such as processors and retail. Currently, information is often not shared and there is dissatisfaction with how markets function. Pilots within LegValue emphasise interventions such as inter-farm cooperation for shorter value chains, knowledge exchange but also the development of distinctive labels for legume products. There is a great need for market transparency. Contracts can also play a role in developing technical knowledge.

The scenarios

In each scenario, the building blocks work out differently.

1



TRIBAL PARADISE

2040 – In Tribal Paradise, Member States strive towards a self-sufficient protein production, with legumes using 15% of all arable land. Awareness of environmental, climate and biodiversity issues has led to an increased demand for local and sustainable products, preferring plant proteins over animal proteins. This has created a push to smaller farms. Biodiversity has drastically increased, but trade barriers have been set up between EU countries.

What pathway can be followed towards Tribal Paradise?

In 2020, despite increasing awareness of the negative effects of agriculture on climate and biodiversity, meat consumption was still high, and market share of meat alternatives was still small. The Farm to Fork strategy failed to adequately address local conditions. Nations wanted to be self-sufficient and independent of geopolitical tensions. By 2025, countries implemented regional and national policies to stimulate legume production, and consumer demand increased rapidly. By 2030, legume cultivation was still not competitive. Therefore, countries introduced policies such as ecosystem service pricing, pricing of environmental costs, trade barriers and local networks of legume farmers. By 2035, there were strong regional and/or national value chains across the EU. The consumers' preference for plant protein allowed processors to offer guaranteed prices for legume farmers.

2



MULTINATIONAL PARADISE

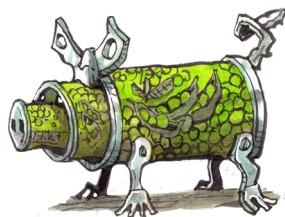
2040 – In Multinational Paradise, big corporations produce more legume crops in a number of countries in Europe. This gives them a competitive advantage over other EU Member States. Agricultural research has increased yields by using GMO crops and advanced smart technologies. While meat remains cheap, multinationals also offer cheap, healthy and tasty meat alternatives.

What pathway can be followed towards Multinational Paradise?

In 2020, the EU dependency on imports triggered a political push with high research investments into soy cultivation. However, by 2025 most legumes for feed were still imported, and big companies did not see a competitive market for EU-produced legumes yet. By 2025, researchers found new varieties and developed GMO crops to lower costs and improve yields and quality, even in colder climates. Some opportunistic companies jumped in. By 2030, national policies supported soy production by offering price guarantees and import taxes and relaxing regulations around GMO crops. Multinationals started to really get on board. Member States started to compete for the location of these multinationals. By 2030, competition within the EU was fierce, and consumers took advantage of low legume and meat prices. By 2035, many multinationals had taken over small companies that produced tasty meat alternatives. As a result, consumer demand for plant proteins also increased, and prices dropped. Multinationals introduced contracts with farmers.

The scenarios

3



CITIZENS' PARADISE

2040 – In Citizens' Paradise, the public's worries about the old cheap but unsustainable food system are reflected in the political debate. Now companies underpin their social responsibility by growing more legumes in Europe. Presently, consumers have to do their best to find meat products in supermarkets, with a 50% reduction of animal protein production compared to 2020. Animal products are available at a high cost, but they are produced based on homegrown legumes. Of all arable land within the EU, 15% is now used for legumes.

What pathway can be followed towards Citizens' Paradise?

In 2020, legumes were not yet profitable for farmers. Governments stimulated legume cultivation by closing green deals with companies and value chains for better varieties and knowledge, or even with financial support. EU-wide campaigns increased consumer awareness and the market for eating less meat and more plant proteins. By 2025, the price of legume production was still too high. Therefore, a subsidy and certification scheme was put into place. Research and development increased yields and protein quality. EU Member States agreed to produce legumes in those places with the most favourable environmental conditions. By 2030, consumers agreed: plant-based products were not only good for the environment, but also cheap and tasty. However, most legumes were still imported into the EU. To achieve more EU production, governments supported breeders and growers to develop better varieties and cropping systems. By 2035, the cost price of legumes became competitive, even for feed products.

4



CONSUMERS' PARADISE

2040 – In Consumers' Paradise, it is evident: cooperation to produce legumes within the EU reduces dependence of the EU on imported soy. This allows the EU to protect its own livestock industry, and speeds up technological advancement in agriculture. All trade barriers between EU countries are lifted, so now farmers within the EU are able to produce soy for a lucrative market. Consumers are increasingly offered affordable EU grown legumes and meat in the supermarkets. With a small market share for meat alternatives and increased consumer health awareness, consumers are more inclined to include beans in their diet.

What pathway can be followed towards Consumers' Paradise?

In 2020, farmers and researchers began to experiment with 'smart' agriculture, such as robotics and precision farming. This increased yields and decreased inputs of manure and pesticides. Within the EU, there was an increasing awareness of our dependence on import from the Americas. Research and innovation agendas stimulated the development of more efficient legume varieties, also for colder climates. By 2025, there was a slight increase of legume area within the EU, but legumes were still largely imported. Because of the high investment costs in smart technology, farm sizes needed to increase. Governments continued to support research. Trade was free within the EU and import rates were increased. By 2030, this resulted in cheaper EU products for consumers and a protected EU livestock industry. Meat alternatives remained expensive, however, because the profit margin was too small. Therefore an EU policy programme and tax-reduction system were implemented to increase plant-based protein consumption. This resulted in a stable market for EU grown legumes.

The building blocks of the scenarios



TECHNOLOGY



POLICY

	TECHNOLOGY	POLICY
	<p>In one scenario technology focuses on circularity, whereas the focus is on maximising yields in another. There is also a wide variety in the use of innovative technology such as GMO, precision farming and robotics. The focus of knowledge production also varies widely.</p>	<p>Policies such as price regulation, subsidies, tax reduction and trade incentives are used in one scenario, and not in the other.</p>
<p>TRIBAL PARADISE</p>	<ul style="list-style-type: none"> • Agricultural systems focus on circularity. • Improving yield and quality of legume crops is important, because member states want to be self-sufficient. • Multi-cropping systems are implemented to reduce inputs while less land is needed to produce the same output. • Pilots are used as a learning by doing approach. • Knowledge production is focused on know-how on a variety of legume production and transformation processes, adapted to local conditions. 	<ul style="list-style-type: none"> • Policies around legumes put national interest first, so farmers mainly benefit from policy at the national/regional levels. • To stimulate legume production, there is a price regulation on legumes and a system of ecosystem service pricing to ensure that farmers are paid a 'true cost' price. • Additional policy is focused on reducing inorganic fertilisers. • Protected Designation of Origin (PDO) and Protected Geographical Indication (PGI) schemes are used to guarantee originality and quality of specific legume foods.
<p>MULTINATIONAL PARADISE</p>	<ul style="list-style-type: none"> • There is a strong focus on improving yields and protein quality. • GMO technology is widely used to achieve this goal. • Pilots are used as a 'learning by doing' approach to test innovations. • Knowledge production is aimed at reducing costs of cultivation and processing. 	<ul style="list-style-type: none"> • Although there is limited government regulation on production of legumes, prices of legumes are regulated to stimulate self-sufficiency within Europe. • Countries introduce trade incentives to make legume cultivation and/or processing attractive. • Policies around GMO crops are relaxed.
<p>CITIZENS' PARADISE</p>	<ul style="list-style-type: none"> • Legume production happens in those places in the EU with most favourable environmental conditions. • Agronomy focuses on improving yield and protein quality, making use of pilots in a 'learning by doing' approach. • Companies invest in R&D on food and innovation. • Farmers make use of multi-cropping systems and use robotics and precision agriculture. • Knowledge production includes environmental impact assessment of legume cultivation. • Knowledge exchange is facilitated through partnerships between European countries. 	<ul style="list-style-type: none"> • A wide set of regulations is enforced to stimulate sustainable development. • Farmers can make use of subsidies and certification schemes if they deliver ecosystem services with their legume production. • The EU wide Farm to Fork Strategy is an important policy instrument to stimulate legumes for sustainable food production and consumption. • Farmers can make use of optional direct support schemes directed at legume cultivation.
<p>CONSUMERS' PARADISE</p>	<ul style="list-style-type: none"> • Farmers are very specialized. • Farmers make use of robotics and precision agriculture to increase yields and reduce costs while decreasing the use of manure, pesticides and water. • Agronomy makes use of economies of scale: production methods intensify and the average farm size increases. • Knowledge production is aimed at increasing yields and quality and reducing cultivation and processing costs. 	<ul style="list-style-type: none"> • There is a tax-reduction system in place for products that provide health benefits. • The EU and national governments put research and innovation agendas in place that focus on reducing costs of legume foods for consumers and achieving high yields. • On EU level, subsidies are available to speed up development of smart farming techniques.

The building blocks of the scenarios



MARKETS



VALUE CHAINS

	MARKETS	VALUE CHAINS
	<p>Markets vary widely in how much they are focused on local, regional, national, EU or even global levels. This is, of course, related to policy measures such as trade barriers and price guarantees.</p>	<p>In the value chains, concepts such as contracts and tracking/tracing systems are used for different goals in the various scenarios. There is also a variation in the extent to which legumes are used for feed or food.</p>
<p>TRIBAL PARADISE</p>	<ul style="list-style-type: none"> • Because national interests are put first, trade barriers are put into place and markets focus on self-sufficiency. • Fuelled by the desire to efficiently utilise Member States' own resources in a sustainable manner, there is a preference for plant-based protein versus animal protein, so price guarantees are put into place for legumes. • Because national interests are put first, local products are stimulated. • Consumer demand for GMO-free products increases, as well as willingness to pay more for sustainable food products. 	<ul style="list-style-type: none"> • Value chains are characterised by low economies of scale. • Tracking/tracing systems are put into place to gain insight into supply chain routes. • Value chains are characterised by oral/informal contracts between neighbours in order to exchange legume grain for another good, in a self-sufficient group. • Value chains are mostly dedicated to legumes for food with efficient information sharing between national stakeholders.
<p>MULTINATIONAL PARADISE</p>	<ul style="list-style-type: none"> • Markets are focused on maximisation of economic growth, stock markets are erected and there are price guarantees for legumes. • Countries compete with each other's legume markets. • There are cheap alternatives for plant protein supplies. • Coordination between actors in the EU value chain weakens, but competitiveness between EU countries increases. 	<ul style="list-style-type: none"> • The goal of value chains is to supply cheap products. • They offer tracking/tracing approaches to disclose supply chain routes and overcome the barrier of demand and supply uncertainty. • There is ample opportunity for feed proteins, since meat consumption remains high. • Multinationals use contracts to secure their legume-grain procurement and secure their relationship with farmers.
<p>CITIZENS' PARADISE</p>	<ul style="list-style-type: none"> • Consumers are stimulated to purchase locally produced, sustainable food products. • Meat prices are high and there is a tax on imported products. • Trade within the EU is unrestricted: there is a borderless EU. • Within the EU, campaigns are set up to increase consumer awareness about the benefits of legumes. • Market organisation within the EU is strengthened. 	<ul style="list-style-type: none"> • Value chains can be characterised as integrated sustainable food systems. • Tracking/tracing mechanisms are put in place to gain insight into the supply chain route. • Stakeholders use contracts to guarantee the traceability of the best environmental production practices and give insight into product quality.
<p>CONSUMERS' PARADISE</p>	<ul style="list-style-type: none"> • Consumers can buy cheap legume products, while producers can make use of free trade with no regulation within the EU. • The competitive disadvantage of legumes continues. • Limited processing facilities continue to exist. • Consumers are unwilling to pay higher prices for legume foods. • To protect the economic interest of Europe's livestock industry, the EU takes measures to limit import of soy. 	<ul style="list-style-type: none"> • Import of protein-rich feed as well as cheap products into the EU are limited to decrease dependence on import from the Americas. • Contracts are used by stakeholders in order to minimise their transaction cost and sell the products cheaper to consumers. • Value chains are focused on feed and autonomy at the farm level.

The stakeholders

How can stakeholders act or react in the transition to a future with more legume cultivation in the EU? We have worked this out for the three main stakeholders: public authorities, value chain partners and farmers.

1. Public authorities: economic stimulus for public interest

To stimulate resilience and protein independence, in every scenario, public authorities would be wise to encourage legume cultivation. It enhances agricultural competitiveness and is beneficial to the environment (clean air, soil and water, fewer inputs) and public health. In any scenario, this means taxing undesirable activities and/or stimulating desirable ones, such as innovation of plant-based proteins for food and stimulation of the consumer demand for them.

- In **Tribal Paradise**, the authorities focus on food protein, support the pioneers, promote circularity and reward ecosystem services. They may instigate price measures, such as a meat tax or import tax. Local authorities stimulate short supply chains
- In **Citizens' Paradise**, authorities promote ecosystem services through subsidies and certification. Production chains are influenced with Green Deals, and a meat tax can be imposed. Consumers are addressed with campaigns, and the Common Agricultural Policy focuses on green measures.
- In **Multinational Paradise**, the focus is on economic growth, with as few regulations as possible, but with some stimulating measures for legume cultivation.
- In **Consumers' Paradise**, the taxes on legumes are lowered to promote healthy food, and there are subsidies for smart farming. There is free trade within the EU, but import duties on legumes from outside.

2. Value chain partners: looking for market opportunities

The food industry's motto is often: we produce what consumers want. But they can also play a more proactive role in providing healthier and more sustainable food, even giving them a competitive advantage. They can conclude covenants with the authorities or long-term agreements with farmers.

- In **Tribal Paradise**, value chain partners can meet the large demand by encouraging farmers to produce protein crops. This creates a strong national GMO-free production chain with certification and trade restrictions.
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- In **Citizens' Paradise**, the focus is on R&D and innovation. Quality is secured by contracts and innovation occurs bottom-up. A clear perspective leads to integration in the value chain.
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- In **Multinational Paradise**, with its high meat consumption, the focus is on feed, grown on long-term contracts. There is a strong competition on pricing and production, in which GMOs play a role. Countries compete for the location of companies. Large companies take over successful start-ups.
- In **Consumers' Paradise** the production chain is also aimed at feed. There is free trade within Europe, and the focus is largely on healthy and affordable food.

The stakeholders

3. Farmers: looking for diversity and resilience

At present, legumes are aimed mainly at feed, so farmers will focus on that. On the other hand, they see the threats of climate change and social pressure to produce more sustainably. They will need to diversify.

If the market for plant protein food grows, they will meet this demand, which will also make them less dependent on world market prices.

- In **Tribal Paradise**, farmers will play into consumers' demand for local plant proteins. They will invest in knowledge, and incorporate rotation and diversification into their farm system. Farmers will cooperate to create more sales security.
- In **Citizens' Paradise**, farmers will follow the EU leading the protein transition. The focus is on mixed crops and developing new crop breeds. A sustainable production process gives them a competitive advantage.
- In **Multinational Paradise**, there is a strong agricultural lobby towards the authorities to make the country attractive for multinationals. A strong and cooperative sector is interesting for other value chain parties. The focus is on high production and protein quality (GMO), mainly for feed.
- In **Consumers' Paradise**, farmers invest in higher yield and quality, while lowering costs and inputs, with smart agriculture. Larger farms benefit from economies of scale.

Concluding remarks

In the scenarios described above, a protein transition is primarily driven by the interaction between authorities and food companies. This is in both of their interests: the authorities to promote sustainability and public health, the industry to create new, long-term stable markets. Their centralised decision-making structure makes this relatively easy. This is much more complicated for farmers as thousands of individuals all make their own decisions. However, if farmers see stable markets with sufficient earning potential, they will certainly be interested.



Appendix 1 – Main policies related to legume cultivation

CAP POLICIES

- Price support to soybean producers - 1974 Regulation (EEC) No 1900/74 of the Council of 15 July 1974
 - Price support to producers of pea, lupins and faba bean - 1978 Council Regulation (EEC) No 1119/78 of 22 May 1978
 - Uniform area support for producers of chickpea, lentils and vetch - 1989 Council Regulation (EEC) No 762/89 of 20 March 1989
 - Replacement of price support with uniform area payments - 1992 Council Regulation (EEC) No 1765/92 of 30 June 1992
 - Single Payment Scheme - 2003 Council Regulation (EC) No 1782/2003 of 29 September 2003
 - Agri- environmental schemes and Rural Development Programmes - 2005 Council Regulation (EC) No. 1698/2005 of 20 September 2005
 - Optional direct support schemes - 2009 Council Regulation (EC) No 73/2009 of 19 January 2009
 - Greening component, ecological focus areas - 2013 Regulation (EU) No. 1305/2013 and No. 1307/2013 of the European Parliament and of the Council of 17 December 2013
-

OTHER POLICIES

- Health Policies – European Food and Nutrition Action Plan, 2015 (World Health Organization and Regional Office for Europe, 2015)
 - Energy Policies – EU Directive 2003/30/EC
 - Environmental Policies - Natura 2000, EU's Nitrates Directive
 - Trade Policies - EU-Canada Comprehensive Economic and Trade Agreement -CETA), 2016
-

Appendix 2 – Drivers and barriers for legume markets in Europe

	DRIVERS	BARRIERS
SUPPLY	<ul style="list-style-type: none"> • Policy measures (e.g. Ecological Focus Areas, crop rotation diversification programmes) • Large farm size • Legumes network (e.g. DemoNetErBo) • Agronomic (breaking pest cycles, soil fertility, ...) • Contracts farming along the value chains • Strong coordination between actors in value chains 	<ul style="list-style-type: none"> • Less breeding progress in the past • Yield stability • Lack of market organisation • Diseases and pests • Restriction in some policy measures • Subsidising legume cultivation • Low producer prices • Lack of competitiveness regarding imports • Lack of knowledge about potential end uses • Lack of value for the delivery of ecosystem services • Lack of coordination between actors in value chains
DEMAND	<ul style="list-style-type: none"> • GMO-free • Gluten free • Higher protein content • Consumption as meat alternative • Food services • Protected Designation of Origin (PDO) (to guarantee originality and quality) • Regionality (local food) • Increasing demand of the food industries • Well-adapted for organic farming • Lower phosphorus content 	<ul style="list-style-type: none"> • Substitutes (e.g. imported soybeans) • High prices/willingness to pay (for food) • Acceptance in compound feed • Quality (post-harvest treatment) • Variation of protein content • Suboptimal storage capacity for legumes • Plant pest • No guarantee of constant availability • Lack of public awareness of the benefits of legumes • Market segmentation (missing link between production and use) • Limited processing facilities

About LegValue



LegValue is a participatory project around the pulse and legume industry in Europe. Its objectives: greater EU self-sufficiency in vegetable protein production, more opportunities for innovation, more value in the value chains, and change at commercial, research or policy level. This should also deliver social and environmental benefits.

During the project, stakeholders cooperate in an open access network and European stakeholder directory. The project consortium consists of 24 research and industry partners and will study a wide range of value chains, producer networks, processors and markets. This will be combined with environmental studies and the impacts of policy propositions, ultimately outlining and recommending opportunities to influence pathways for change all along the supply chain.

Consortium Members

- Association de coordination technique pour l'industrie agro-alimentaire
- RSK ADAS Limited
- Aicf Agro Inovação
- Chambre d'agriculture de Normandie
- Stichting Wageningen Research
- Fachhochschule Südwestfalen
- Forschungsinstitut für biologischen Landbau Stiftung
- Instituto Nacional de Investigação Agrária e Veterinária
- Institut für Lebensmittel- und Umweltforschung e.V.
- Institut national de la recherche agronomique
- INRAE Transfert
- Lietuvos Agrarinis Ir Misku Mokslu Centras
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