Fostering sustainable legume-based farming systems and agri-feed and food chains in the EU

Deliverable D5.2

Scenarios for legume value chain development across Europe

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Preface

The H2020 project of LegValue contributes to increase the use of legumes in European farming systems for both food and feed value chains. In Deliverable 5.1 we have described both opportunities and barriers for developing legume value chains in the EU. Interventions are required that can effectively bring around a future of legume-based farming systems in Europe, but the effect of interventions is to a large extent determined by the circumstances [1]. One can think of factors related to infrastructure, markets, values, policy, knowledge, and co-operation. As it is hard to predict the future, it is important to explore diverging visions of the future – or future scenario's – and assess how possible interventions would fail or would be successful. The interventions that appear to be most robust should have preference over interventions that are very sensitive to future developments. This report explores the future in two dimensions resulting in four diverging visions of the future and aims to contribute to developing and choosing effective interventions that support more legumes in EU farming systems.

This deliverable is part of work package 5 of the H2020 project LegValue which is aiming to develop transition pathways for scaling out legume-based farming systems in the EU. Important domains that develop knowledge about opportunities and barriers that can influence failure or success of legume-based interventions, are addressed in work packages 1 (production), 2 (value chains), 3 (markets) and 4 (policies). Thus, information from these domains are important inputs for work package 5 and specifically for this report while vice versa this exercise can provide assistance in developing successful interventions.

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Summary

In order to reduce its dependency on legume imports (mainly soya bean), which poses a risk for EU livestock production, the European Union wants to promote the development of legume production chains in the EU. The goal of the analysis discussed in this report is to identify a robust package of interventions that, when applied as a strategy, can be used to promote the development of legume value chains under different future conditions. This analysis is to be used as input for the workshop to be held in Roskilde in March 2018. In a scenario analysis using two dimensions – one on economics and one on EU cohesion – we defined four very different scenario's, or Visions of the Future. We characterise these on three levels: firstly, on a societal level using STEEP methodology, secondly, on the level of the agro-food system, and thirdly, specifically on legumes for food and feed application. We analysed a variety of optional interventions for the promotion of legume value chains for robustness under the different visions of the future. The exploration described in this report leads to the conclusion that knowledge interventions are the most robust as a strategy implemented to promote the development of legume value chains in the European Union, taking the very different visions of the future into account. It is however also important to realise that in real life implementation of innovations, conditions will not vary as much as they do in the visions characterised in this report, and that the act of doing an exploration of possible interventions is an important part of finding a suitable strategy.

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1. Introduction

The current situation that 70 % to 75 % of the compounds used for European animal feed -mainly soya bean- are imported, is considered undesirable. In part, this is because of the negative environmental and ecological consequences, such as deforestation, that are associated with the expected increase in animal protein demand due to world population growth and increased income per capita. Another reason is that the EU dependency on legume import results in higher risks and uncertainty for the European livestock. Therefore, the development of legume value chains in the EU is to be promoted, to which end interventions are required. As the effect of many interventions is to a large degree dependent on the prevailing conditions [1], it is important to identify a robust set of interventions, meaning that these remain effective under different future conditions. Therefore, after first having described developments that can influence European legume value chains in the previous report, the goal of the current report is help identify a strategy consisting of several robust interventions that can be used to promote the development of legume value chains under different future conditions. In order to facilitate this, and after an explanation of the methodology in Chapter 2, four diverging visions of the future are created in Chapter 3.1, and these are further described and characterised in Chapters 3.2 and 3.3, using three levels: that of general society, the agro-food system, and the role of legumes. Optional interventions are described and analysed for their robustness in Chapters 3.4 and 0, leading to the concluding remarks in Chapter 4. The information in this report is used as input for the workshop to be held in Roskilde in March 2018.

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2. Methodology

2.1. The role of scenario studies

In this study we will use a scenario analysis to explore the potential role of legumes in future agro-food systems. A common misunderstanding about scenarios is that they represent predictions of the future. This is rarely the case, and most scenario analyses should instead be considered as explorations of the future. They explore what kind of situations might develop under the assumptions of certain macro-circumstances, e.g. the assumption that economic growth is either low or high; or that societal and political emphasis on sustainability is either low or high.

A scenario analysis often develops a small number - usually two to four - of scenarios. Quite common is to define two main driving forces, such as economic growth and attention for sustainability, assuming each to be either be low or high. This defines a matrix with four cells, for each of which a scenario can be developed. This is the approach that is applied in the analysis in this report.

2.2. Various scenario methods

There are a variety of methods to actually develop scenarios and especially for the domain of energy they have a long history. Historically, the most common type of scenario focused on technical innovation, e.g. analysing what the energy system may look like in the future. For decades, various energy companies, research organisations, and international bodies such as the International Energy Agency/Organisation for Economic Co-operation and Development, and the World Energy Council, have developed energy scenarios to help assess potential strategies [2, 3]. Although these types of scenario exercises provide clues about the possible nature of future (energy) systems they do not offer much insight in how paths towards these futures may unfold.

Backcasting projects have a stronger focus on the co-evolution of technology and society by describing desirable futures [4]. Changes in actor networks and shifts such as those from a product to a service economy - implying also cultural changes - are commonly part of the descriptions of these futures. Interactivity is also key to these methods, with stakeholders participating in the development of scenarios, such as to create a shared vision regarding the future. More limited in these methods is attention for the way transition towards these visionary futures may occur.

Sociotechnical scenarios (STSc) take up these challenges by addressing the way transition paths may unfold in a process of interaction between a range of actors and the rules they act upon: technical, regulatory, forms of provision, cost models, infrastructure requirements, etc [5]. In this way sociotechnical scenarios can complement other scenario methods and be used as a reflexive tool for transition policy. An important starting point is that it is not technological change that predominantly induces a transition in a socio-technical system but more the way various actors organise, use, and deal with technologies and develop expectations regarding their potential and the way to realise these. Changes in the way actors perceive and organise technologies occur because our society as a whole is changing, e.g. the increasing awareness in society and politics that agriculture has to be made more sustainable.

2.3. Approach used in this study

For the domain of agriculture, scenario analyses are frequently performed by institutes like FAO and IIASA [6, 7]. A changing role of legumes for food and feed in a future society will require a range of

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changes. It will not just be a matter of replacing one type of crop by another but it will require new eating and feeding habits, new feed processing methods, new trade relations, possibly new industries, new policies, etc. To acknowledge and explore this we need to use a scenario method that addresses a socio-technical dynamic, rather than one that focusses on a technical substitution and/or economic dynamic. Therefore we will use a socio-technical scenario method as discussed in the previous section.

2.4. Scenario development approach

To identify the two dimensions or driving forces, we had initially identified in a brainstorm:

- Strong focus on sustainability vs. Strong focus on maximising profit (and no focus on sustainability)
- Nationalism, local economy, trade barriers vs. Liberalism, global economy, free trade.

These dimensions were discussed with various LegValue partners at a meeting prior to the October 2017 workshop and used as such during the workshop; see Annex. We used the results from the workshop as a starting point for writing this report. We found that we could not simply take the workshop results as, by nature, these contained various 'ripe' and 'not so ripe' ideas, and more importantly, ideas that at closer inspection were inconsistent with one of the dimensions for a scenario. These considerations eventually led to the Visions of the Future, as we call scenarios in this report, that are described in the next chapter.

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3. Results

3.1. Defining the Visions of the Future

Similarly to the workshop held on 9 October 2017 (summary in Annex), we have defined four visions of the future'[1] using two dimensions. These dimensions are: firstly, Inclusive growth vs Reaganomics; secondly: Nationalism in EU vs. Integrated EU. The defining terms for the different extremes of the dimensions are mentioned in Table 1.

Table 1. Dimensions used for defining Visions of the Future

Economic Dimension		
Inclusive growth • Focus on environmental quality, social protection • Circular use of resources • High degree of regulation by government	vs	Reagonomics: • Focus on hard capitalism • Linear use of resources • "Laissez faire" attitude from government
EU cohesion Dimension		
Nationalism in EU • Focus on national and regional interests • National government more powerful than EU • Trade barriers	vs	Integrated EU • Focus on EU interests • Completely unified EU, no internal borders • Free trade

The resulting visions of the future are depicted in Figure 1. To facilitate discussion, the vision (1) that combines Nationalism and Inclusive Growth will be referred to as "Tribal Paradise". Combining Nationalism and Reaganomics results in the vision (2) referred to as "Multinational's Paradise". When Inclusive Growth and Integrated EU are combined, the resulting vision (3) is referred to as "Citizen's Paradise", while the combination of Integrated EU and Reaganomics results in the vision (4) to be referred to as "Consumer's Paradise".

[1] For this we use the term 'vision of the future' rather than 'scenario' in this report. In the STSc method, the term scenario is used to describe the socio-technical developments that lead from the present towards this vision. The scenario thus describes a development pathway while the vision describes the outcome of this pathway.

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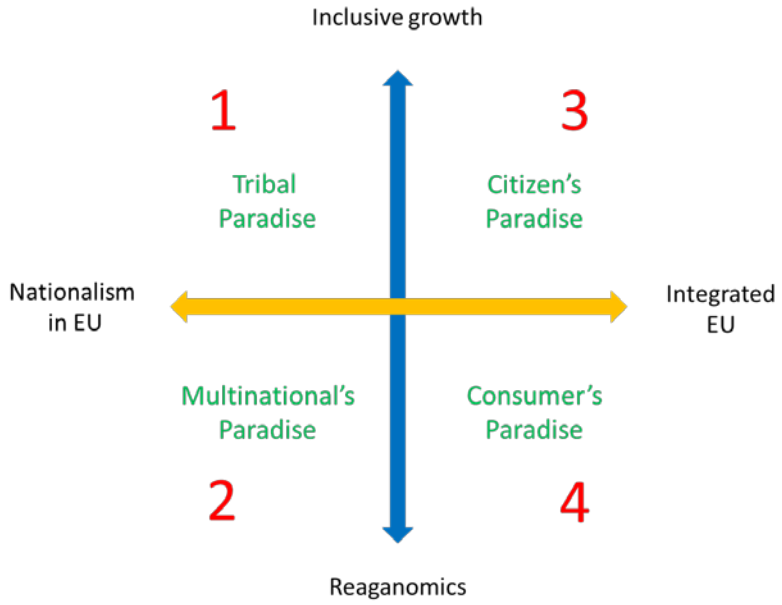

Figure 1. Four visions of the future resulting from two dimensions

3.2. Description of Visions of the Future

Below, we elaborate on the description of the four visions of the future that are defined in the previous chapter. For each of these visions, we address the following three levels:

1. A general characterisation of society
2. The agro-food system, such that is consistent with the general societal characteristics;
3. The role of legumes, such that it is consistent with the two previous aspects.

Concerning the general characterisation of society, we use the STEEP methodology This methodology was initially defined as a business strategy tool to characterise the environment in which a business operates.[2] We use it here as it is also very useful to characterise a socio-technical system like agriculture for which a scenario is to be developed. STEEP stands for Social/cultural, Technological, Economic, Environmental, and Political aspects. For the description of the agro-food system, we use a variety of terms, ranging from agricultural scale, and meat prices, to usage of pesticides and GMO. In describing the role of legumes, we focus on legume production for food – bulk and specialised – as well as bulk production of feed legumes.

Vision of the future 1: Tribal Paradise

General characterisation of society

The Tribal Paradise vision is defined by the dimensions Nationalism in EU and Inclusive Growth. In this vision, countries focus on national interest and emphasise sustainability to protect the environment, as people do in a tribe. Hence this scenario is called this a 'Tribal Paradise'.

[2] See e.g. http://pestleanalysis.com/what-is-steep-analysis/

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In this vision, societies have clear and well protected borders and are maximally self-sufficient. Wishes and needs of all members are taken into consideration when developing, including ecological and environmental issues. In a society in the Tribal vision, biodiversity and circular use of resources are very important, and these goals have resulted in related legislation.

The focus on nationalism implies that national and even local production are favoured. Import duties make foreign products expensive, leading to lower international trade. The focus on inclusive growth implies that there is a large emphasis on protecting the environment and clean & sustainable production, with circular use of resources, which resulted in little growth of GDP. Light duty vehicles largely run on clean fuels but for heavy duty (trucks and ships) this is difficult to realise and they still largely run on diesel. Everything that pollutes is heavily taxed, including fossil fuels, which makes air transport expensive.

The agro-food system

Agriculture focusses on national and regional sustenance, both social and environmentally, as well as economically. There is a strong focus on animal welfare and soil quality. This results in nationally and regionally oriented circular systems. To achieve some economies of scale, there will be a limited increase in farm sizes, mostly in present small scale farming countries. Non-GMO farming is the norm, with a high degree of rotation and only the bare minimal use of chemical pesticides.

Import and export of agricultural products is limited by trade barriers. Food and feed prices are high due to (high) production costs related to sustainability. Especially meat is expensive to account for inefficient nutrient use, leading to less consumption of meat. Remaining animal protein production does ensure a high degree of animal welfare. Imported products will be very expensive due to import barriers and possibly also due to high cost of non-sustainable freight transport.

The role of legumes

The emphasis on national self-reliance and a low meat consumption stimulate the national production of legumes to provide protein to the human diet. Other plant protein sources also exist, but because legumes are preferably produced because of their low fertiliser requirement. As legumes are an important part of the diet, a considerable variety of legume crops exists, but the number remains limited as national self-reliance makes it difficult to reach advantageous economies of scale. Bulk production for food takes places using a small number of varieties, while specialised food legume production takes place in smaller but considerable volumes, related to the emphasis on quality of life. Production of feed legumes is quite low compared to that for food, as meat consumption is substantially low. Any production of feed legumes that takes place is of a bulk variety.

Feed demand that is not met through national production, is met through import, mostly from other EU countries, as some European integration still exists and higher trade barriers exists for countries outside the EU than within the EU. Also, long distance transport is considered less sustainable.

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Vision of the future 2: Multinational's Paradise

General characterisation of society

The Multinational's Paradise vision is defined by the dimensions Nationalism in EU and Reaganomics. In this vision, national governments aim for national interests and maximal economic growth, with little attention for sustainability issues, and intervening very little in economic affairs. Economic legislation is aimed at facilitating companies. This situation is very favourable for multinationals, as virtually no barriers to production exists and countries are competing (e.g. through tax benefits) to get multinationals to create production facilities on their territory. Hence, this scenario describes a 'Multinational's Paradise'.

Because of trade barriers, many multinationals have facilities in a large number of countries, leading to some loss of production efficiency (less economies of scale). Economic growth is substantial but still somewhat limited because of limited economies of scale. On the one hand international trade in goods that are produced within the country is limited due to of trade barriers, while on the other hand people still buy other goods from elsewhere. Low taxation of transport fuels leads to no evident limitation of national transport. Environmental regulation is not very strong, leading to decreased biodiversity and continued pollution. GHG emissions go up, as they are considered an international issue and are poorly regulated.

The agro-food system

Under 'Reaganomics' conditions, agriculture focusses on supplying cheap products while the emphasis on nationalism favours locally produced food and feed. Soil quality receives considerable attention to facilitate a sufficient degree of national self-sustenance. Limited government regulation provides room for high levels of pesticide and GMO use and low production costs of agricultural produce. Farm sizes increase to achieve economies of scale. Feed prices are relatively low, although further decrease is limited due to the though not as low as in an 'open world'. Attention for animal welfare is low, leading to relatively low meat prices and in turn to high meat consumption. National self-sustenance is less than in the 'tribal' scenario because import / export is somewhat higher (despite trade barriers) due to lower production prices in other parts of the world.

The role of legumes

In the 'Multinational's Paradise' vision, opportunities exist for both feed as well as food legumes, but the extent does depend on which of the dimensions takes the upper hand: self-sustenance or low cost food/feed production. Strong price competition from overseas exists, despite trade barriers. The total volume of food legumes is rather low as there are many cheap plant food alternatives (partially GMO) while feed legume production is relatively high due to the high meat consumption. Also, as ecosystems services are absent, these do not promote legume value chain development.

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Vision of the future 3: Citizen's Paradise

General characterisation of society

The Citizen's Paradise vision is defined by the dimensions Integrated EU and Inclusive Growth. Within the EU, borders play virtually no role, and wishes and needs of all citizens are considered, as well as ecological and environmental issues. Citizens value quality of life in a clean environment, more than cheap products. Government intervention in the economy is common. Resource use is circular, and enforced by legislation. Generally speaking, policies serve citizens and are decided upon by citizens. Hence, this scenario describes a 'Citizen's Paradise'.

Economic growth is slow, possibly even negative. Regulation targets sustainability in the broad sense, implying that there are high taxes on polluting and GHG emitting activities. Road transport is cleaner but ships still largely rely on diesel, which leads to higher taxes on transport over water. There is a high degree of sustainable production. There are no trade barriers within the EU, but goods produced in the EU are favoured, mostly for sustainability reasons.

The agro-food system

Agriculture in the Citizen's Paradise society is socially responsible, and highly environmentally sustainable. Agriculture is entirely made up from circular systems that may span several or all EU countries. Animal welfare and soil health have a high priority, only non-GM crops are grown, and chemical pesticide use is kept at a minimum. Value chains are long. There is a considerable degree of trade of food products, although largely within Europe due to the high taxation of (water) transport fuels. National self-sustenance therefore is low while European self-sustenance is high. Meat prices are very high as this is considered a very inefficient way of producing necessary proteins. Plant based protein is cheaper that meat protein, but animal feed is cheap as well because low trade barriers facilitate economies of scale, implying that farm size increases significantly.

The role of legumes

As inclusive growth is important, meat consumption and animal protein production will be low, and plant protein production will be high. Legumes are a prevalent source of plant protein in food, resulting from the low amount of fertiliser needed to grow legumes. The remaining animal feed protein production will depend, to a large extend, on legumes as well. Legumes are produced in the EU countries where the climate and other circumstances are most favourable and are then distributed across the EU. Since meat consumption is low, so is the production volume of feed legumes. Because of the emphasis on quality of life, legumes are not only produced for bulk food application, but also specialised legume food crops are grown.

Vision of the future 4: Consumer's Paradise

General characterisation of society

The Consumer's Paradise vision is defined by the dimensions Integrated EU and Reaganomics. This vision features a considerable degree of EU internal cooperation and a strong focus on economic growth with relatively little attention for environmental and climate change issues. The main goal is

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to produce goods for consumers as cheaply as possible. Hence, this scenario describes a 'Consumer's Paradise'.

Free trade is the norm, and there is minimal regulation by government, in order to enhance business competitiveness. International trade flourishes since there are no trade barriers. This is There is a lot of import and export, also stimulated by low transport costs. Resource use is linear, meaning, amongst other things, that energy sources are mostly fossil based. GDP growth is substantial. Pollution levels and GHG emissions are high, while biodiversity decreases, as this is not a point of focus.

The agro-food system

Agriculture's main objective in the 'Consumer's Paradise' vision of the future is to produce as cheaply as possible, resulting in large specialised farming to achieve economies of scale. As a result, food prices are low, for plant as well as animal products, also because animal welfare has a low priority. Meat consumption is high (also booming in developing economies) creating a huge demand for feed. Due to economies of scale, feed prices are low. Both food and feed are produced where it is the cheapest and because transportation costs are low, international trade of food products is high, also from outside of Europe. Especially feed consists mostly of bulk materials that are produced in large quantities in countries like the US and Brazil. Agricultural production in Europe is mostly for food. Attention for soil quality is low as technological developments like GMO and precision nutrient supply are tweaked to make plants grow in poor soil. Use of pesticides is common.

The role of legumes

As feed protein (mostly soya bean) comes exclusively from outside of Europe, there is little feed legume production in the EU. For food, due to the high economic growth there may be a demand for highly specialised legumes, but this will only be produced in the EU if a reasonable economies of scale can be reached, producing for the whole of Europe.

3.3. Summarised characterisation of Visions of the Future

In Tables 2, 3, and 4, the characterisations above are summarised. The meaning of the – and + in the tables varies somewhat, sometimes indicating a low or high volume, sometimes a decrease or increase compared to the present situation. This slight variation of meaning should not be a problem, since it is not the absolute value of these indicators that is of relevance for the analysis, but the variation across the different visions. These contrasts will form the basis for the further analysis.

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Table 2. General characterisation of society for the four visions of the future

	1. Tribal Paradise	2. Multinational's Paradise	3. Citizen's Paradise	4. Consumer's Paradise
Economic				
Growth GDP	0	+	-	++
International trade	-	0	+	++
Cost of freight transport	+	--	+	--
Socio/cultural				
Materialism/ consumerism	-	+	--	+
(International) solidarity	-	-	+	-
Technological				
Clean production and clean energy	+	0	+	-
Clean freight transport	0	-	+	--
Environmental				
Pollution	-	0	--	+
GHG emissions	-	+	-	++
Biodiversity	+	-	+	++
Political				
Environmental regulation	++	+	++	0
GHG regulation	+	0	+	0
Import duties	+	+	-	-

0 = little or no influence; - = negative influence; + = positive influence; -- and ++ are used to distinguish from - and + in the same row.

Table 3. The agro-food system in the four visions

Agro-food	1. Tribal Paradise	2. Multinational's Paradise	3. Citizen's Paradise	4. Consumer's Paradise
Scale increase of agriculture	0	+	++	++
Pesticide use	-	+	-	+
GMO use	-	+	-	+
Soil health	++	+	++	0
Animal welfare	+	-	+	--
Plant food prices	+	-	0	--
Meat prices	+	-	+	--
Feed prices	+	-	0	--
National self-sustenance	++	+	-	--
Import/export volume	-	0	+	++

0 = little or no change; - = decrease; + = increase; -- and ++ are used to distinguish from - and + in the same row.

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Table 4. The role of legumes in EU agriculture in the four visions

Legumes	1. Tribal Paradise	2. Multinationals Paradise	3. Citizens Paradise	4. Consumers Paradise
Food				
Production volume bulk	+	+	++	0
Production volume specialised	++	0	++	+
Feed				
Production volume bulk	++	++	+	0

0 = little or no production; + = substantial production; ++ is used to distinguish from + in the same row.

3.4. Optional interventions to promote the development of legume value chains

A variety of options exist that can be used to promote the development of legume value chains in the EU. A summarised list of optional interventions can be found in Table 5, which can be used to evaluate the robustness of possible interventions.

Policy interventions

Somewhat by definition, visions of the future that encompass a Reaganomics-dimension, in other words the Multinational's and Consumer's Paradise, are less likely to have Policy interventions applied. That said, if the reason is important enough, even a government that usually exhibits a 'laissez faire' attitude, may still apply interventions. Optional interventions are described below.

Deal government-private sector: reducing risk

The government can remove part of the financial risk that companies take when entering the market, or when introducing a new product. Specifically in a Consumer's Paradise, deals between government and the private sector may be difficult. As there is no common interest, companies may not honour agreements if this would lead to, for example, cheaper production.

Ecosystems services pricing

This type of intervention can be compared to the Greening policy that is part of the EU Common Agricultural Policy (CAP) since 2013 [8]. This policy aims to promote environmentally friendly farming by connecting it to the direct payments system (see Legvalue report 5.1). This intervention is likely to work in Tribal and especially in a Citizen's Paradise, but not in the two visions of the future that encompass Reaganomics, as no value is put on sustainability.

Price regulation on legumes

Guaranteeing legume producers a minimum price for their product can be used for promoting production. This can be seen to work in a Tribal and Multinational's Paradise, but not in a Citizen's

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and Consumer's Paradise, as in the latter two the open borders would mean that products would simply be imported from EU countries without the price regulation.

Trade barriers to improve competitiveness

Trade barriers can be used to protect national producers. In short, they make products from abroad more expensive, hereby improving the competitiveness of national producers. Trade barriers are obviously not consistent with the open borders in the Citizen's and Consumer's Paradise, and can only be successfully applied in the a Tribal and Multinational's Paradise.

Tax on transport

A transport tax would the most effect on developing legume value chains in the Citizen's Paradise, as borders are open, but people generally want sustainable production, in which less transport would be positive. In the Tribal Paradise, production is already very local, so transport would already be minimal, leaving little effect for transport tax. In the more Reaganomics oriented visions of the future, the likelihood of this intervention being applied is very small, as it is not consistent with the visions.

Market interventions

Price guarantees: bridging a quality gap

A company buying from a producer can agree to pay a certain price even though the desired quality is not yet reached, to ensure that the producer is able to improve the product. This type of intervention would have a positive effect in the two more nationalistic visions, but in a Consumer's Paradise, cheaper production would be more important than high quality, negating such an approach.

Stimulate home products

This can be seen as an example of normative control. For example: advertising campaigns, deals between companies and NGO's, interest groups, et cetera. Government is not necessarily involved. This type of intervention would be most effective in the Inclusive Growth visions. Probably most so in Tribal, as in Citizen's Paradise, the focus is less on regional production. If however home production could be presented as more sustainable, this intervention could also have a noticeable effect in Citizen's Paradise.

Set up a legume stock market

This intervention is comparable to the already existing EU stock market for onions. In the US, a soy stock market exists, supporting a large number of small transactions. So far, the legume market in EU seems small in volume on the one hand and, on the other hand, consisting of relatively large transactions. This means that resulting data are not reliable enough to a dependable stock market.

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But in principle, it could be set up with support of different organisations or companies. A functioning legume stock market would have a positive effect on increasing legume production in Multinational's and Consumer's Paradise, as these societies are focused on lowering costs. In a Tribal Paradise, society would likely be too locally oriented for a stock exchange to work, and in a Citizen's Paradise, a legume stock market could function, but as society focusses more on inclusive growth than on cheap production, the effect would likely be limited.

Knowledge interventions

Improving yield and quality

Legume yield and quality may be improved by breeding, but also through other means. For example, it may be that a bacterium is developed that can fixate more N_2 in root nodules of legumes. Interventions focussing on scientifically improving legumes could be successful in the Inclusive Growth visions of the future, and probably also to some extent in the Multinational's Paradise. We estimate that in the Consumer's Paradise, needed investments for long term results will be difficult to acquire, as the focus is on cheap production.

Pilots in practice: learning by doing

Governments, companies, or interest groups can promote practical research on pilot scale, in order to facilitate introduction of innovations, as well as their chance of success. Interventions focussing on facilitating pilot scale practical research could be successful in the Inclusive Growth visions of the future, and probably also to some extent in the Multinational's Paradise. We estimate that in the Consumer's Paradise, needed investments for pilot plants will be difficult to acquire, as the focus is on cheap production.

Knowledge dissemination

This intervention would most likely be a positive influence in all visions of the future, probably somewhat more so in the Inclusive Growth visions, because of society's interest in quality, a wider concept when compared to cheaper production alone.

R&D investments on food innovation

We estimate that in the Tribal and Citizen's Paradise, this intervention has a large probability of success in promoting more legumes in farming systems. In order for R&D investments on legume food innovation to occur, several matters need to be in place, such as an interest in vegetarian food and sustainability, as well as less focus on the cheapest production of protein.

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Technical interventions

Genetic modification

Acceptance and/or promotion of GM techniques in breeding would have a positive influence on the inclusion of legumes in EU farming systems in the Multinational's and Consumer's Paradise, as these societies would focus strongly on cheaper production. Executing this intervention in a Tribal and Citizen's Paradise would not be likely, as GM would to a large extent be associated with non-sustainability in these visions of the future.

Tracking/tracing: supply chain route

Improving transparency of the supply chain route would be an intervention with a positive influence in all vision of the future, except the Consumer's Paradise with people simply interested in cheap production and do not caring greatly about the supply chain. The positive effect would likely be greatest in the Citizen's Paradise, as transparency of the supply chain can be seen as important when valuing sustainability and open borders.

Multi-cropping

This intervention is a way to improve sustainability of production. It is therefore more likely to be successful in the Tribal and Citizen's Paradise, compared to the Multinational's and Consumer's Paradise, where there is no interest in sustainability.

Robotics & precision agriculture

As further development of robotics and precision agriculture can lead to more sustainable legume production, this intervention has the highest likelihood of success in the Citizen's Paradise, and because of the potential cost savings also in the Consumer's Paradise.

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Table 5. Optional interventions and their expected success

Intervention	1. Tribal Paradise	2. Multinational's Paradise	3. Citizen's Paradise	4. Consumer's Paradise
Policy				
Deal government-private sector: reducing risk	+	+/-	+	-
Ecosystems services pricing	+	-	++	-
Price regulation on legumes	++	+	-	-
Trade barriers to improve competitiveness	+	0	-	0
Tax on transport	-	0	+	0
Market intervention				
Price guarantees: bridging a quality gap	+	+	-	-
Stimulate home products	++	-	+	-
Set up a stock market	-	+	-	+
Knowledge				
Improving yield and quality	++	+	++	0
Promote pilots: learning by doing	++	+	++	0
Knowledge dissemination	++	+	++	+
R&D investments on food innovation	+	-	+	-
Technical				
Genetic modification	0	+	0	+
Tracking/tracing: supply chain route	+	+	++	-
Multi-cropping	+	-	+	-
Robotics & precision agriculture	-	-	++	+

0 = very unlikely to be applied because not consistent with vision; - = little or no expected success; + = expected success; ++ is used to distinguish from + in the same row.

3.5. Analysis of interventions and discussion

Looking at Table 5, interventions in the area of knowledge acquisition and dissemination seem to be the most robust in promoting the development of EU legume value chains, under possibly changing future conditions, possibly in combination with 'Track & Trace' and 'Deals between Government and private sector to reduce risk'.

Focussing briefly on the current political status EU and on the issue of change, it could be stated that recent political events in the EU, such as the election of Macron in France and the re-election of Merkel in Germany, seem to indicate that – in the language used in this report – a movement from

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Reaganomics combined with Integrated EU (Consumer's Paradise) towards the more Inclusive Growth combined with Integrated EU (Citizen's Paradise), instead of towards the combination of Nationalism combined with Reaganomics (Multinational's Paradise). Although there is a risk of oversimplification, this would be a positive sign for developing EU legume value chains.

When analysing optional interventions, it is wise to realise that policy interventions can be sensitive. What we mean by this is that when a goal requires a policy change, it is good to take into account what the general policy is, so that a small change can be promoted. It would be likely be all but impossible to get a policy change implemented if said change contradicts the general policy or political situation.

As a side note, the authors want to point out recent trends in the production of meat replacement food products that use legumes as a protein source, see report Deliverable 5.1: "Developments that can influence European legume value chains". It seems that this – meaning using niches in the food market – is a way to explore and learn how to best apply innovations.

It may come as no surprise that knowledge interventions seem to be the most robust, as this type of intervention does not contradict with the defining dimensions of the vision of the future. We certainly do not want to claim that only knowledge interventions can promote development of legume value chains in the EU. What the type of exploration as performed for this report can do, is to raise awareness on the issue that a best fitting strategy needs to be found to get an innovation implemented. In this way, it is not the final result of this study that is the most valuable, but the process used to reach the result.

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4. Conclusion

The exploration of very different visions of the future in this report leads to the conclusion that generally speaking, knowledge interventions are the most robust as a strategy implemented to promote the development of legume value chains in the European Union. It is however also important to realise that in real life implementation of innovations, conditions will not vary as much as they do in the applied visions, and that the act of doing such an exploration of possible interventions is an important part of finding a suitable strategy.

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Partners involved in the work

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- H.B. Schoorlemmer
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Annex : Summary of Workshop LegValue Task 9 October 2017

General information on workshop

Date: Monday, 9 October 2017
Place: Amsterdam-Schiphol (World Trade Centre)
Participants:

1. Frédéric Muel (Terres Inovia)
2. Francesco Galioto (Unibo)
3. Nathalie Blosseville (Terres Univia)
4. Marcus Mergenthaler (FH-SWF)
5. Stephane Douabin (Valorex)
6. Roger Vickers (PGRO)
7. Inger Bertelsen (Seges)
8. Zydre Kadziul (LMMC)
9. Maarten Kootstra (Wageningen Research)
10. Boelie Elzen (Wageningen Research)
11. Herman Schoorlemmer (Wageningen Research)

Methodology of exercise

The workshop participants expressed ideas on how the world might look in different visions in 2040. Participants commented on four visions, resulting from two driving forces that were chosen and discussed by the participants. These driving forces are:

- Strong focus on sustainability vs. Strong focus on maximising profit (and no focus on sustainability)
- Nationalism, local economy, trade barriers vs. Liberalism, global economy, free trade

When combining the two driving forces, four visions emerge, as illustrated in Figure 2.

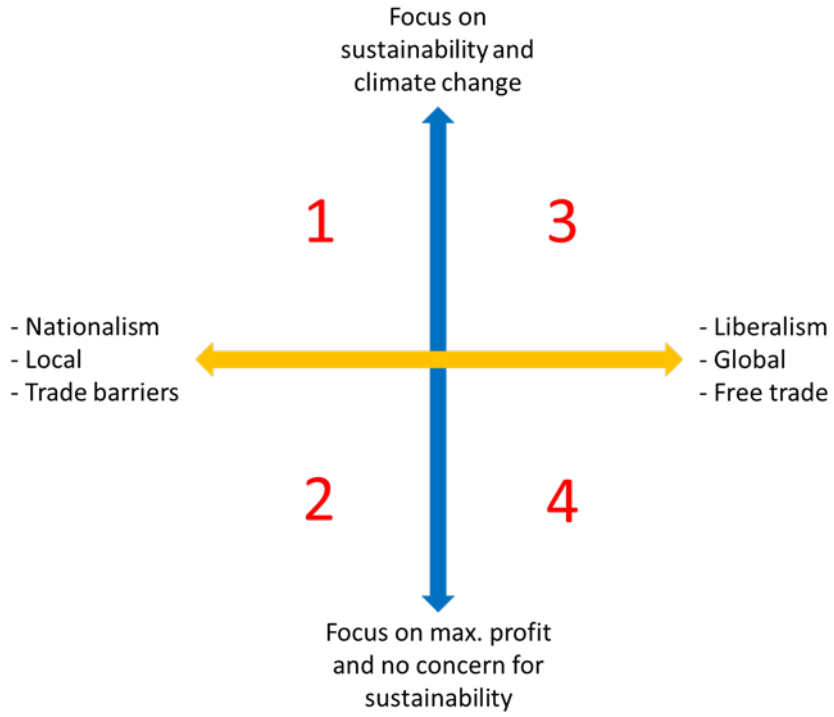

Figure 2. The driving forces and resulting visions used in the workshop exercise

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Ideas were expressed for three levels: 1. The world in general, 2. EU agro-food, and 3. Legume value chains. Different views and comments were shared and noted down. The results of this exercise can be found in Tables 1 to 3.

1. What does the world look like?
2. What does the agro-food sector look like?
3. What do legume based value chains look like?

It is assumed that economic growth takes place in all four visions. The resulting visions were discussed with all participants, and are outlined in the result section.

Results

Views of workshop participants for different visions

Table 6. Workshop participants views on the world, under the different visions

WORLD	
1 • High focus on sustainability and climate change • Nationalism, Local, Trade barriers	**3** • High focus on sustainability and climate change • Liberalism, Global, Free trade
Strong regions Bilateral contracts (complex) on nature climate issues Local production: buy own produce Less multinationals Strong regulation for production Weak EU Circular economy Reduced diversity (less imports) French bananas Climate/nature part of value proposition Ecological services -> new organisations Feed/food discussion	High/over-population Resources – more cyclic Income – Equalisation? Global warming: ≤ present (25 yr timeframe) - Stabilisation of land use Potentially slower industry consolidation Requires stronger political intervention in sustainability issues. - Counter-intuitive in regard to Liberalism, Global/Free trade
2 • Focus on max. profit and no concern for sustainability • Nationalism, Local, Trade barriers	**4** • Focus on max. profit and no concern for sustainability • Liberalism, Global, Free trade
Bilateral contracts focussed on companies Competition, differences winners/losers Diversity if you have money Decentralised multinationals Hedonistic/materialistic value proposition	High/over-population Resource hunger (for fuel, water, land, and minerals) Income disparity: more than today Global warming: ≥ present (25 yr timeframe) - Land use change Concentration of industrial and economic power Lower cost prices/Race to the bottom

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Table 7. Workshop participants views on EU Agri-Food, under the different visions

EU Agri-Food	
1 • High focus on sustainability and climate change • Nationalism, Local, Trade barriers	**3** • High focus on sustainability and climate change • Liberalism, Global, Free trade
Lots of brands with local/environment Breeding for local adaptation of crops CO_2-neutral greenhouses Technological innovations to realise diverse menu Complex cropping systems Integration animal/arable/urban Highly controlled indoor (in climate concerns, not nature concerns) Small animal production Resource efficiency / self sufficient Strong role policies / public goods Companies aware of public concerns (Corporate social responsibility) No GMO (nature) Increased organic production Wind/solar energy Strong lobby of NGO's on government Education. Government takes lead in transition	Smaller farm size compared to scen. 4 (or smaller increase) Less farm specialisation Less junk food consumption Low growth of meat consumption Increase in animal welfare Increase in biodiversity Less animal feed production Technologies focus on alternative food/feed products More regulation on practices on food products
2 • Focus on max. profit and no concern for sustainability • Nationalism, Local, Trade barriers	**4** • Focus on max. profit and no concern for sustainability • Liberalism, Global, Free trade
Nuclear energy, fossil energy (shale gas) Brands with personal health, national origin Company brands Focus on cost-efficiency Strong lobby of companies on government Mass individualisation (concerned about own needs) GMO and gene-editing in breeding Increased number of crops (less imports) Specialisation Technology intensive production Energy intensive production Highly technological bio-industry for national market	Larger farm size compared to scen. 3 More farm specialisation More junk food consumption High growth of meat consumption Decrease in animal welfare Decrease in biodiversity Increased production of animal feed

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Table 8. Workshop participants views on Legume Value Chains, under the different visions

Legume value chains	
1 • High focus on sustainability and climate change • Nationalism, Local, Trade barriers	**3** • High focus on sustainability and climate change • Liberalism, Global, Free trade
Ecosystems -> subsidised public goods Mixed farming systems Legumes part of crop rotation Technology to increase nutritional value of legumes Fodder legumes Optimal use of waste streams Sub-optimal land used for feed Regulation/quota Farmers interested in self-sufficiency Governmental programmes on breeding PPP programmes on breeding Flexitarians/vegetarians -> new innovative companies/products - Synthetic meat Local food/feed production/consumption - Consumers cooperations Regional optimisation Biorefinery	EU opportunities for legumes: increase Legumes to food processing: increase Longer value chains More potential value for producer More innovation - in breeding varieties - in processing - in product variety EU production legumes: increase Feed consumption: decrease Potentially less GMO
2 • Focus on max. profit and no concern for sustainability • Nationalism, Local, Trade barriers	**4** • Focus on max. profit and no concern for sustainability • Liberalism, Global, Free trade
GMO soy adapted to local conditions GMO soy competitive with wheat Contract agriculture/monopoly Animal production/farms have no feed production; they buy the cheapest - Specialised -> balanced feed Synthetic proteins Food: protein isolate Only legumes if they are marketed Differences between production for food or feed Biotechnological innovations	EU opportunities for legumes: decrease Legumes to food processing: decrease Shorter value chains Less potential value for producer Less innovation - in breeding varieties - in processing - in product variety EU production legumes: decrease Feed consumption: increase Potentially more GMO Later addition: Faba bean vs. soya to feed the poor

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