CHAPTER 3

EUROPEAN SOYBEAN MARKET ANALYSIS

This chapter provides basic information to understand soybean market developments. Soybean production, consumption and trade are covered in the first section, while the second part provides data on European soybean growing potential.

3.1 Soybean production, consumption and trade

First, the global soybean production and its trade are described. Then the soybean complex is introduced, so the reader can understand the crop and its characteristics. Furthermore, this chapter includes background information on the use of soybeans in the animal feeding sector as well as the frame of agricultural politics and their historical backgrounds. Additionally, the function of organizations and associations, which are involved in protein strategies, are represented. The chapter will finalize with the current pricing situation of European non-GMO soybean commodities.

3.1.1 Global soybean production

The United States of America still dominate the global soybean trade, holding a market share of 33 %, closely followed by Brazil with 30 % and distantly Argentina with 19%. Worldwide 319,730 thousand metric tons (tmt) of soybeans are produced, of which approximately 40 % (126,155 tmt) are intended for trade. Thereof in the year 2014/15, the US exported 54 tmt, Brazil 50.6 tmt and Argentina 10.5 tmt (USDA FAS, 2016). The fastest growing exporters from 2007 to 2014 were India (+ 103 % per year) and Uruguay (+ 34 % per year) (IndexBox, 2015).

China is by far the biggest consumer with imports of more than 72 mmt soybeans and only small quantities of soybean meal as China is processing soybeans itself. Europe has an overall import of 33 mmt soybeans and meals collectively of which Germany is one of the top four trading partners to the US. The significant increase of Chinas shares of imports continue to rise (+ 20 %) (OVID, 2015; IndexBox, 2015).

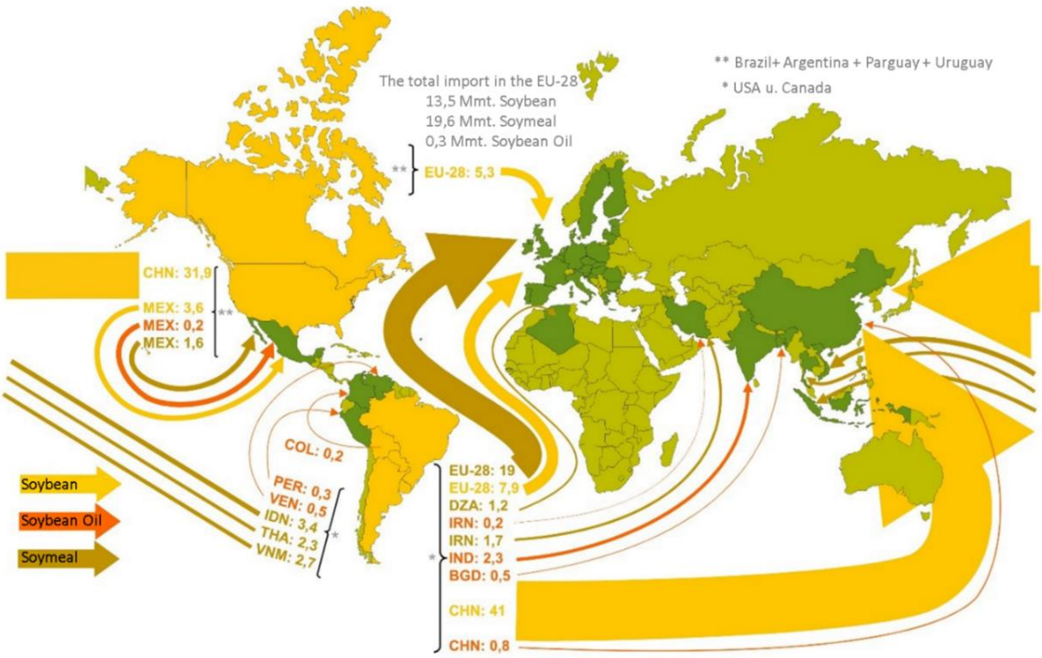

Figure 3 World trade flows of soybeans, -oils and -meals (2014)
Source: Adapted from OVID 2015.

Figure 3 pictures the described situation of the major imports to China as well as considerable soybean meal imports of 33 % (19.6 mmt) and of 12 % (13.5 mmt) of soybeans to the EU-28. Therewith 95 % of the EU's overall consumed soybeans and derived products are imported (Tillie and Rodríguez-Cerezo, 2015). About 25 mmt are used for animal feeding in form of soybean meal. In Europe, soybeans were processed into soybean meal as well and 0.5 % of the world's traded soybean meal were even re-exported by EU-28. The biggest European demands are coming from Germany, France and Netherlands. This correlates with the intensive factory farming in these countries (FAO, 2012). Germany had an import demand of 3.7 mmt soybeans and 2.7 mmt soybean meal in 2014.

Table 1 Major exporting countries to the EU-28

Export to the EU-28: Soybeans and –soybean meal in mmt (2014)				
			Exports to EU-28	
Rank	**Exporting Country**	**Area of GMO Soybeans (%)**	**Soybeans (mmt)**	**Soybean meal (mmt)**
1	Brazil	93 % GMO	5.3	8.3
2	Argentina	100 % GMO	0.1	8.7
3	USA	94 % GMO	4.4	1.0
4	Paraguay	95 % GMO	1.7	1.0
5	Canada	95 % GMO	1.2	0.1
6	Uruguay	100 % GMO	0.9	0.0

Source: Adapted from data obtained from OVID 2015.

As shown in table 2 the most important exporting countries for soybean meal are Brazil and Argentina. Moreover, the table reveals information about the acreages in percentage of GMO soybeans. The 7 % of non-GMO production in Brazil stand for 93% of grown area with GMO soybeans, Brazil is the largest non-GMO producer. Also the export numbers of soybeans and soybean meal to the EU-28 in 2014 are given in the table. Again Brazil can be noticed as the most important non-GMO soybean producer due to the country's large export amounts compared to other countries.

Table 3 Available amounts of non-GMO soybeans and -meal for the EU-28

Countries	Total Production	GMO	Non-GMO	For the EU-28 theoretical available amounts of non-GMO soy-		
				-beans (mmt)	-beans meal (mmt)	% of non-GMO available amounts
Brazil	95.1	88.6	6.5	6.5	5.2	100%
India	8.7	0.0	8.7	2.2	1.8	25%
Paraguay	8.6	8.2	0.4	0.4	0.3	100 %
Bolivia	2.6	2.2	0.4	0.4	0.4	100%
EU-28	1.8	0.0	1.8	1.8	1.5	100%
Sum	116.8	990.	17.8	11.3	9.2	

Assumption: Non-GMO soybeans are completely available for meal production.
Note: Derivation of GMO soybean production is based on percentage of the grown soybean area. Thus, there is no division between yields per hectare of GMO and Non-GMO production which leads rather to an overestimation of Non-GMO soybean production.

Source: Adapted from data obtained from OVID 2015.

To get a better idea of the globally available quantities of non-GMO soybeans and soybean meal, table 3 shows the biggest producing countries of non-GMO soybeans and – soybean meal. Other countries grow non-GMO soybeans as well, but these soybeans are not available for exportation to Europe for different reasons. In North America for example, non-GMO goods are only produced for groceries. In Ukraine and Russia, a separated detection of non-GMO goods is not guaranteed (Ovid,2015), mainly caused by illegal cultivation of GMO varieties (Danube Soya, 2016). China produced 12.2 mmt non-GMO soybeans for its own use. India has the biggest amount of non-GMO soybeans available, but ways of detection and ways of transportation have to be developed (cf. Ovid, 2015).

Market Situation

For the marketing year 2015 a decline can be reported for the oilseeds rapeseed, sunflower and groundnuts compared to the previous year. However, global soybean production continued to increase. The growing share of soybeans lead to lower production of vegetable oils reasoned by lower oil content in soybeans compared to the others. Furthermore, the contracting of biodiesel production from vegetable oils last year have slowed demand for vegetable oils. The expansion of soybean production over other oilseeds (due its high protein content) is a result from the constantly increasing demand for protein meals. Prices for protein meals have declined to historically average levels and are 1.5 to 2 times those of corn (OECD FAO, 2016).

Outlook – global yields and production

According to the OECD forecast the global soybean production will continue to grow for a rate of 2.4 % yearly in the projected period to 2025. Soybean meal represents the largest part of soybeans usage, which will result in more intensive crushing. For 2015 it is expected that 91 % of the total soybean production will be crushed. Soybean oil as another component increases at the same time. However, the demand for the oil component will decline within the next decades reasoned by limited growth of biodiesel production (OECD FAO, 2016).

The demand from China for protein meals is expected to grow more slowly by 2.7 % annualy with less than half in the previous decade. In correlation, the declining demand from the Chinese for soybean meal ease soybeans world trade drastically within the next decade. But, within China the usage of protein meals is expected to increase due to more intensive livestock production (OECD FAO, 2016).

3.1.2 Soybean characteristics

Soybeans (Glycine max (L.) Merr.) are the world's leading produced and consumed oilseed crop of today. The largest amount of soybeans is produced in the US with 29 mn ha of land used for soybean cultivation. As a member of the legume family, soybeans originated from northeastern China around 25 000 B.C. (Palle and Licht, 2014). Until today, soybeans are primarily used for human consumption in Asia (Wilhelm, 2012; Lieberei et al., 2007). The legume can be characterized as a self-pollinating short-day plant, whose days to flower are also dependent on accumulated temperature. Thus, genotypes differ in photoperiod requirements for flowering. Varieties are adapted for growth in a relatively narrow area. This means, depending on the regions conditions rather early or late-maturing varieties are chosen to reach soybeans full maturity.

The topic of the adaptability of suitable genotypes of soybeans in certain regions and growing seasons will be analyzed in chapter 3.2.

The bacterial N-fixation in the nodules is a well-known advantageous attribute of the species from the legume family. Via symbiotic root bacteria, atmospheric nitrogen can be fixed, which contributes to a more sustainable agriculture (Palle and Licht, 2014). Additionally, the soybean is known as a high protein (30-48 %) and oil (18-23 %) containing crop, which allows divisive areas of its usage and makes the soybean quite unique compared to other crops. Principally, the plant is used for food, feed, industrial and pharmaceutical needs as well as for energy production in terms of biodiesel. There is an increasing usage in form of concentrates, isolates and textured protein for human consumption. Especially in Asia liquid, powder and curd forms are manufactured from soybeans and consumed as paste, sauce, cheese and other forms. The rising trend in western regions for vegetarianism is causing an increasing demand for these products (Hartman, 2015).

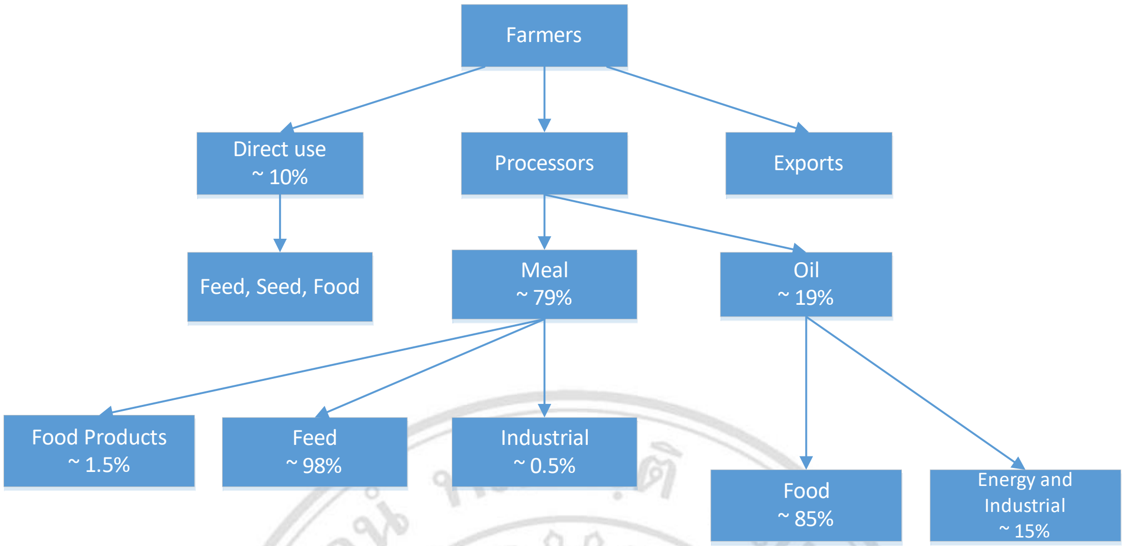

Figure 4 Structure of the soybean industry

Source: Adapted from Goldsmith in Johnsons et al. 2008, p.119.

In figure 4 the structure of the soybean complex illustrates the soybean production chains starting from farmers separated in direct use or further processing into oil and meals. The most important components of processed soybeans are soybean meal and soybean oil - with oil being the most valuable part. The leftover after solvent extraction of oil is about 80 % soybean meal, which is used almost completely as feedstuff in animal production due to the high protein content (Hartman, 2011), primarily for poultry and pork. Since soybeans contain all essential amino acids (39% of their protein content) they are a very important almost full-fledged protein source. In particular, the limiting amino acids Lysin, Threoninand and Thryptophan play an important role for animal feeding (BLL, 2001). However, a heat treatment in form of a toasting process is necessary to enhance the digestibility for humans as well as for animals. Otherwise, the digestibility of soybeans is restricted by anti-nutritive substances like oligosaccharides and trypsin inhibitors (Ali, 2010).

3.1.3 Animal feeding

As mentioned in the previous chapter the amount of soybean meal is nearly up to 100% worldwide - as well as in Europe - used for animal feeds (world: 98.3%, EU 99.3%), far before human consumption (Hartman, 2015; Soyatech, 2016). Therefore, the mainly derived products from soybean meal are beef, butter, eggs, fish, lamb, milk and pork (Hartman, 2015). Reasoned by that, this part will provide some information on European regions, which are most important for animals' production and therewith major consumers of soybean meal. Furthermore, the specific areas of application in poultry, cattle and pork will be investigated and pointed out.

For feed, the most effective type of soybeans is HP 48 (High Protein), which contains crude protein and 2-3 % crude lipid. The type LP 44 (Low Protein) is rather a normal value, but frequently protein contents are below the target set point (Marquart, 2016). According to the EU-feed law the value indicates the total percentage content of crude protein and crude lipid together. HP 48 is made of peeled soybeans and has therewith a higher protein content compared to HP 44, which still contains peels (fibers) (Pistrich et al., 2014). The protein content of soybeans is significantly higher compared to alternative protein crops such as rapeseed, sunflower, field bean, field pea and blue lupine. This fact, as well as the qualitative mixture of limiting amino acids makes soybeans besides corn and wheat the most important resource of the modern animals production industry (Salim, 2010).

Soybean meal HP 48 provides the best digestibility[1] for all animal categories and is mainly used for feeding pigs and fattening poultry. The relative amount of soybeans in energy- and mixed fodder components is with 15 % higher in pig- and fattening poultry feed as compared to cattle (dairy cows included) and laying hens with 10 % (Jeroch et al., 1999). Especially in the intensive poultry nutrition the highly digestive protein source of soybeans is by far the first choice and reaches often up to 30 % in laying hens as well as in fattening poultry feed rations (Fefac, n.d.).

To illustrate a comparison to other oilseeds, figure 5 shows the percentage share of the protein consumption in form of oil meals in the EU-28. The given values have been rounded. The percentage in brackets in CP means Crude Protein related to fresh mass. Here soybean meal consumption shows with the yellow part by far the highest share. Additionally, soybean meal points out the highest CP values (OVID, 2015).

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The digestibility determines the amount which can be absorbed by animals and is therewith responsible for the nutrients availability and the animals growth or reproduction.

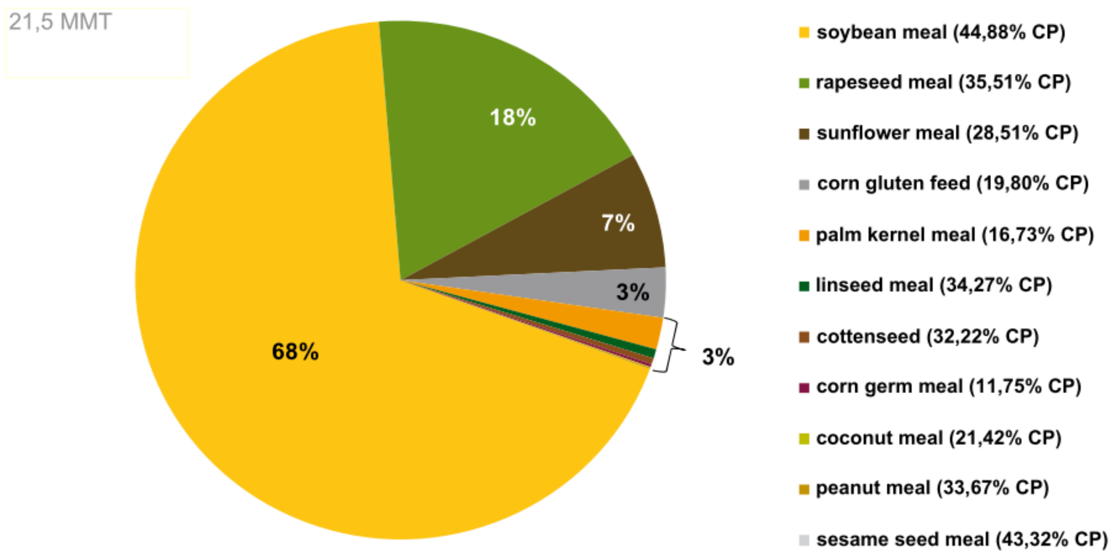

Figure 5 Europeans consumption of protein out of oil meals (Ø 2004-2014)
Source: Adapted from OVID 2015.

The European total amount of consumed protein feed in 2014 was 64 mmt. Almost half of this amount (30.30 mmt) consisted of soybean meal (OVID, 2015). An overview of the main countries, which use soybean meal for feed, is given in figure 6.

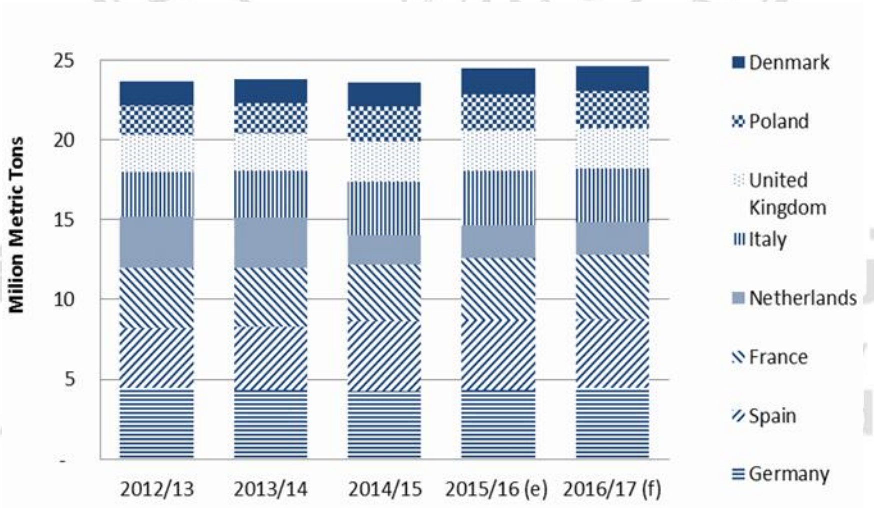

Figure 6 EU-28 feed use of soybean meal (main countries only)
Source: USDA FAS 2016a.

Besides the mentioned countries of Germany, France and the Netherlands also Spain, Italy, Poland as well as Denmark and the UK are feeding considerable amounts of soybean meal. As meat consumption is increasing constantly, an increase in feedstuff demand can be noticed (USDA, 2016a).

Regarding the total amounts of produced animal products within the EU, the sector of milk and milk products is leading with 15 % of the agricultural output. The production of pork follows with 9 % of the total agricultural output and poultry with 5 % of the output for the EU (EU Commission, 2016a).

Since in this study the potential for European non-GMO soybeans shall be analyzed, at this point the interests of the major non-GMO fodder producers will be briefly presented.

The EU's leading demand for non-GMO IP certified soybean with about 21 % of the volume of produced feedstuff is the poultry subsector, while the dairy and beef cattle subsectors dispose a share of 9 % and less than 5 % for the pork subsector* (Tillie and Rodríguez-Cerezo, 2015). The following table 4 provides the main facts in order to summarize the changes happening in the feeding industry. The table shows a summary of the European total output per animal sector to stress the size and importance of each sector. Moreover, the third column lists the main producing countries of each animal sector in declining order. It is especially interesting to compare the third and last column which shows the countries that mainly produce non-GMO feedstuff, compounds.

Table 4 Summary of total outputs in animal sectors in the EU-28

Animal subsector	EU's total output in (%)	EU's 5 major producing countries	Volume of produced non-GMO industrial feedstuff compounds in EU (in % / Country) *	
Poultry	5 %	FR/ IT/ RO / PL/ DE	21 %	AT/ DE/ IE/ DK/ GB
Dairy and beef cattle	15 %	DE/ FR/ GB/ NL/ IT	9 %	HU/ AT/ FR/ IT/ DE
Pig	9 %	ES/ DE/ FR/ DK/ NL	5 %	HU/ FR/ IT/ AT

*This numbers are based on a sample of 14 EU Member States which are responsible for 93%, 93% and 91% of the total EU production of cattle, pork and poultry industrial compounds, respectively.
* Sweden and Hungary produce almost exclusively non-GMO feeding compounds.
(Countries are in declining order)

Source: Adapted from data obtained from Eurostat 2015, Eurostat 2016, EU Commission 2016, FAO STAT 2016, Tillie and Rodríguez-Cerezo 2015.

When comparing the numbers, it is obvious that France and Italy are the main producers for poultry. With a share of 21 %, non-GMO feeding compounds for poultry are leading in Austria and Germany. In particular, the main producing countries of specific animal subsectors do not very often produce non-GMO feedstuff compounds for their large animal sector. Smaller producers, such as Austria and Hungary, have already adapted to a larger amount of non-GMO feedstuff.

Especially in the largest output areas of European dairy, cattle and pig production currently below 10 % of non-GMO feeding compounds are produced. Hence, Germany, the Netherlands and Spain are missing as important participating producer countries of non-GMO feedstuff. While France and Italy are already using non-GMO feedstuff in all areas, feed which is subject to labelling because of GM-contents can only be found in the poultry production (Tillie and Rodríguez-Cerezo, 2015). Spain and the Netherlands, being major importers of soybean meal and animal producers, are not using noticeable amounts of non-GMO feed which will probably not change in the foreseeable future.

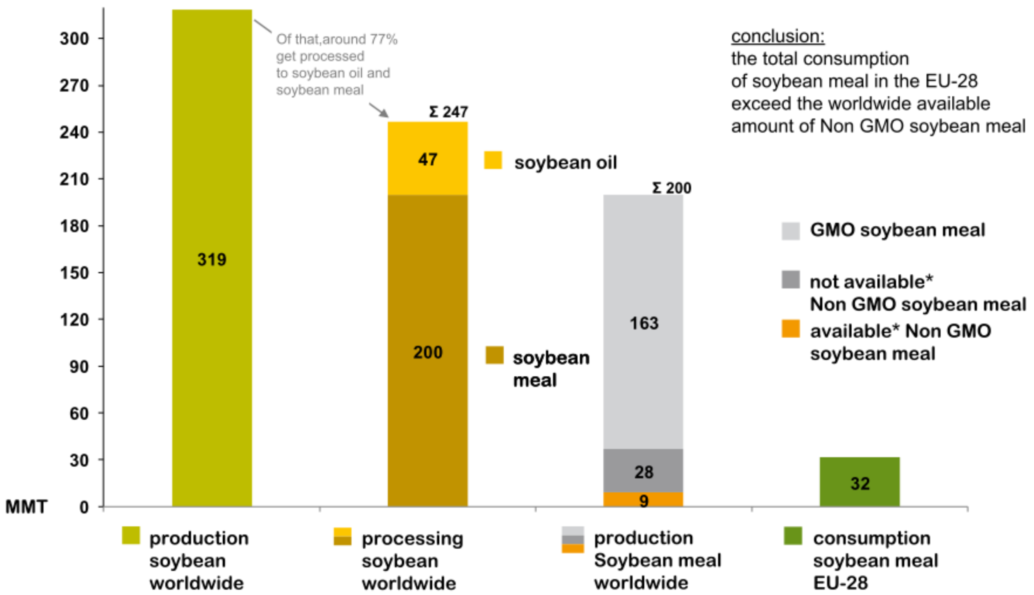

Figure 7 Production, availability* of soybean commodities (2014/15)

*Assumptions for a theoretical availability

Source: Adapted from Ovid 2015.

For the year 2014 Pro Terra and Danube Soya indicated the European consumption of non-GMO soybean meal with 5 mmt including Germany with 1 mmt, France with 0.7 mmt and the Scandinavian countries with 0.75 mmt (Kruppa, 2015). The global amount of available non-GMO soybean meal of about 9 mmt (figure 7) would not be sufficient to cover the total soybean meal needs of the EU-28. Thus, if the EU theoretically would like to change animal production systems into non-GMO, there would be 23 mmt, which could not be covered yet. When total European non-GMO soybean meal consumption is approximately 5 mmt, this represents about 60 % of global available amounts of non-GMO soybean meal (Ovid, 2015).

In general, the demand for non-GMO soybean meal for livestock feeding increases in the EU (USDA, 2016.a; FAO Stat, 2016). Especially the high demand in the farming sector for dairy cows (Peter and Krug, 2016; FAO Stat, 2016).

Outlook

Some EU countries, for example Germany, have become a net exporter of animal products. Therefore, movements in export markets are crucial for domestic markets and price trends. Especially the poultry sector with fattening broiler gains more importance since the last decade (DVT, 2016). Also from a global view fattening broiler is predicted to gain more importance in the future regarding an increasing meat consumption (OECD FAO, 2016).

For 2016/17 the dairy industry is still forecasting a rising demand for non-GMO compound fodder. This is reasoned by discounter brands, like Lidl switching to label their dairy products as Non-GMO (LZ, 2016). These changes in the market may lead to an increased demand for rapeseed meal which is justified by a decisive advantage (DVT, 2016). Additionally, for the trend in non-GMO feeding of dairy cows in single EU countries, rapeseed meal represents the often-favored option as GMO soybean compounds substitution, because dairy cows physiological feeding demands are less dependent on soybeans specific amino acids. The good availability and lower prices on the European market for rapeseed could favor rapeseed before non-GMO Soybeans for substitution (Stopp et al., 2013; DVT, 2016).

3.1.4 European agricultural policy

The four major soybean trade partners for Germany are Brazil, the Netherlands, the US and Argentina. Considering that most soybean commodities (imported from the Netherlands) is only re-imported, it becomes clear that Brazil is by far the most important state of origin of soybeans and soybean meal used for Germany. One of the historic reasons for the intense soybean trade are the 1960s negotiations on the General Agreement on Tariffs and Trade (GATT), where soybean was excluded from import quotas when sold to the EU. Consequently, soybean meal was predominantly used as protein feedstuff within the intensifying animal husbandry. The demand for soybean meal drastically increased while domestic feedstuff was demanded less and less (EU Commission, 2011).

Another reason for this development was the Blair House Agreement in 1992. This memorandum allowed the supported production of certain oilseeds but only under restrictions. Thus, limits were not to exceed 5482 hectares of supported area and not to produce more than 1 mmt of by-products (for example soybean meal). In 2008 the payments for the set-aside regime and energy crops have been abolished under the CAP Health Check. Thus, there were no longer restrictions on oilseeds for the EU in the context of today's CAP, although the Blair House Agreement still is in force (EU Commission, 2011).

Principles of Europeans GMO-legislation

Since the introduction of green genetic engineering in 1996, soybean being one of the most important commodity markets is split in two market segments, GMO and non-GMO. Through segregation along the whole value chain by a system called Identity Preservation (IP) the public policies do justice to obligatory labelling standards in some sectors. For instance, the rejection of Genetically Modified Plants in the majority of European countries is such a contrary to the worldwide increasing adaptation and usage of this technology (Tillie and Roríguez, 2015).

Thus, the EU-28 MS are subjected to the same valid GMO legislation which has been intensified in 2003. This comprises a general permission for the application of GMOs in agriculture and food production - as long as the product is authorized in the EU. According to the ISAA (2016) there are 95 authorized GMO events of which some are limited in terms of their use.

The joint EU-legislation includes the following requirements in order to secure and control the market regarding the placement of GM food, feed and crops. Special labelling is required for all GM products where GMOs have been deliberately used. This aims at the request of consumers to secure the freedom of choice to decide consciously for or against GM products. Furthermore, traceability must be ensured by companies due to appropriate documentation- and information systems. Irrespective of whether GMOs are detectable in the product or not. However, this regulation only refers to the conscious use of GMOs. Unavoidable traces and admixtures are regulated in the EU by threshold values. This implies a GMO content in food and feed up to 0.9 % except the labelling regulation for conventional products. For seeds and the cultivation of GM plants, the situation is different. Since 2015, each single MS of the EU can decide whether authorized varieties are allowed to be grown or not (EU Commission, 2003). Furthermore, the definition of a threshold value for GMO admixtures in seeds is up to the MS. In consequence, Germany has a zero tolerance compared to Austria where a threshold value up to 0.1 % is valid (transGEN, 2015; Birschitzky and Mayr 2016).

CAP – greening payment

In 2015, at the same time when the greening regulation came into force, there was a noticeable sharp increase of soybean cultivation in Europe. The rise is mainly driven by public policies (Common Agricultural Policy ecological focus areas and coupled payments) (USDA, 2016a).

As a mandatory component of decoupled payments this policy has been implemented by EU MS to be given to farmers meeting requirements like the diversification of arable crops grown on their farms.

If farmers want to receive direct payments, they have to fulfill three elements of greening: crop diversification, conservation of permanent grassland and the ecological focus areas (EFA). These elements can be summarized as the greening component of the Common Agriculture Policy (CAP). EFAs are required to be established on 5 % of the arable land where specifically environment beneficial elements are needed. These elements (EFA types) are specified in the legislation and it is for MS to select EFA types they offer to their farmers to choose from. Where MS selected nitrogen-fixing crop (NFC) as EFA, they were also to define which NFC crops will be acceptable for this purpose with a view to optimizing their agronomic and environmental contribution to biodiversity.

Also soybeans can be applied since they are nitrogen-fixing crops. According to the European Commission (2016), 16 MS selected soybean as a nitrogen-fixing crop qualifying for EFA (BE, BG, CZ, DE, FR, HR, IT, HU, AT, PL, RO, SI, SK, FI, SE and UK). In these countries, and only there, soybeans can be declared by farmers as an EFA nitrogen-fixing crop. To count the area concerned regarding the obligation of having 5 % of EFA, the weighting factor of 0.7 must be applied. The weighting factor can be explained, as 1 hectare of soybeans equaling 0.7 hectare of an EFA area (Kruppa, 2016; European Parliament, 2015).

The CAP supports MS with their production of soybeans or other protein crops with up to two percent of their national envelopes. Additionally, MS have the possibility of coupled payments, which includes an extra payment for protein crops on top of the basic payments. These levels of coupled payments are shown in table 5 (Kruppa, 2016; European Parliament, 2015).

There are significant differences between subsidy payments in countries where soybeans are allowed on EFA areas. Beginning from 40 € per hectare in Spain up to 417 € per hectare in Slovenia. Also the requirements can vary for receiving voluntary coupled payments (VCS) as it is listed below the table (Kruppa, 2016).

Table 5 Voluntary coupled payments for soybean

Countries	Estimated rate
Bulgaria	157,00 €/ha
Croatia[a)]	260,00 €/ha
Czech Republic	n/a
France	116,00 €/ha
Hungary[b)]	209,00 €/ha
Greece[c)]	n/a
Italy	53,00 €/ha
Poland[d)]	98,00 €/ha
Romania[e)]	335,00 €/ha
Spain	40,00 €/ha
Slovenia	417,00€/ha

Requirement for receiving VCS:

a) only for fodder soy, min 4 livestock units/ha required
b) certified seed for sowing and minimum 1.0 t/ha yield
c) only for seed production
d) payment is granted up to a 75 ha max. area on a farm
e) certified seed for sowing, min 1.3t/ha hayfield and contract with processor

Source: Adapted from data obtained from Kruppa 2016.

Apart from the mandatory green payment, the MS can be flexible in other areas, such as equivalent practices in the agri-environmental programs, whether they want an individual or flat payment and if they want to apply it at international or regional level (Article 47.2; European Parliament, 2015). The Implementation of the greening payment of the CAP 2014-2020 in the EU MS refer to annex X Implementation of the green-payment in MS.

Outlook for the greening regulation

After a year of experience with greening payments the EU, Commission has made more suggestions for the Agriculture Council in terms of further development. Their statement was clear: The original goal of greening, namely more biodiversity, should regain more attention. This is important, because greening measures have been implemented to only one quarter of the land so far. Measures that are particularly beneficial for the environment should be chosen primarily i.e. follows. About one quarter of the area was used for catch crops and half of them were legumes. Especially the latter should be less attractive as greening measure. The commission proposes to ban pesticides on greening surfaces. So they deprive the ground from faba beans, field beans or soybeans. This counteracts the efforts at retail to offer more non-GMO products.

Some agriculture ministers, including the German minister, see this critically. The closure period for fallows should be extended in the calendar year from six to nine months. Thus, the crop rape would be dropped as a subsequent crop. Furthermore, the commission proposes the setting and control of buffer-, flowering and edge stripes (DLG, 2016).

3.1.5 Clubs and associations involved in the European protein strategy

Protein initiatives make a contribution to promote the European protein supply, which also supports the European soybean production. Today, the Austrian association Danube Soya is active in 19 signed states today according to the associations own information (Krön, 2016). The goal of the non-governmental organization (NGO) is the support of non-GMO soybean cultivations and the processing in the Danube region in Europe – for the brand Danube Soya. The focus is on reliable supply with non-GMO soybeans from the Danube region- and creating value chains via association members. Moreover, the guidance of a supported breeding, research, and control program for non-GMO soybeans is part of the members. Therefore, Danube soya is especially important for the EU as a base for about 200 members from 19 European Danube countries. The association is mainly funded by its members (Danube Soya, 2016a).

As opposed to Danube Soya, the protein strategy also aims at supporting protein plants to improve their competitiveness. It’s important that international standards are considered. Therefore, legumes are promoted since 2013 by agricultural policy arrangements like the CAP and by projects like the National Demo Network” (Bundesweites Demonetzwerk) or the Bavarian strategy on proteins (Bayerische Eiweißinitative). The aim is to improve the cultivation and use of soybeans or other legumes like field bean, peas and lupines to support the legume research. This is organized by expert congresses, field trips, cultivation advices and online platforms. Most research projects are funded by the Federal Institute for Agriculture and Food (Bundesanstalt für Landwirtschaft und Ernährung (BLE)), whose funds will end in 2018. Furthermore, there are other associations such as the National Soy-Network called Sojaförderring, which is active since 1980 in regard of soybean cultivation. The financial support by BLE started in 2012 since the importance of soybean as a protein plant has been recognized.

3.1.6 Pricing

While analyzing prices and pricing of European non-GMO soybeans and soybean commodities, it turned out that major information gaps exist. After contacting experts such as Federal ministries like of the Baden-Wuerttemberg State Ministry of Rural Affairs and Consumer Protection (Landesanstalt für Entwicklung der Landwirtschaft (LEL)) or the Bavarian State Research Centre for Agriculture (Bayerische Landesanstalt für Landwirtschaft (LfL)), (Thünen Institute) and the Rabobank FAR (Food & Agribusiness Research and Advisory) or Soyabrokers the unitary statement was that no general formula can be given for the pricing of European produced non-GMO soybean commodities. As also described in the paper by Tillie and Rodriguez-Cerezo (2015), actors in the supply chain (agricultural processing and wholesale) are the only possibility to receive information on European non-GMO soybean pricing. The only major processor, which had been willing to disclose prices, was ADM in Straubing. Thus, information on what influences pricing can be given, not however, an exact breakdown of the prices. In this chapter, the available information on pricing in the soybean sector will be given.

As in any market economy, also for soybean commodities pricing takes place under the influence of demand and supply. Basically, European prices for soybean and soybean products depend on the world market prices. Hence, they are similar to the price curve of the Chicago Board of Trade (CBoT). Also European commodity buyers connect their prices to the CBoT (Burghardt, 2016; Van der Poel, 2016).

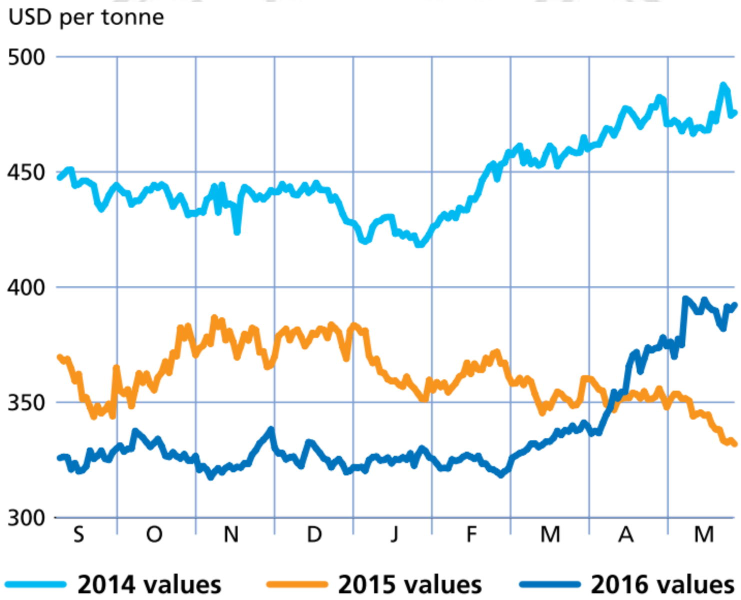

Figure 8 CBoT soybean prices

Source: FAO 2016 p.35.

Figure 8 provides an overview of CBoT prices of soybeans from 2014 to 2016 to give a sense of the price range of commercial soybeans. The graph shows for September-March 2014 an average price of 450 USD per ton. In 2016, prices are relatively low compared to the previous year with an average of 325 USD per ton. In May/April 2016, the previous downward turn in soybean prices came abruptly to an end. The line shows a steep upward trend and with it an increase in value on the previous year of about 50 USD per ton.

Reasoned by Europeans strong dependence regarding oilseed imports and the resulting products such as protein meals and vegetable oils, import duties were abolished.

Hence, the supply of food, feed, as well as industrial components, is almost entirely determined by the world market (EU Commission, 2016c).

Most of the main database on agricultural prices only report conventional soybean or soybean meal commodity prices, but do not distinguish non-GM IP products. Hence, especially in regard of the price premium for European non-GMO soybean products and commodities major information gaps exist. The reason for that is that non-GMO soybean commodities are not traded at a stock exchange. Only price notations are available on that non-GMO prices are oriented (Krön, 2016).

Generally, it can be stated that the existence of a price premium for non-GM IP soybean products is explained by the following factors (Tillie and Rodrìguez, 2016):

- Product segregation by producers, collection points and terminals, mills, transportation and loading in general

- Disadvantages for farmers due to profit losses for not growing GM soybeans. Thus, opportunity costs shall be compensated by higher prices for foregone benefits.

- Costs for certification and controls to preserve the identity of the non-GMO soybeans along the value chain.

- A breakdown premium levied by feedstuff producers, if commodities exceed threshold values of GMO contamination.

In addition to these components it can be assumed that the expected availability compared to the expected demand will reflect in the price premium. An increasing/decreasing premium for non-GMO soybean increases/lowers the consumer prices (Kruppa, 2016). Also the demand for the valuable soybean oil and the availability of crush capacities as well as weather/climatic extremes can influence price formation (Van der Poel, 2016).

Looking back from 2006 to 2015 it can be noted that prices of soybeans have risen drastically. The relatively high price, as assumed by the FAO, tend to remain a rather high level in the next decade after the low in 2003 (FAO, 2011). While the price for soybean meal can be explained by the increasing demand especially in Asia, rising logistics costs for the separation of products as well as the low supply as compared to the demand, were named as reasons for the currently increasing premium (Tillie and Rodríguez, 2016; Schmied 2016, Rupschus, 2016).

The premium for non-GMO soybean over GMO soybean commodities differs widely according to different factors, such as the protein content, certification level, transportation destination and country of origin. Due to the variation of protein and oil contained, a soybean commodity is always more expensive than a soybean meal, which has a higher oil content. This is why a consistent premium throughout Europe is impossible to determine. The premium for a non-GMO soybean meal of four European countries (AT, DE, UK and FR) is presented in figure 9 over the period 2009-2014. The premium for non-GMO soybean meal is usually set 15 % below the commodity price. Over the last twelve years the premium has been fluctuating between 5 to 35 % which means about 20 € and 120 € (Tillie and Rodríguez-Cerezo, 2015).

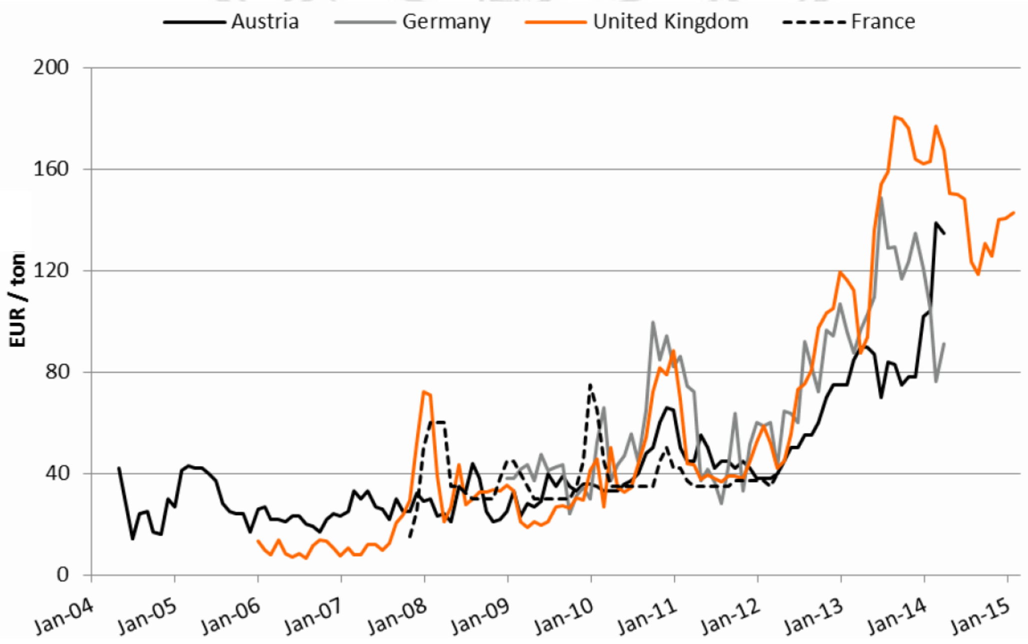

Figure 9 Price premium of non-GMO soybean meal in 4 countries (2004-2015)
Source: Tillie and Rodríquez-Cerezo, 2015 p. 32.

It is particularly noticeable that at the end of 2012 beginning 2013 the price premium increased drastically to a record high. The main reason for this development can be found in a market shortage of soybean meal due to rising segregation costs, reasoned by acreages planted with GM soybeans in Brazil. This makes it increasingly difficult as well as cost intensive to prevent from GMO contaminations.

The market responded swiftly and adapted in supply and demand. Two main movements have been observed which eased the pressure on the availability of non-GMO soybeans: firstly, some industries switched back from non-GMO soybean meal to GMO soybean meal. This was the case for the UK, DK and DE. Secondly, India has been discovered as a new and fast growing non-GMO soybean exporter. In order to bypass higher premium prices in Brazil, importers are interested in the continually improving quality of India's soybean production (IndexBox, 2015; Tillie and Rodríguez, 2015).

An example of pricing for non-GMO soybeans is shown in table 6. The price assumptions are based on data from the LTZ, the ZG Raiffeisen and the LEL. The derived soybean commodity price shall serve for orientation to estimate the soybean price for domestic non-GMO soybean commodities.

Table 6 Price* derivation of soybeans from the CBoT

Price derivation Soybeans (CBoT)	**Date: 14.07.2016**	**Exchange rate: 1.1072 US $ for 1€**		
CBoT on the stock exchange	1128.00	US ct. / bushel	374.34	€ / ton
Non GMO premium	195.90	US ct. / bushel	65.01	€ / ton
Non GMO Soybean (fob US Port)	1323.90	US ct. / bushel	439.35	€ / ton
Freight and trading costs (cif Rotterdam)	105.50	US ct. / bushel	35.01	€ / ton
Non GMO Soybean (cif Rotterdam)	1429.40	US ct. / bushel	474.36	€ / ton
Transhipment costs Rotterdam and freight paid to Southern German Fodder Plant			20.00	€ / ton
Non GMO Soybean (freight paid Southern German fodder plant)			**494.36**	€ / ton

*Based on Incoterms 2010 (without duties).

Source: Adapted from data obtained from Rupschus 2015,Schmied 2015.

Pricing Outlook:

To determine a price forecast for soybeans, Oil World and Rabobank make predictions mainly based on three global influencing factors: The demand from China, the acreage development in the US and the acreage development in South America. Another factor which affects price stability is the increasing appearance of extreme weather conditions like El Niño and El Niña (heavy rainfalls and hot/dry periods).

Increased acreages and high yield expectations in 2015 and 2016 in the US and South America lead to a well-balanced global sheet with good supplies. As a result it is assumed that demand and supply will be balanced and prices compared to the forward curve are likely to increase what should avoid declining acreages in the US 2016 (Rabobank, 2016; Market Watch, 2016).

Corresponding to that, the following table 7 will give an indication for HP, LP and non-GMO soybean meal prices expected in Germany for 2016 / 2017 (prices refer to annex XI).

Table 7 Purchase price* indication for soybean meal (HP, LP, non-GMO)

	LP – Soybean meal (44 %)		HP – Soybean meal (49 %)		Non-GMO Soybean meal
Dates	Hamburg	Straubing	Hamburg	Straubing	Straubing
07 / 16	373.00 €	396.00 €	404.00 €	429.00 €	422.00 €
08 / 16	373.00 €	395.00 €	404.00 €	428.00 €	422.00 €
09 / 16	377.00 €	399.00 €	409.00 €	432.00 €	422.00 €
10 / 16	377.00 €	400.00 €	409.00 €	433.00 €	422.00 €
11-04 / 17	375.00 €	394.00 €	407.00 €	427.00 €	422.00 €
05-10 / 17	354.00 €	374.00 €	386.00 €	407.00 €	422.00 €
*Prices are based on notations per metric ton *Prices from July 11 2016, exchange rate: 1 USD = 0.9052					

Source: Adapted from data obtained from Scheffler GmbH 2016.

The OECD is publishing price forecasts up to 2025 (see table 8). It is pointed out, that at the end of the projection period soybeans stock-to-use level will decrease. As a result, there is an uncertainty for stable prices in the future especially in case that unfavourable weather conditions will affect soybean productions (OECD FAO, 2016).

Table 8 Soybean prices for the EU-28 (2017-2025) in USD per metric ton

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
Producer Price	351,16	315,43	381,85	416,00	407,36	424,95	443,53	459,04	487,02

Source: Adapted from data obtained from OECD FAO 2016.

Differences can be noticed between the prices on tables 7 and 8. This is because retail prices are listed in table 7 which include sanitation and processing costs, and are therefore higher than the costs in table 8, as table 8 shows purchase prices for soybean commodities on farmer level.

3.2 European soybean growing potential

This chapter illustrates the situation and actual potential of soybean growing in Europe. In order to understand the differing potentials for the growth of soybean in different regions several factors which affect the rate at which crops develop have to be considered. These are for example temperature, moisture, soil conditions and photoperiod. Soybeans require a shorter day length in order to have strong physiological growth which makes them belong to the group of short-day plants. The more the cultivation areas lie in the north, the longer the days. This implies that especially in northern growing regions a delay in maturity can be expected. Consequently there is the risk of frost days during the final days of ripening which would prevent full ripening (Podolsky, 2015).

This is a considerable fact which influences yield and has a great influence on the choice of growing areas for soybean. In the following, developments from recent years as well as potentials for the cultivation of soybeanwill be described (Palle and Licht, 2014).

In the first place, soybean is not a new crop in Europe. Italy, France and Austria have been growing soybean since decades (FAO, 2016). In these countries the production has already reached a high level and good yields are achievable. France is growing soybeans since 1779. From that time until today, the cultivation and the processing have never stopped. Italy cultivates soybean since 1760 which means, they are not only pioneers but also the most productive soybean growing country in Europe. Considerable yields can be achieved due to the cultivation of high yielding late maturing soybean varieties in contrast to most of the other European countries (cf. Shurtleff and Aoyagi, 2015).

Since the whole value chain is very mature in France and Italy these countries are self-sustaining in production and are not players on the export markets. Hence, they are highly relevant for considerations on the development of a European soybean market. In order to provide a general comparison of the infrastructures it should be mentioned, that Italy has six soybean crushing plants besides the organic oil producers (Micheloni, 2016), France even ten (fncg, 2015). In comparison the whole Danube region (after Danube Soya definitions – without Italy) has an overall number of seven up to eight crushing plants. Out of them four crushing plants are processing non-GM soybean and two plants are in the process shifting to a non-GM soybean crush.

However, in Germany ADM (Staubing) has increased the oil extraction capacities for soybean this year. Also Austria has just one oil extracting plant for soybeans (BAG, 2016). For geographical reasons Austria is currently the driving force in the European soybean market. For this purpose, the Danube Soya association was founded (Krön, 2016). Besides the already mentioned large and experienced soybean producing countries, in figure 10 also Romania, Hungry and Croatia are shown as considerable soybean producers within the European community. Also a steady increase of acreage extent is noticeable since 2012/13 as well as a fast increase of the cultivated area since 2015/16 via greening payments (USDA, 2016a). According to the Annual USDA report 2016, an increased demand for soybean commodity is noticeable through the increasing acreage in Europe.

Cultivation of soybean within Europe is only possible in regions with a vegetation period of 105 to 140 days per year which equals rather early to mid-maturing varieties. Which means that the temperature sum is defined in 1500 up to 1800 degree days in relation to a value of 6°C. In general, the growing conditions of soybean resemble closely to those of corn for grain usage, both requiring warmer and moisture soils. This means that possible production areas extend a broad scope from tempered to (sub-) tropical regions. The soil temperature for germination should be at least 10-12 °C over a certain period of time (Heyland, 1996 and Hartman, 2015). This makes Romania, Bulgaria, Hungary and Croatia (EU) as well as the Republic of Moldova, Ukraine and Serbia (outside EU) countries that have a high potential for growing soybeans (Dima, 2015).

The European soybean acreages development in 2015 increased by almost 20.5 % but declined in 2016 by 3.5 %.

In 2015 Germany (17 tsd. ha) and Czech Republic (12 tsd. ha) increased by 70 % compared to the planted area in 2014. Austria (57 tsd. ha) and Slovakia (44 tsd. ha) increased about 30 %. Especially in the eastern European regions some areas have more than doubled. Hungary's (73 tsd. ha) as well Croatia's (81 tsd. ha) production for example increased by 72 %, Serbia's (240 tsd. ha) by 56 % and Romania's (122 tsd. ha) soybean production increased by 54 % (Eurostat, 2015). The Ukraine (2145 tsd. ha) was 2015 by far the largest producer in Europe but outside of the EU-28. Ukraine had an increase of about 20 % (APK-Inform, 2015).

Political support (VCS) and the availability of arable land could be a factor causing this extension in 2015 (USDA, 2016a; LfU, 2007). Thus, the shrinking demand for winterrapein the biofuels sector could be an additional essential driver for available hectares (EU Commission, 2016c).

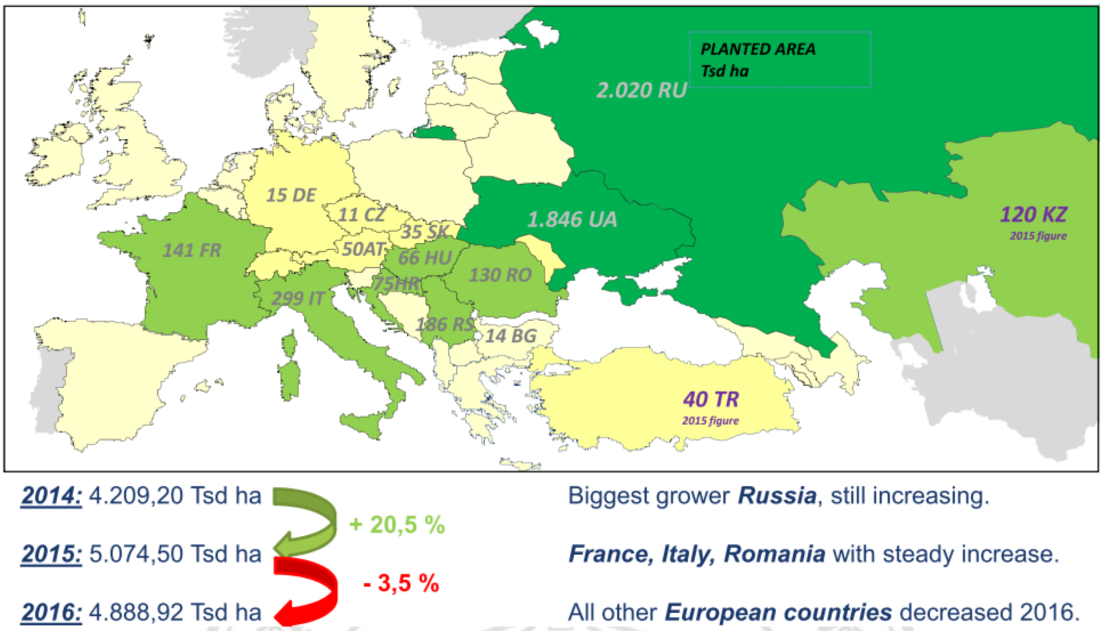

Figure 10 Total acreages planted in Europe 2016 (in thousand hectares)
Source: Own illustration, data obtained from Eurostat 2016, APK-Inform 2016, Gossort, 2016.

The figure is divided in three colors. The pale-yellow countries are those where soybean is grown in a smaller scale but nevertheless nameable. The light green color of the countries indicates if the country is growing soybean on a larger scale within the EU-28 and the dark green countries produce on largest scale soybeans. According to figure 10 the actual planting data in 2016, the soybean acreages are more likely to decline throughout Europe. The only countries where an increase of the acreage has been recorded is France with 141 tsd. ha (+ 39 %), Italy with approximate 300 tsd. ha (+ 12 %) and Romania with more than 130 tsd. ha (+ 7 %). In most other European countries the soybean acreage declined by about 13 % compared to the planted areas in 2015 (Eurostat, 2016).

The following figures summarize the soybean planted area from 2014 up to 2016. The area of each country is given in tsd. ha. The figures clearly illustrate the large soybean production dimensions in Ukraine and Russia. Besides France and Italy, Serbia and Romania produce soybean on nameable hectares (see figure 11). The origin numbers refer to annex XII.

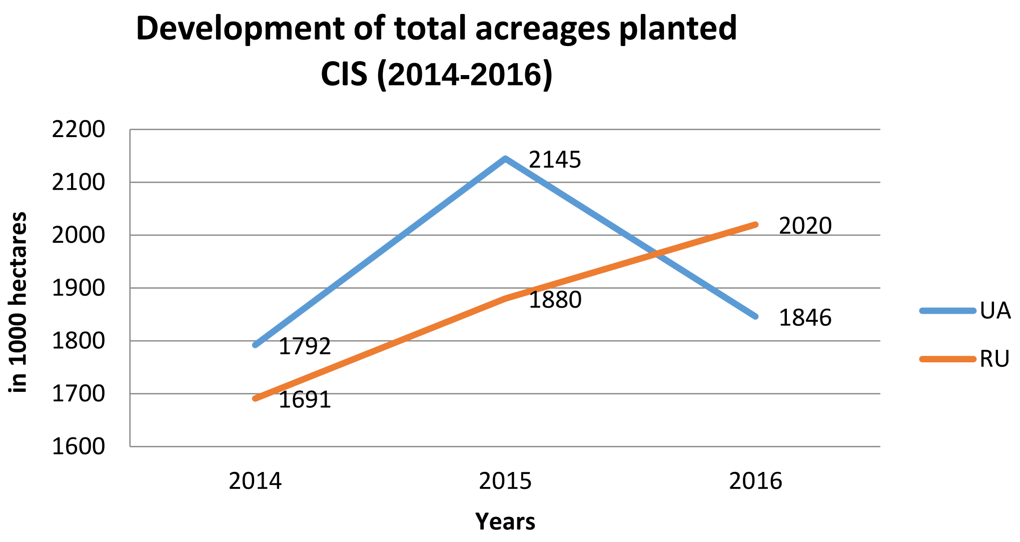

Figure 11 Total acreages planted in the CIS (2014-2016)

Source: Own illustration, data obtained from APK-Inform 2016, Gossort 2016.

The graph shows Ukraine and Russia as the strongest European producers in relation to the total planted land area. At a peak production of 2020 tsd.ha, Russia has overtaken Ukraine (1846 tsd. ha).

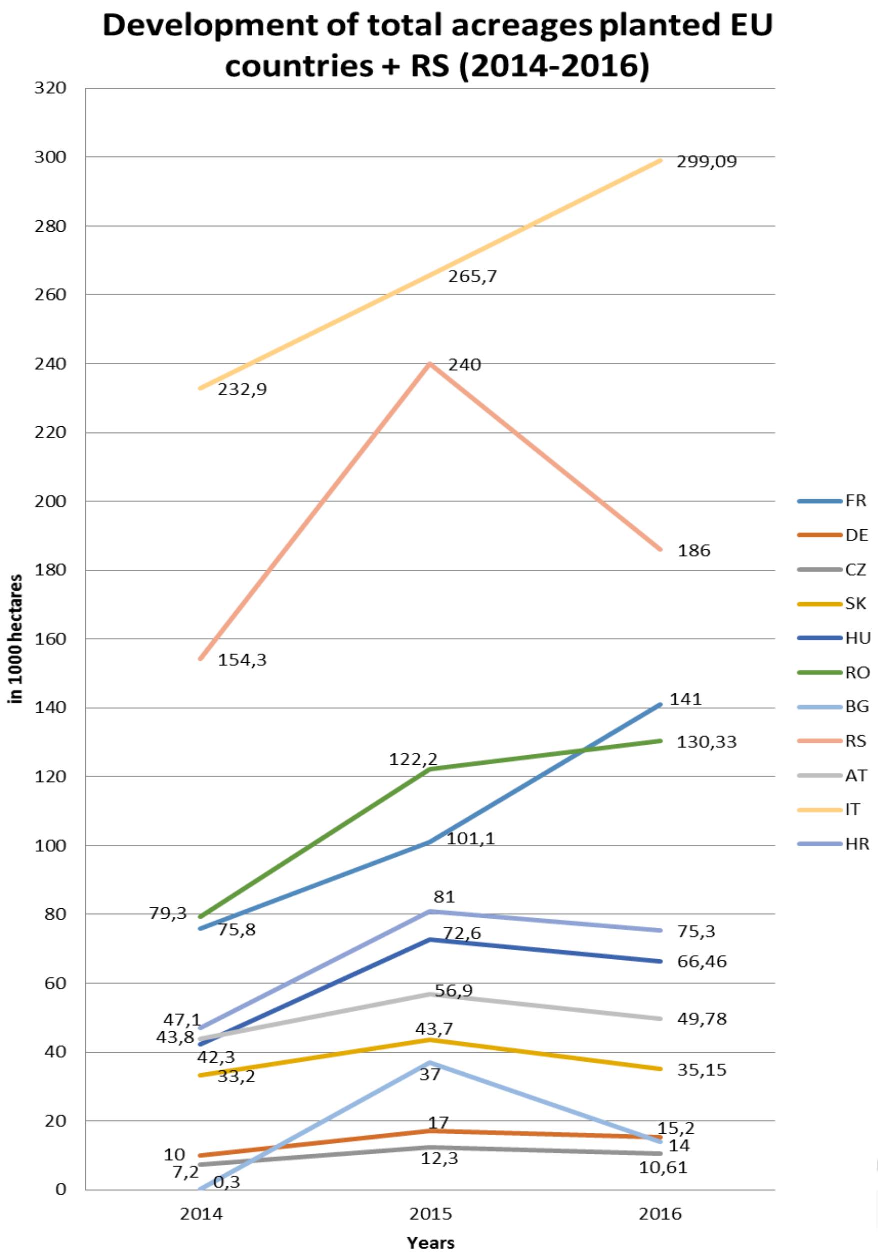

Figure 12 Total acreages planted in the EU + RS (2014-2016)

Source: Own illustration, data obtained from Eurostat 2016, Sorte 2016.

Figure 12 shows the planted acreages in EU states and Serbia. Three groups of European countries can be identified. The first group includes Italy and Serbia showing highest acreages. The second group refers to France and Romania, occupying a middle position. The rest of the EU countries is grouped in the lower-third of the graph.

Starting with the highest acreages during this period, Italy shows the strongest linear growth and reaches almost 300 tsd. ha, whereas, in Serbia soybean acreage decreased in 2016, having reached peak production in the previous year. In reference to the middle group, it can be seen that in 2016 there were more soybean acreages in France than in Romania. Both countries achieved growth in total planted area throughout the time period represented. The graph clearly shows that the planted area of most of the countries grouped in the lower-third of the graph climaxed in 2015. However, this peak has started to decrease in 2016. The reason for the peak in 2015 were linked to the greening payments and the decrease was mainly caused by disappointing harvests due to adverse weather conditions in 2015.

Soybean cultivation developments are expressed as a percentage in figure 13. This graph depicts increases from 2014 until 2015. However, most countries are characterized by a negative growth in 2016, except for the large producers: Italy, Russia, Romania and France. Overall, between 2015 and 2016 the European acreage only dropped by 3.5%.

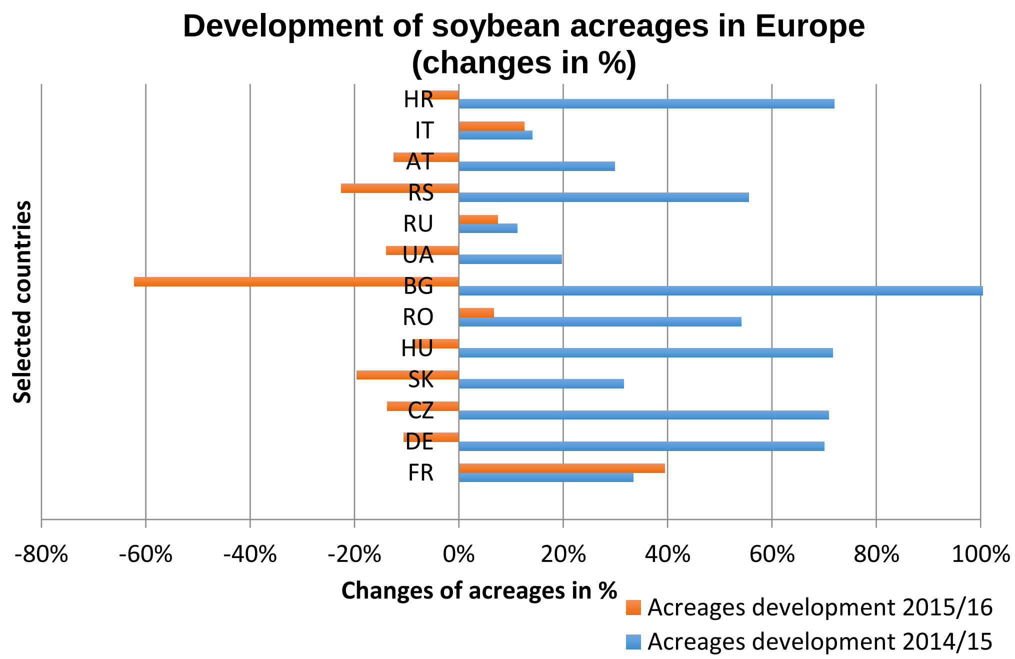

Figure 13 Changes of soybean acreages on a percentage basis

Source: Own illustration, data obtained from Eurostat 2016, Sorte 2016, APK-Inform 2016, Gossort 2016.

Dima (2015) describes the cropping potential for soybean in Romania, Bulgaria and the Republic of Moldova with 0.8 - 1 mn ha. Hence, there is a production potential of about 2 mmt. This could represent 30 % of the yearly required demand for non-GMO soybean in the EU, correspondingly about 5 % of total EU consumption per year. However, one of the challenges with the Ukraine is that there is still a problem with an illegal use of GM soybean seed and one has to be careful with GMO contamination into the EU via importation (Birschitzky, 2016). With respect to the USDA FAS (2016d) report, within the Ukraine GMO soybeans use is estimated to be about 80 % of the overall production, despite a political ban on GMO seeds. Yet, the situation has improved in the last 2-5 years, since about 90 % seed of varieties with a GM event were grown. According to a statement from the Danube Soya report (2016b) on the Ukrainian soybean sector, since 2010 there is more pressure from the state, for large companies like agro holdings to commit to switch to non-GMO production.

Cultivation of soybean in mid-Europe is limited due to unfavorable climatic conditions (Hahn, 2015). In Germany, for example, only the southern parts of the country provide the required conditions for growing soybean. Nevertheless, the planting area for soybean is constantly growing (LfL, 2015b). Plant breeding companies which inserted or intend to insert soybean into their product range could therefore focus on the fast expanding regions in Eastern and South-Eastern Europe.

To extend the European soybean growing areas, the plant breeding research recommends very early maturing varieties (up to maturity group 000-0000). These maturity groups are important for the agriculture in order to be able to grow soybeans that mature in higher latitudes up to 51° (e.g. Thuringia in Germany), where the average temperatures are not as high as they are in typical soybean growing regions, where latitudes are usually below 48°. More about this topic will be explained in the subchapter Maturity classification.

Generally, one of the challenges that has to be faced is the gap of breeding efforts and growing expertise for soybean in Europe. There are limited numbers of early soybean varieties on the market, which are well adapted to European regions caused by a lack of breeding activities over the last 20 years (Hahn, 2015; Saatzucht Donau, 2016). Hence, breeding and growing maturity adapted varieties is an important goal in order to enhance soybean profitability in Europe through increased yield potentials. There are already projects and activities of breeders as well as the University of Hohenheim, which aim to develop early maturing maturity groups (MGs) well adapted varieties with improved characteristics. These are besides early maturing, cold resistance and an increase of protein content as primary targets (Hahn, 2015). However, if a maximum yield potential is targeted, it should be focused on common –later ripening varieties (MG I-V) planted within the adequate latitude because the short vegetation period of earlier varieties involves losses in yield (Palle and Licht, 2014).

3.2.1 Maturity classification

In high yielding and highly developed countries like North America an adequate maturity classification system is used. Different systems of maturity classification are evolved but most common is the US American System which is expressed in relative maturity (RM). There is a range of MGs from 000, 00 and 0 for northern growing regions close to Canada and for southern soybean production up to I-X in adaptation from the Northern to the Southern direction (Zhang, 2007). In total there are 13 classified MGs. Additionally, in the US classification system each classified MG is subdivided in ten numbers to designate the appropriate RM rating for a soybean variety (iGrow, 2015).

At this point the maturity classification of soybean varieties within certain latitudes is one of the important challenges within Europe. As there is no uniform maturity classification system to classify soybean varieties used in Europe, this fact complicates the expansion of soybean growing within Europe.

Neither the definitions of MGs are uniform across the EU nor is it sure, if a variety classified in a certain MG remains in the same MG in another country. Therefore, an attempt during the internship at the plant breeding company was to create a table summarizing the different systems of MGs in Europe (see annex XIII). Agricultural Ministries and Plant Variety Offices of European States which had been contacted confirmed the gap of an overall MG system in soybeans in Europe. This fact, considerably impede the European soybean market by selection and distribution of optimal adapted varieties (Hartmann, 2015; Hahn 2015). In 2014/2015 Alena Pfeiffer's master's thesis

(University Hohenheim) has already focused on the same subject from an agronomic perspective.

3.2.2 Soybean acreages

In order to respond research question 4 (How much of total imports could be replaced by a European soybean production?) production capacities of Europe and the global leading soybean producers US and Brazil are investigated to define Europeans position.

As described in the previous part (European soybean growing potential), soybeans sensitivity to photoperiod and temperature represent a critical factor in increasing its further adaptation to different more northern growing zones. The relative maturity classification system serves as an assessment to account all influencing factors, which affect the maturity and the number of vegetative days to reach full maturity. Besides temperature also solar radiation, germplasm, latitude, planting date, disease resistances as well as water supply combine influencing factors.

Growing regions in the US

Figure 14 represents the US map with its subdivided maturity regions. Latitude plays an important role, because flowering of soybean occurs only when the day length is shorter than the critical photoperiod. While the beginning of flowering depends on both, day length and temperature sum, maturity is decisively dependent on temperature sum and solar radiation. Therewith a late maturing variety would not reach full maturity when planted northwards. On the other hand, an early variety planted in southern latitudes would flower too early reasoned by the shorter day length in the South. Therewith, in both cases varieties are not able to exploit full vegetative growth in order to achieve the maximum yield.

On the US map in figure 14 it is obvious that MGs begin in the northernmost with MG 00 and theoretically can be extended to MG IX in Florida. Therewith, the map only displays 11 of the existing 13 MGs. However, the most productive main region of the US is in MGs I-V. This is due to excellent surrounding growing conditions for soybeans which includes ideal sowing dates, day length, temperature sum and sufficient precipitation which offers highest yields (Fox 2016).

The top soybean producing states in the US are Illionis, Iowa, Indiana and Minnesota, followed by Nebraska, Missouri, and Ohio (USDA, 2015; Statista, 2016a).

The states with high yields are mainly between latitudes from 44°-38° within the scope of MGs II-IV. The seven states listed above had 2015 average yields of 3.5 t/ha (Miller-Gravin and Naeve, 2015).

Figure 14 Maturity groups of Soybean varieties in the US
Source: Palle and Licht 2014 p.2.

Growing regions in Brazil

The US maturity classification system also has replaced the traditional Brazilian approach (early, medium and late by region) due to the marketing activities of US American based breeding companies, as for example Monsanto (Alberini, 2009). The subdivided acreages are shown in figure 15. However, as well as for Europe until today there is no published research proving the use of the US American maturity classification system under Brazilian conditions.

The main production regions of soybeans can be divided in two regions. The south-central or Midwestern region and the south which includes Mato Grosso, Goiás, Mato Grosso do Sul, Minas Gerais, Sao Paulo, Paraná, Santa Catarina and Rio Grande do Sul. Most of the expansion occurred in Mato Grosso.

Regarding to figure 15 in Brazil overall later maturing varieties are used compared to the US. According to Paschal (Paschal et al. 2000), about 44 % of soybean are grown in the Midwestern regions (10 - 20° latitude) using late and subtropical adapted varieties with MGs from VII to IX. The southern regions are more like the major growing regions in the US. Within latitudes from 20 - 30° the map displays MGs V to VII, which account for approximately 56 % of soybean grown in Brazil (Paschal et al. 2000).

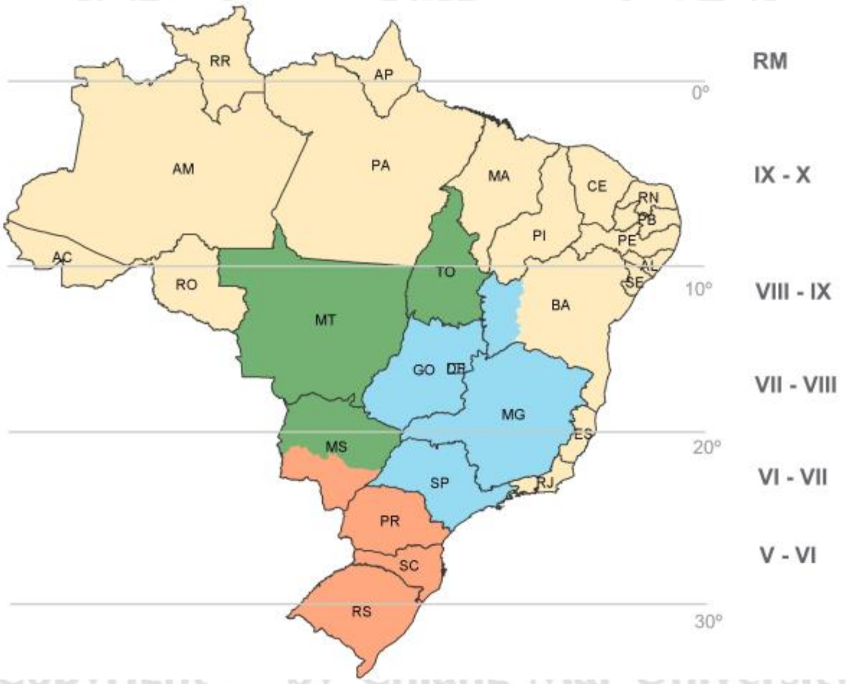

Figure 15 Maturity groups of soybean varieties in Brazil
Source: Bowers, 2011 p.3.

Growing regions in Europe

As there is no uniform maturity classification system for the European Union, Miladinović et al. created a map (Figure 16), which follows the ideas of maps from the US. The distribution of soybean MGs was made on assumptions and transfers from the US American maturity classification, combined with growing experiences in Europe. The colored areas are highlighting the optimal zones for particular MGs, while the real growing area is much wider (Miladinović, 2015).

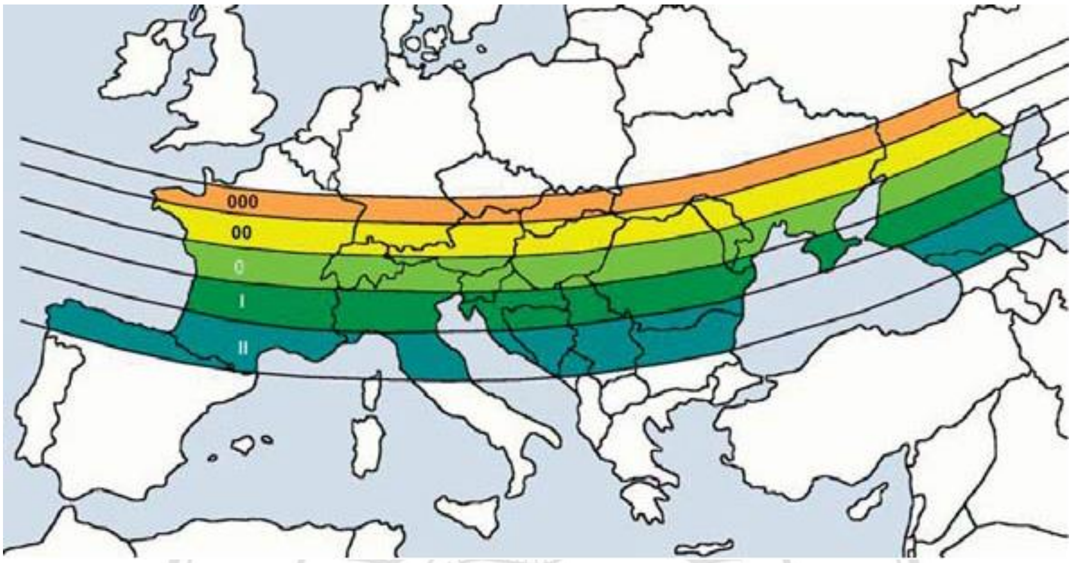

Figure 16 Maturity groups of soybean varieties in Europe
Source: Miladinović, 2011 p. 513.

Due to the intensive investigation on MGs of European countries and which standard soybean varieties are grown in countries, estimates could be made about main MGs. This knowledge about major MGs combined with data of hectares grown with soybean of each country, allowed an overall calculation assisted by own estimates to make statements of European most grown MGs.

As a result, the main cultivation area in Europe was concentrated in MGs 00-I. These MGs are grown in the European latitudes of 48°-47°. Austria for example is a typical 000/00/0 region, Hungary 00/0 and Serbia I/II.

When comparing these three growing regions - USA, Brazil and Europe, the following disadvantages for the soybean cultivation are apparent for Europe:

- Due to the rather early occurrence of low temperatures, rainfall and frosts towards harvest in wide ranges of Europe early maturing varieties are necessary (nearly 70 % are MG 000/00/0).

- The US and Brazil have an advantageous position by latitude, what provides higher temperature sums-, and shorter day-lengths. Thus, later maturing varieties can be grown.
- The planting- and harvesting period is more limited in Europe due to cold and wet weather conditions in spring and autumn.
- Precipitation in Brazil is more expectable and lasts into the growing season.
- In general, the US and Brazil have longer growing seasons, which result naturally in higher yields.

Summarized it can be stated, that crucial limits of growing soybean in Europe results from the necessity to cultivate early maturing soybean varieties.

Although, soybean genotypes have been adapted to northern areas with longer day-lengths and lower temperatures which ensures reliable higher yields. However, according to Euralis (2016) (a French plant breeding company) and Hartmann (2016), these adapted early varieties result in lower grain yield potentials as well as lower protein contents compared to late maturing varieties. From this consequence, breeding activities have to be forced in the future, as described in the last part chapter 3.2 (Hahn, 2015).

The yield level per hectare is therefore poorer in Europe than in the two compared countries US and Brazil. Therefore, the income situation for farmers in the US and Brazil should generally be higher than for European farmers. The European crop usage on arable land is considered more in detail to pursue the research question 4 about how much acreages of other crops could be replaced by soybeans.

3.2.3 Analysis of a replacement of other crops by soybean in Europe

In the EU-28 arable land is about 60 % (107,032.1 tsd. ha) of the overall utilized agricultural area (178,5411.0 tsd. ha) in 2015 (Forti and Henrard, 2016).

The most produced crop on European arable land is cereal. Common wheat, barley and corn including CCM make up the highest share with more than 86.4 % of all European cereals. 23.4 % is corn and CCM (Forti and Henrard, 2016). The most important oilseeds produced in Europe are rapeseed (69.83 %), sunflower (25.73 %) and soybean (4.5 %).

The values in the brackets show the respective percentages when one presumes that these three represent 100 % of all oil crops (Statista, 2016b).

In the following table 9, selected spring crops are compared with soybeans. Soybean is a spring crop as well, hence decisive factors for or against a specific cultivation or maybe replacements will be analyzed. In reality, there are numerous of influencing factors on which decisions for a specific cultivar are based on. As the scope of this thesis is limited the focus is on selected spring crops, sunflower and corn, and chosen influencing factors.

It should be mentioned that spring barley has been neglected from this investigation, because the main growing countries of spring barley differ too much from countries where soybeans are grown. However, corn, sunflower and soybeans potentially are grown in more or less similar agricultural regions (Baruth et al., 2015). Thus, it makes sense, to provide an overview of production area, yields and prices of possibly rivaling crops (table 9).

Table 9 Production, yields and prices of competitive spring crops (Ø 2014/15)

	Area (1000 ha)	Production (mmt)	Yield (t/ha)	Commodity Prices* Oilseeds (USD/t)	Commodity Prices* Protein meals (USD/t)
Sunflower (seed)	4,229.04	9.2	2.17	506	231
Corn and CCM	9,432.44	78.03	8.27	170	--
Soybeans	730.26	1.8	2.46	362	406

*2014/15 average wholesale, 48 % protein.

Source: Data obtained from Eurostat 2016, FAO STAT 2016, USDA FAS 2016b.

As it is shown in table 9, soybeans have only small acreages and their total production (mmt) is low when compared to corn and CCM. Yields in tons per hectare for corn are a lot higher, while the crop sectors sunflower and soybean have comparable yields. It is important to mention at this point that yields in the soybean production are significantly less stable under drought conditions than for sunflower (Hartmann, 2016).

Hence, soybean yields in Germany 2014 with 3.17 t/ha are comparatively high and 2015 with 2.0 t/ha are rather low modest.

With regard to pricing, soybean meal has an average of 44 USD/t more added value as soybeans commodities. For sunflower, it is the other way around. During the 2014/15 sowing Sunflower seeds achieved on average 144 USD/t higher prices than meal (FAS USDA, 2016 in annex XIV).

Table 10 shows the revenue calculation. It can be illustrated, that revenues for corn and CCM are significantly higher and therefore a high yielding soybean crop would be less competitive compared to corn when highest revenues are targeted. On the other hand, concerning revenues, soybean can compete better with sunflower in case of reasonable high soybean yields.

Table 10 Revenue calculation

		Revenue* (USD/ha)
Sunflower	506 (USD/t) * 2.17 (t/ha)	1098.02
Corn and CCM	170 (USD/t) * 8.27 (t/ha)	1405.90
Soybeans	362 (USD/t) * 2.50 (t/ha)	890.52
Soybeans (2014)	362 (USD/t) * 3.17 (t/ha)	1147.54

*Average commodity price multiplied with average yield.

Source: Own calculations data obtained from FAS USDA 2016.

Moreover, in Rotterdam Oilseed commodity prices for US commodities of sunflower (2015/16) cost 25 USD per ton more than soy beans. For this reason, the imports of sunflower instead of soybeans would be uneconomical (USDA, 2016). An exclusive examination of revenues in agribusiness is too unilateral. From cultivation recommendations and experts experience it can be emerged that local conditions cannot necessarily be compared with each other.

Water supply is an essential limiting factor in agriculture, which is decisive to achieve optimum profits and optimum yields in crop rotations. Besides the revenue situation, a second major profit influencing factor will be analyzed based on the crop water needs and the sensitivity to drought (see table 11). In general, this is a very complex analysis which includes different types of water uptake and soil moisture availability. In this case, it is a simplified isolated comparison of both factors based on data from the FAO and expert's knowledge. A detailed analysis would go beyond the scope of this thesis, as it only will be shown, why or why not acres of a certain crop could theoretically be substituted by another.

Table 11 Crop water needs and sensitivity to drought

Crop	Crop water need (mm/total growing period)	Sensitivity to drought
Sunflower	600 - 1000	low-medium
Corn	500 - 800	medium-high
Soybean	450 - 700	low-medium

Source: Adapted from data obtained from FAO n.d.

The duration of growing periods is different depending on areas and environmental factors, e.g. temperature. Thus, the table provides minimum and maximum values for crop water needs in accordance to the duration of the growing period (FAO, n.d.). As shown in the table, sunflower has the highest water requirements for total yields compared to corn and soybean. But, according to the FAO (2015) and experts, sunflower is able to withstand drought periods after flowering with a decelerated reduction of the yield potential. For each crop, water deficiencies in different growth stages result in different intensive losses. The most water sensitive period is the flowering stage. In this case, flowers could not reach full development, which leads to yield losses (FAO, 2015). Other growing stages are less sensitive to water deficiencies in respect to yield. Experts reported from experience, that sunflower has the ability to achieve satisfying yields (2 t/ha) even if precipitation were minimal since flowering. This does not mean that sunflowers in high quantities are tolerant to drought. However, they are capable of delivering high yields under drought conditions. (Schuster and Marquart, 2003; Hartmann, 2016).

Based on the FAO data, corn has lower water needs, but is more sensitive to drought. The occurrence of drought during flowering affects growth and ear formation, due to insufficient pollination. In consequence, this results in considerable losses of yield and yield potential. However, under consistent conditions of water supply corn as well as soybean show a strong correlation to high yields (Ehlers, 2013). For soybean, the table provides the same sensitivity to drought as for sunflower but water needs are lower.

Despite of that, soybeans are extremely sensitive towards water deficiencies (Imgraben und Recknagel, 2016). This happens especially from the stage of flowering until pod filling which is from late July to mid-August. Within this period, water shortages cause massive flower and pod dropping and hence considerable yield losses (FAO, 2015).

In addition to those mentioned above, sowing of winter crops in autumn influences available acreages for spring planting. If the conditions are too dry in autumn, rapeseed will not be sown in winter. However, if the soil conditions are too wet, winter wheat cannot be sown. Since both winter cultivations will not be harvest before early summer (May-August), sowing of winter crops is an important factor for spring planting. (Hartmann, 2016; AMIS, 2015).

Altered crop rotation cannot be ignored as well. As soybean and sunflower belong to foliage plants, a substitution between both crops would be theoretically reasonable (Hartmann, 2015).

In order to fully and correctly refer to the exchange worthiness of the three cultivations corn, sunflower and soybean, hereinafter the spring cultivations will be discussed with the above-mentioned influencing factors. Cultivating soybean rather than corn is environmentally possible, as corn locations are equally advantageous for soybean (Imgraben und Recknagel, 2016; Hartmann 2016). With regard to revenue of corn and soybean it hasn't any economical purpose-driven substitution. Corn achieves significantly higher yields per hectare, especially when sufficient water is available. Furthermore, corn as starch plant has worldwide a more major position than oil plants (soybean), since corn ranks among the most important crops (wheat, corn, rice) of world nutrition (Wilhelm, 2012). Those could be arguments that prevent the substitution of corn by soybean. Locations, that show too dry conditions for good corn yields, are alternatively planted with sunflowers. The decisive reason therefore is that they respond much slower to water shortages. Sunflowers also respond to water shortages with yield losses, but lower than other types of cultivation and more slowly. Especially soybeans could respond to dry periods with total crop failures.

In summary, it can be said that, besides the disadvantages regarding profitability of soybeans compared to corn and sunflower, also the sensitivity of a cultivar to environmental conditions (drought, water scarcity) or crop rotation represent crucial cultivation criteria's. Hence, this chapter elucidates that a realistic assumption of the ability to substitute crops depends on a variety of factors and that such an inquest would be too complex for this work. The findings that emerge from this chapter will be taken up again in the results section and the discussion.

Outlook for European acreages development

According to the OECD (2016) forecasts, rising yields per hectares are expected for cereals and oilseeds in Eastern Europe. Especially for soybeans the strongest increases in yield are predicted. Because soybeans as a rather new crop for some areas in eastern Europe are expected to increase due to better adapted varieties and the appropriate crop management by farmers. However, in total Eastern Europe yields are not forecast to exceed global averages. For western Europe, the OECD (2016) forecasted predict a further concentration on cereals but for oilseeds the production is expected to decrease.

Based on several expert statements (Van der Poel 2016; Stoll 2016; Hartmann 2016) it can be assumed that the potential for European non-GMO soybean production which can be added towards the existing produced amount is a rise of maximum 20 % of the annually imported amount. Proceeding from a total of 33 mmt of imported soybean commodity (Ovid, 2015) which are named in chapter 3.1.1 the following model calculation can be made: At current, the named 20 % of 33 mmt soybean imports would be 6.6 mmt. Assuming an average yield in Europe of 2.7 t/ha (Ovid 2016; Oil World 2016), this results in an additional future crop area of 2.4 mn ha of soybean Today soybeans are produced on 5 mn ha in the EU + CIS, a growth in the planted surface by 48 % would hence be expected. This equals a future total of 7.4 mn ha. This development could only be based on crop substitutions as there are none or scarcely any additional acreages of arable land available in Europe.