

GRAIN LEGUMES - MAIN SOURCE OF VEGETAL PROTEINS FOR EUROPEAN CONSUMPTION

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Abstract

Grain legumes (pulses) are currently grown on 1.8% of the EU's arable land (compared to 4.7% in 1961) and as a result, Europe is dependent on protein imports totalling annually about 20 mil. tons of soybean meals and 12 mil. tons of soybean grains. Only about 2.5% of soybean meal consumed is produced in the EU. This imbalance between production and consumption creates economic and trade problems; in addition, imported soybean is mostly GM, which is not accepted by many European consumers. Since 2013, the Common Agricultural Policy included as a priority increasing the production of vegetal proteins by subsidies to grain legumes crops (including soybean non-GM), forage crops (alfalfa, clover) and oil crops (rapeseed, sunflower). In this framework encompasses the initiative Donau Soja (Danube Soya), which promotes the cultivation of conventional soybean in the Danube region and the development of yields processing and valorisation network. Romania falls well into these trends by traditions in cultivating soybean (over 500 thou ha before 1990), the favourability of natural conditions, the existence of biological material adapted to the specific natural conditions (varieties developed in ARDS Turda and NARDI Fundulea). Romanian farmers are interested in expanding soybean cultivation for ameliorating soil fertility and as a very good previous crop for winter cereals, but by providing an efficient weeds control, supplying water by irrigation and treating the seeds with bacterial preparations. Also, taking soybean harvest in the food networks involves a very rigorous quality control in terms of protein content and of avoiding contamination by GMOs. It is estimated that it can reach 700 thou ha with soybean, which can produce about 0.51 mil. tons proteins, which would add about 0.40 mil. tons of sunflower proteins (from 800 thou ha) and about 0.25 mil. tons of rapeseed proteins (from 500 thou ha).

Key words: protein supply, Common Agricultural Policy, grain legumes, soybean.

INTRODUCTION

Compared with other major agricultural regions of the world, the EU is characterized by a low level of vegetal protein production.

The dominance of cereals in European agriculture combined with the import of large quantities of soybean grains and meal enable self-sufficiency in livestock products. Increasing the cultivation of protein crops (grain legumes) would be an important contribution to the sustainable development of European agriculture and food systems.

The direct farm, regional and global level environmental benefits of increased grain legumes production, combined with the indirect benefits arising from the better balance of EU agriculture and trade, justify public intervention in this sense (European Parliament, 2013).

In 2013, provisions of new Common Agriculture Policy (CAP) include as a priority the promotion of protein crops to cover a large proportion of the protein consumption from own production.

Grain legumes crops (or pulses), species of *Fabaceae* (*Leguminosae*) family - first pea, field beans and soybean, but broad beans, chick pea, lentils and lupine too -, are now grown on only 1.8% of arable land in the EU, compared with 4.7% in 1961. This decline is the result of diverse economic and policy factors. The direct human consumption of pulses has declined and this had resulted in a reduction in the area of food legumes. Only 11-15% of pea and 9-14% of broad beans are now used for human consumption.

Grain legumes yields are unsteady and technological and breeding efforts are necessary to improvement, as these crops

compete better with cereals. They are less competitive in the fight against weeds, some are susceptible to dropping and shaking of the seeds, water stress, pests and diseases attack.

Legumes crops require small quantities or no nitrogen fertilizer and are effective in the use of soil phosphorus reserves. On the other hand, plant residues rich in nitrogen and left on the soil helps to reduce the need for nitrogen fertilizers of next crops. Grain legumes increase biodiversity, reduce consumption of fossil fuels by reducing the need for fertilizers, produce fewer polluting emissions.

Soybean is currently one of the most important agricultural crop in the world, holding over 100 mil. ha sown annually, the 4th place after wheat, maize and rice. Extent that soybean cultivation has taken in recent decades is due to: chemical composition of the crop, rich in biochemical constituents with high biological value (approximately 20% lipids and proteins around 40%) formed a significant proportion of essential fatty acids and amino acids for human body; very varied possibilities of processing and use of crop (edible fats, animal feed concentrates, protein preparation for food, bio-fuels, other uses as row material in different industries); importance as leguminous plant for land fertility improvement in crop rotations. In this context, decreasing soybean growing in Romania, while in the 80s it had reached over 500 thou ha (the area cultivated was more that over all other European countries together) is an unwanted process with multiple causes and negative consequences.

Our approach comes in the context of decision at EU level on the not-acceptance of GM soybean growing in Europe and new CAP which intend to promote protein crops. In addition, is coming the launch of „Donau Soja” initiative according to a document signed by agriculture ministers from 18 European countries to support traditional soybean varieties growing, including organic soybean crop.

MATERIALS AND METHODS

In the studies carried out they were collected and analyzed statistical data on cultivation of soybean and other crops that produce protein at global, European and national levels, provided

by specialized institutions on statistical data collection and processing. There were studied documents in the last decades on European policies regarding soybean and other protein crops.

A particular attention was paid to evaluate the competitiveness of protein crops under economic aspect, using data from different sources and comparing them with data from wheat and maize, crops which are expected to be replaced in some extend by grain legumes crops. To this end, in specific documents data were collected at EU level and in different European countries. Crops value was assessed using average content in starch, lipids and proteins and using the market value of these products, including market prices for grain legumes (pea, field beans, soybean, lupines, alfalfa), sunflower and rapeseed.

In this study were included data obtained in our own research with soybean crop in order to illustrate the level of the competitiveness of this crop in the specific conditions of South Romania.

RESULTS AND DISCUSSIONS

The current situation of grain legumes growing in the world. Most protein crops are components of the grain legumes group, belonging to the *Fabaceae* (*Leguminosae*) family and include dozens of cultivated plant species in the world, especially in Asia, Latin America, Africa; of these 9 species with economic importance stand out (Table 1). Global area with these legumes totals 201,728 thou ha, of which detaches soybean with 111,271 thou ha (55.2% of world total), field beans with 26,827 thou ha (13.3%), peanuts with 25,408 thou ha (12.6%), chick pea with 13,529 thou ha (6.7%) and cow pea with 11,274 thou ha (5.6%).

Of the legumes, soybean dominates by the production of 276,405 thou tons (72.1% of global) and by productivity – 2,485 kg/ha, and is followed by peanuts with 45,160 thou tons (11.8%), field beans with 22,855 tons (6%) and chick pea with 13,103 thou tons (3.4%). Great growers and producers of soybean are found in South and Central America (52,106 thou ha and 146,149 thou tons, mainly Brazil and Argentina), North America (32,523 thou ha and

94,681 thou tons, mainly the USA) and Asia (20,629 thou ha and 27,294 thou tons, mainly China).

Grain legumes crops growing in Europe.

Traditional grain legumes for the European continent, with food and feed use, are pea, field beans, lentils, broad bean, soybean and lupines. In Europe, grain legumes are grown on only 5,726 thou ha in 2015 (2.8% of the global area). The most important legumes crops on the European continent are soybean with 3,176 thou ha (5,943 thou tons and 1,871 kg/ha) and pea with 1,723 thou ha (3,021 thou tons and 1,753 kg/ha).

Protein crop minor role in European agriculture reflects the large imbalances in the European agro-food system. The decline in grain legumes production and cereals production increase is due to higher productivity of cereals, by comparison with grain legumes crops grown in Europe. Thus, after 1961, of relatively equal production of protein crops, cereals production has almost doubled from those of grain legumes. Coupled payments that took into account protein crops have slowed down to some extent the decline in protein crops production, but not much changed the interest of businesses agents.

In recent years, protein crops production prices have increased slightly faster than the price of wheat, soybean protein feed have become more expensive and fertilizer prices also increased significantly. As a result, competing legumes position strengthened in terms of economic return (European Parliament, 2013).

As noted, since 2013 promoting protein crops is a priority of the Common Agricultural Policy. The reason for this decision was the EU's dependence on imports of proteic agricultural products and reduce protein crops diversity in European agriculture.

Table 3 contains a summary of the EU balance of feed rich in proteins and shows that the EU is totally dependent on imports of 70%, and for soybean meal dependence is over 97%. This illustrates the risks associated with the growing requirements of vegetal protein products, the sustainability of the European agricultural system is questionable and the evolution of

prices on the international market is unpredictable (Schreuder, de Visser, 2014).

The competitiveness of protein crops and European agricultural policies to support these crops.

As noted, the EU is heavily dependent on imports of vegetal products rich in proteins. The main reason is that protein crops in the EU is not competitive with other crops commonly grown as productivity, steady production and sometimes growing technology costs. This competition was assessed using data from various protein crops and comparing them with those from wheat and maize, which are expected to be replaced with the growing of protein crops, including grain legumes.

Table 4 presents the situation for wheat and Table 5 the situation for maize. From tables results, in order to become competitive with wheat or maize, the protein crops productivity should increase considerably. Thus, for soybean, the main source of vegetal proteins, increasing of average production should be about 30% (from 2.7 t/ha to 3.4 t/ha) to compete with wheat and about 63% to compete with maize (from 2.7 t/ha to 4.3 t/ha). For other legumes (pea and field beans) increases should be much higher, eg 76-69% in the competition with wheat and 120-112% in the competition with maize.

It notes that, over the past few decades in Europe were initiated a series of measures designed to support protein crops including: price protection, subsidies and direct coupled payments, agriculture-environment schemes; thus: between 1958 and 1992, various schemes have been developed to support prices for soybean, pea, and lupine; in 1989, they were introduced area payments to chick pea, lentils and pea; in 1992, production subsidies were reduced and replaced by area payments, these payments varying according to the type of crop, and soybean received less than other protein crops; in 2012, 17 EU Member States introduced "The protein award", in the protein crops major growing countries; moreover, Lithuania, Poland and Slovenia have used special measures available to the new Member States to support protein crops (European Parliament, 2013).

Table 1. Grain legumes growing area in the world (thou ha)
(Gh.V. Roman, 2015)

Species	North America	South and Central America	Europe	Africa	Asia	Oceania	Total
Pea	1,634	152	1,723	812	1,875	181	6,377
Field beans	616	5,957	260	5,695	14,237	62	26,827
Soybean	32,523	52,106	3,176	1,797	20,629	41	111,272
Lentils	1,095	20	84	178	2,820	146	4,343
Chick pea	158	161	74	483	12,079	574	13,529
Broad bean	0	163	238	570	964	112	2,047
Lupine	0	34	153	14	0	450	651
Peanuts	421	686	11	12,405	11,871	14	25,408
Cow pea	16	16	7	11,075	160	0	11,274
TOTAL	36,463	60,295	5,726	33,029	64,635	1,580	201,728

Table 2. Grain legumes total production in the world (thou tons)
(Gh.V. Roman, 2015)

Species	North America	South and Central America	Europe	Africa	Asia	Oceania	Total
Pea	4,558	188	3,021	720	2,229	263	10,979
Field beans	1,317	5,590	500	4,860	10,635	53	22,855
Soybean	94,681	146,149	5,943	2,246	27,294	92	276,405
Lentils	2,108	12	71	186	2,246	327	4,950
Chick pea	327	270	94	531	11,068	813	13,103
Broad bean	0	192	663	738	1,494	297	3,381
Lupine	0	55	251	21	1	459	787
Peanuts	1,893	1,759	8	11,547	29,951	28	45,160
Cow pea	29	19	24	5,422	193	0	5,687
TOTAL	104,913	154,134	10,575	26,271	85,108	2,306	383,307

Table 3. EU balance of protein-rich feeds in 2012
(R. Schreuder, C. de Visser, 2014)

Material	EU production (Mt)		EU consumption (Mt)	
	Product	Protein	Product	Protein
Soybean/meal	1,189	452	34,134	15,904
Rapeseed and sunflower seed/meal	27,481	5,213	19,721	6,329
Grain legumes (Pulses)	3,045	670	2,800	616
Dried forage	4,056	771	3,900	741
Miscellaneous plant sources	2,877	654	5,859	1,260
Sub-total	38,648	7,760	66,414	24,850
Fish-meal	398	275	599	433
Total	39,046	8,035	67,013	25,283

Table 4. Indication of required yield level increase to match wheat yield based on EU-member states average
(R. Schreuder, C. de Visser, 2014)

Crop	Yield (tons)			Oil production (Mton)	Starch production (Mton)
	Actual	Increased	% increase		
Soybean	2.7	3.4	30%	3.9	0.0
Rapeseed	3.1	3.1	0%	13.8	0.0
Sunflower	2.2	2.9	31%	20.3	0.0
Lupine	1.0	4.2	334%	1.9	0.0
Pea	2.7	4.8	76%	0.0	15.5
Field beans	2.7	4.5	69%	0.0	11.1
Alfalfa	22.9	24.8	8%	0.0	0.0

Table 5. Indication of required yield level increase to match maize based on EU-member states average (R. Schreuder, C. de Visser, 2014)

Crop	Yield (tons)			Oil production (Mton)	Starch production (Mton)
	Actual	Increased	% increase		
Soybean	2.7	4.3	63%	3.9	0.0
Rapeseed	3.1	3.9	25	13.8	0.0
Sunflower	2.2	3.6	64	20.3	0.0
Lupine	1.0	52	443	1.9	0.0
Pea	2.7	6.0	120%	0.0	15.5
Field beans	2.7	5.7	112%	0.0	11.1
Alfalfa	22.9	31.0	36%	0.0	0.0

The evolution of grain legumes in Romania and the current situation. In Romania, the assortment of grain legumes covered, over time, about 10 species, some of economic importance (pea, field beans, soybean, chick pea, lentils), some grown on small areas and of regional significance (for example, broad beans, peanuts, white lupine, yellow lupine, cow pea). The areas sown with grain legumes have been quite volatile over the last century (Figure 1): about 99 thou ha in 1938 (mainly pea and field beans); 167 thou ha in 1950; 194 thou ha in 1963; 672 thou ha in 1987 (390 thou ha of soybean, 170 thou ha of field beans, 100 thou ha of pea, 10 thou ha of chick pea, and 0.7 thou ha of lentils); 250 thou ha in 1992 (166 thou ha of soybean, 58 thou ha of field beans, 22 thou ha of pea); 125 thou ha in 2013 (67 thou ha of soybean, 21 thou ha of field beans, 30 thou ha of pea).

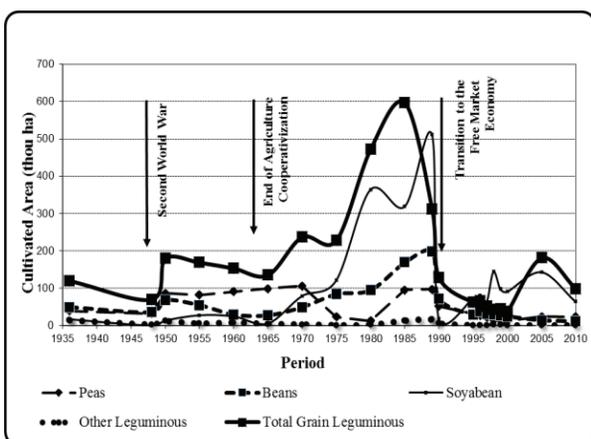


Figure 1. Evolution of Grain Legumes grown acreage in Romania, in 1935-2010 (thou ha) (Gh.V. Roman, 2015)

Soybeans presents a more special situation, in the sense that there were only 5.6 thou ha in 1935, reached over 300 thou ha during 1980-1985 and 500 thou ha in 1989; in that period,

Romania was the most important soybean grower in Europe.

After 1990, the soybean crop has shrunk to 58.1-73.3 thou ha, with a short period with growing areas nearly 200 thou ha, between 2002-2006, when it was permitted growing of GM-modified varieties.

In recent years soybean was grown on 42 thou ha in 2012, 67 thou ha in 2013, 72 thou ha in 2014 and over 100 thou ha in 2015.

European studies have shown that a soybean crop is competitive with wheat at a production least 3.4 tons/ha and with maize at least 4.3 tons/ha. From own research carried out in South Romania, resulted that, under intensive cultivation technology a soybean crop becomes profitable at a production of 3,000 kg grains/ha.

Table 6. Economic efficiency of soybean crop in Dobrudja region (2010-2014)

Index	2010 (very favorable year)	2014 (less favorable year)	Average (2010-2014)
Grain yields (kg/ha)	4,285.2	2,508.1	3,291.1
Market price (lei/t)	1,450	1,450	1,450
Total production value (lei/ha)	6,187.1	3,636.7	4,772.1
Total expenses (lei/ha)	3,773.7	3,610.8	3,680.5
Profit (lei/ha)	2,413.4	25.9	1,091.6
Rentability rate (%)	63.9	0.7	22.9
Production cost (lei/t)	880.6	1,439.7	1,118.3

Donau Soja Initiative and prospects of soybean cultivation in the Danube Basin.

In 2012, it founded Donau Soja (Danube Soya) Association, based in Vienna, whose declaration of constitution was signed so far by 18 European ministers of agriculture (Figure 2).



Figure 2. Region of "Donau Soja" Association ("Danube Soya") activity ("2nd International Danube Soya Congress", Augsburg, 2013)

The organization aims mainly: promoting of GMO-free soybean varieties growing; building a reliable soybean grain and meat supply and a value chain as a contribution to European protein supply; to establish an international breeding-research and control program for GMO-free soybean seeds along the Danube and it will establish concepts for improved crop growing.

The strategies developed in this respect stipulate that potential, among other things, increasing area growing with soybean up to 700 thou ha in Romania (which it can produced about 0.51 mil. tons of proteins), 125 thou ha for Bulgaria, 1 mil. ha for Ukraine, and 75.5 thou ha for Republic of Moldova (Dima, 2015).

CONCLUSIONS

The development of livestock in Europe and the need to balance feed rations based on cereals and the drastic reduction of areas grown with grain legumes crops led to reliance on Europe's imports, which reached 70% for agricultural protein products and over 95% for soybean grains and meal.

Diminishing area with grain legumes was due to the reduction of the use in human food, but also to deficiencies of these crops, including lower productivity, sensitivity to stressors and productions stability.

The consequences of these processes are more important if are considering restricting diversity of agricultural crops in crop rotations, which are dominated by cereals, lack of improving soil fertility that have legumes crops, and high dependence of Europe on imported protein products, in soybean grains and meal, majority GMO.

In recent decades the EU stimulus measures were initiated to extend protein crops growing, and since 2013 this has become a priority objective of the Common Agricultural Policy.

Assortment of legumes (protein crops group) from Europe consists mainly of pea, soybean, field beans, chick pea, lentils, broad beans, and lupine (and alfalfa). As protein sources can be included the oilseed crops important for Europe - rapeseed (a potential of 0.25 mil. tons of protein) and sunflower (a potential of 0.40 mil. tons of protein).

European studies have shown that a soybean crop is competitive with wheat at a production least 3.4 tons/ha and with maize at least 4.3 tons/ha. From own research carried out in South Romania, resulted that, under intensive cultivation technology a soybean crop becomes profitable at a production of 3,000 kg grains/ha. Stimulating farmers to expand the protein crops refers to coupled payments - for example, for non-GM (conventional) soybean in Romania were provided 345 €/ha, by provisions the use of certified seed and harvesting at least 1,300 kg ha (plus current subsidies per ha).

Donau Soja initiative will support farmers in order to increase soybean grown area, will intent to help for establishing harvest processing companies and to develop the trade, accompanied by the certification Donau Soja, allowing production recovery on specific channels. Following this program, provides for Romania, increasing soybean areas up to 700 thou ha, which would ensure a production of about 0.51 mil. tons of proteins.

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