

SOYBEAN IN THE EUROPEAN UNION - AN UPWARD TREND FOR CULTIVATION AND PRODUCTION

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Abstract

The research investigated the trends in soybean crop cultivated area, production and yields in the EU and in its major producing countries: Italy, France and Romania in the period 2015-2024. The data were picked up from European Commission and USDA. Growth rate, trend line regressions, R square, comparisons and forecast, illustrative and tabular methods were used for processing data and commenting the results. The global context was presented first, showing that, in 2024, soybean was cultivated on 146.7 million ha (+22% versus 2015). In Brazil, USA and Argentina are sown the largest areas, accounting for 33.9%, 24.9% and 12.8% summing 71.6%. The world seeds harvest reached 420.8 million tonnes, (+33.12% vs. 2015) to whom Brazil, USA and Argentina contributed by 39.8%, 28.9%, 12.9%, totaling 81.6%. The yield reached 2.87 tonnes/ha (+9.5%) being higher in Brazil 3.4 tonnes/ha, USA 3.09 and Argentina 2.90. In 2024, the EU soybean harvested area was 1,115 thousand ha, (+26.56% vs 2015). The share of Italy, France and Romania in the EU area with this crop was: 30.2%, 13.7%, 13%, summing 56.9%. Production reached 2,992 tonnes (+27.76%), to which Italy, France and Romania contributed with 36.1%, 13.3% and 9.9%, summing 59.3%. The EU yield attained 2,682 kg/ha (+0.9%). In 2024, the yields were: Italy 3,208 kg/ha (-11.29%), France 2,594 kg/ha (-5.3%), Romania 2,034 kg/ha (-0.64%). The worst year for soybean was 2022 when all the EU producers registered the lowest yield. In the EU, smaller surfaces are sown and productions are achieved in Croatia, Hungary, Austria, Slovakia and Germany. Climate change in terms of high temperatures and droughts was the main cause which led to a smaller performance in soybean culture in the Central and Eastern Europe and also in the Mediterranean region. Soybean area, gross output and yield will continue to grow in the EU and at the global level, as soybean plays a crucial role in assuring high quality protein for human diets and animal feed, oil for biofuel and industrial purposes, Nitrogen capture into the soil, fertility improvement, reduction of chemical fertilizers, environment protection and biodiversity preservation. To diminish the negative effect of climate change, farmers must adopt adapted technologies regarding: early cultivation, high production potential and resistant to drought varieties, irrigation systems, plant protection etc Only in this way, they could sustain yield and also they could extend the cultivated area to increase seeds gross output.

Key words: soybean, importance, trends, harvested area, gross output, yield, EU

INTRODUCTION

Soybean is one of the crops of high interest at present, being an important source of protein and like peas, chickpea, lentils, broad bean and also of oil like rape, sunflower and linseed [36].

Soybean chemical composition includes high quality protein (36%), oil (20%), carbohydrates (30%), fiber (13%), vitamins, minerals, enzymes.

Protein production is destined to improve human diet, diminish hunger and nourish the global population [14].

In addition, soybean is lacked of cholesterol, which is beneficial for health assuring protection against cardiovascular diseases [17, 37]. From crushed soybean oilseeds it results meal used as feed for animals (poultry, pigs, cattle, fishes, shrimps) [2, 18, 25]. Also, soybean oil is utilized as a source of renewable energy for producing biodiesel

reducing pollution and protecting environment. Oil is also used in processing industry for obtaining a large range of useful products. Soybean has a large range of utilizations, which could be grouped into two categories: food, including various products and industrial products for various destinations as shown in Figure 1.

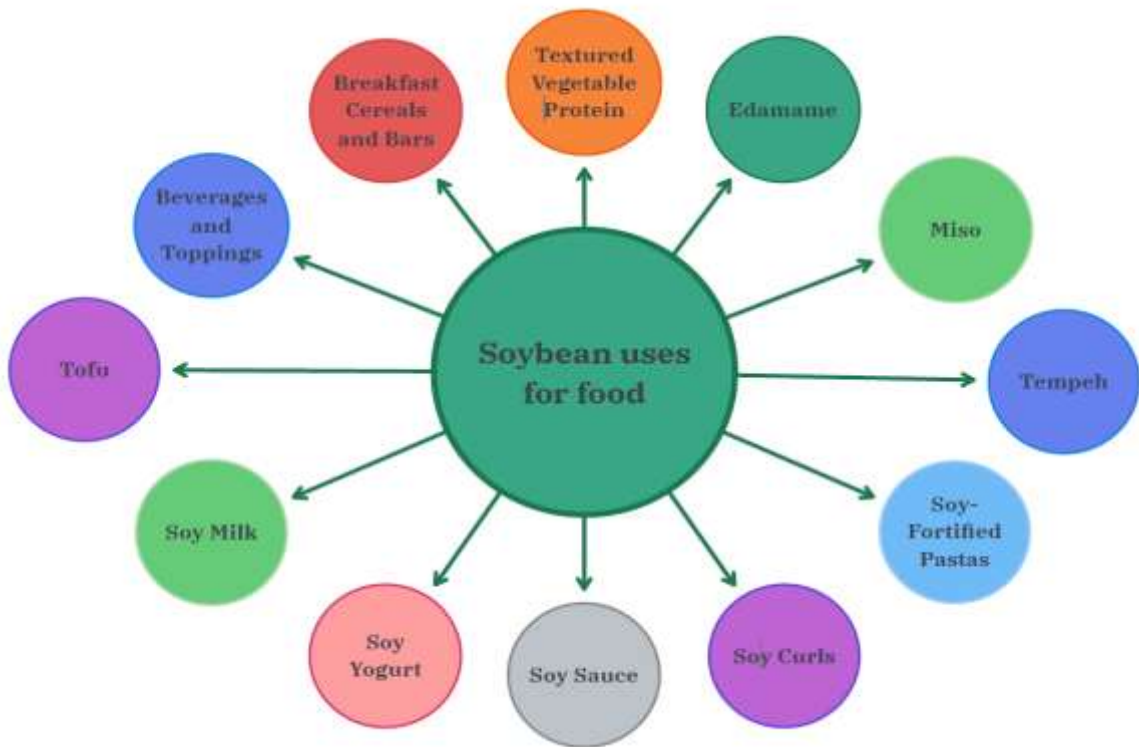


Fig.1. Soybean utilizations for food worldwide
Source: Own conception based on [36].



Fig. 2. Soybean utilizations for industry.
Source: Own conception based on [36].

Soybean uses for industry are also of a large diversity as presented in (Figure 2).

Soybean cultivation could assure important income and profit for farmers and a higher living standard for their families [29]. Soybean is largely cultivated in Brazil, USA and Argentina which are the main producing countries and also at a smaller scale in a few European countries like Italy, France, Romania, Austria, Hungary, Croatia and Germany [28]. In 2023/2024, soybean was cultivated on over 137.10 million ha at the global level, of which in Brazil 33.4%, in the USA 24.3% and in Argentina 12.1%, all together summing 70%. In the EU, soybean is grown on a much smaller area accounting for 1.12 million ha (0.8%). For the years 2024/2025, the projection is 145.81 million ha [34].

Soya cultivation is suitable to temperate climate zones and fertile soils and needs a corresponding amount of precipitations or irrigations. The agricultural technology requires modern machinery and an integrated weed management to assure high yields.

Soybean has a high production potential giving yields which could vary between 1.6 and 2.8 t/ha and even more than 3 t/ha, depending on soil fertility and climate conditions.

Soybean cultivated area and production increased as mentioned by [19, 24].

In 2024, soybean production at the global level accounted for 420.8 million tonnes, of which Brazil 40%, USA 28% and Argentina 12%, summing 80% [33, 35].

In the EU, both the cultivated area and soybean gross output increased across the time [4, 20, 26].

In 2024, the EU-27 soybean gross output reached 2.99 million tonnes, representing 0.71% of the world production. The weight of main producing countries was: Italy 36.1%, France 13.2% and Romania 9.9%, totaling 60% of the EU production [8, 9, 13].

Soybean is recognized as a crop able to capture atmospheric Nitrogen grace to the nodules existing on the roots system of the plant, and in this way soil fertility could be improved, with less chemical fertilizers favoring environment protection. For this reason, soybean could be included in crop rotation [5, 27].

Soybean consumption has increased and continue to grow. In 2021, it accounted for 1.77kg/capita at the world level compared to 1.29 kg in the year 2010 [32].

The higher and higher consumption, generated by the protein and oil need, determines to cultivate soybean on a larger acreage which in the tropical countries has led to deforestation, biodiversity loss, increased CO₂ emissions, water pollution and displacement of indigenous population [3, 6].

In the EU, soybean is cultivated for food, feed, fuel and industrial purposes. Soybean is ranked the 3rd after rape and sunflower for producing oil.

The EU crude protein coming from crops is not enough to cover consumption and for this reason imports are required. In 2024, the EU produced 64 million tonnes of crop crude

protein and imported 19 million tonnes especially from Brazil and USA, which are the main suppliers.

Protein is needed in animal diets for growing and fattening and animal farming is the largest consumer of plant protein as feed.

The EU livestock requires 72 million protein as feed, of which 27% comes from soybean and the rest from roughage (42%), cereals (21%), and oilseeds meals (10%). Soybean meal and other sorts of meals account for 35% in the EU livestock protein intake. Soybean as feed is used 67% for poultry, 21% for pigs and 10% for beef and dairy cattle, and the remaining of 2% fishes and shrimps [11].

Starting from 2023, the EU issued a Deforestation Regulation (EUDR) which provides that the imported soybeans to have zero risk of deforestation, promoting a sustainable agriculture [7].

Therefore, the EU reviewed its policy and priorities to ensure o more resilient food system. In this respect, it issued measures of interventions of the CAP sustaining the expand of the cultivated area, increase yields and production of plant-based crude protein to balance the supply and demand [10].

In the EU, it is cultivated GM-free soybean, but GM soybean can be used under a *"complete and rigorous procedure, which guarantees a high level of protection of human and animal health, as well as for the environment"* [31].

The market request for organic soybean has encouraged the farmers to extend the cultivated surface and grow the output, using new cultivars with a high genetic value and even adapted to the climate conditions existing in the Northern Europe like in Germany, Poland and Netherlands.

Due to the discrepancy in the impact of climate between Western and Northern Europe and Eastern European countries, North of Italy and the Balkan regions, it is still an yield gap, which oblige the members states to look for climate resilient solutions [16, 30].

Organic soybean is produced especially in France, Austria, Romania, Germany and Italy, all together weighting for 90% in total soybean output [1].

Therefore, in the EU internal production of soybean will cover the needs for food, but the

requirements of feed will be still covered by imports.

However, the EU soybean output is deeply affected by the climate factors mainly by higher temperatures and droughts which in the recent years increased the gap of production among the member states with favorable and the ones with non favorable climate conditions. And this aspect will still impose the dependence of external supply of soybeans to cover the deficit.

In the EU, soybean is utilized as food, and also for animal feed, crushing and other purposes. From the crushed soybeans it is obtained 80% soymeal for feeding poultry, pigs and cattle and 20% oil. From the total EU meal consumption, soymeal comes on the top position with 55%, while rape, sunflower and other meal sources have smaller percentages (Figure 3).

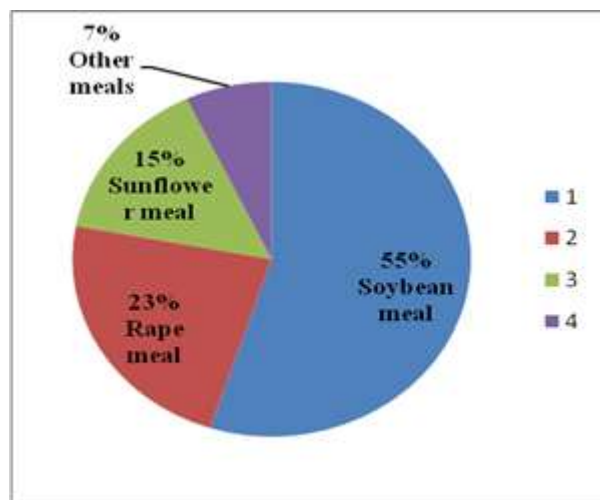


Fig. 3. Share of soybean meal in the EU meal consumption in 2023 (%).

Source: Own design and calculations based on the data from [15].

Soybean meal is largely utilized in the countries where animal farming is well developed like Spain, France, Italy, Germany, Poland, Netherlands, Denmark, Portugal, Belgium and Romania [18].

The use of soybean oil for various purposes in the EU is mentioned in Figure 4.

Taking into account the aspects presented above, the goal of this research is to analyze the status and evolution of soybean crop regarding the cultivated area, production, yield in the EU in the global context, in the period 2015-2024,

highlighting the performance in the main producing countries Italy, France and Romania for identifying the new tendencies in the EU policy for the future of this important protein and oilseed plant.

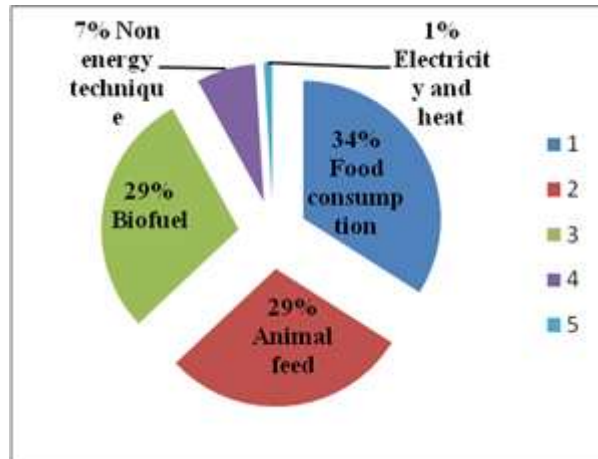


Fig. 4. The uses of soybean oil in the EU (%).

Source: Own design based on the data from [15].

MATERIALS AND METHODS

This research work required a deep documentation regarding the role of soybean crop in assuring food for the population, feed for animals and raw material for industry, studying the published scientific literature, official reports of recognized agricultural organizations such as: European Commission, FAO, USDA, FEDIOL and other source from which the needed empirical data have been picked up.

The data have been structured by the selected items and processed using various procedures and methods including:

- the dynamic analysis in the period 2015-2024 for the key economic indicators: cultivated area, production and yield;
- the growth rate registered in the whole interval;
- regression equations for identifying the trend line;
- coefficient of determination, R square, for reflecting the determinants of the changes across the time;
- descriptive statistics for each indicator in terms of mean, standard deviation, maximum and minimum level and coefficient of variation;

-market share of the selected countries in the total level of the studied indicator;
-comparison method for establishing the similarities and differences among the countries.

-forecast for the year 2025 based on the regression equations.

Graphical illustrations were used for a better understanding of the obtained results and tables summarized the essential data and results, being followed by corresponding discussions.

Finally, the main conclusions were emphasized.

The study consists of two parts:

(a) A brief statistics of the international context of soybean at the global level in terms of cultivated area, production and yield an in the main producing countries Brazil, USA and Argentina.

(b) The EU analysis of the same indicators both the community level and also in the three main producing member states: Italy, France and Romania.

RESULTS AND DISCUSSIONS

A brief statistics on soybean at the global level

The cultivated area with soybean worldwide has registered an upward trend from 120.7 million ha in the year 2015 to 146.7 million ha in the year 2024, accounting for a surplus of 26 million ha, or +22.1%. the value of R square = 0.890 reflects that 89% of the variation of the cultivated area with this crop depended on time and farmers higher interest to cultivate a larger acreage taking into consideration its advantages in terms of income and profit. More than this, looking at the regression equation and the shape of the graphic it is clear the tendency to increase the surface (Fig. 5). Therefore, in 2025, it is expected as the cultivated area with soybean to reach 149.26 million ha.

The main countries cultivating soybean are Brazil, USA and Argentina whose share in the global cultivated surface in the year 2024 was: 33.9%, 24.9% and 12.8% summing 71.6%. Smaller surfaces are cultivated in India and China.

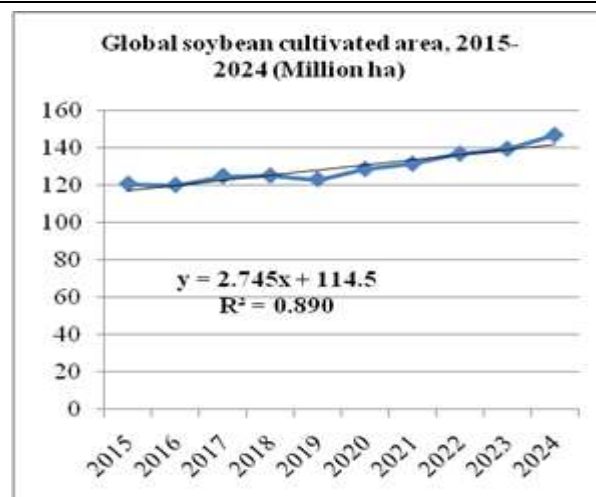


Fig. 5. Cultivated area with soybean worldwide (Million ha)

Source: Own design and calculation based on the data from [35].

The soybean production at the global level had an ascending trend from 316.1 million tonnes in the year 2015 to 420.8 million tonnes in 2024, meaning by 33.12% more than in the first year.

The R square value = 0.809 shows that production varied in time having an increasing trend (Figure 6). This growth was determined by the increased soybean harvested surface and also due to other factors contributing to a higher production in terms of more productive varieties and new technologies applied etc.

Taking into account the regression equation, it is easy to estimate the forecast of seeds production for the year 2025 which is expected to reach 429.66 million tonnes.

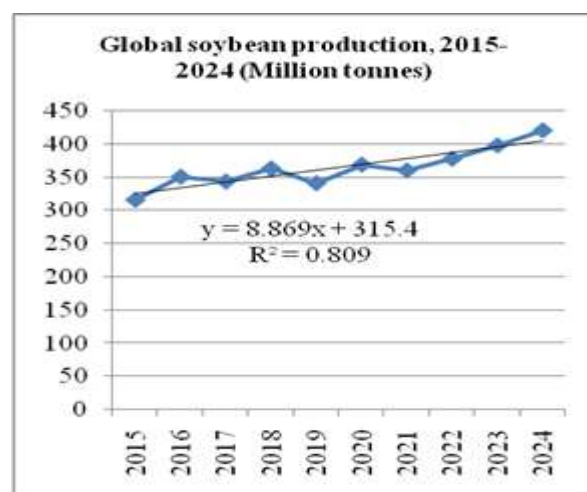


Fig.6. Soybean production worldwide (Million tonnes)

Source: Own design and calculation based on the data from [35].

The production carried out by the main soybean producing countries in the year 2024 had the following contribution to in the global production: 39.8% Brazil, 28.9% USA and 12.9% Argentina, totaling 81.6%.

Soybean yield at the global level increased from 2.62 tonnes/ha in 2015 to 2.87 tonnes/ha in 2024, showing a surplus of +9.5% in the last decade. It does not look to be too much.

The factors responsible of such a situation with a deep impact on the results have been the productive potential the varieties, the zone and its soil and climate conditions, soil fertility, precipitations and temperatures, technologies applied, farmer experience and climate change, which did not allow as average production to reach the desired results (Figure 7).

The value of R square= 0.113 very small shows exactly that the variation of yield was caused by other factors.

In 2025, the mean of global soybean production is expected to be only 2.90 tonnes/ha.

In the main countries producing soybean seeds, yield level was in the year 2024: Brazil 3.4 tonnes/ha, USA 3.09 tonnes/ha and Argentina 2.90 tonnes/ha.

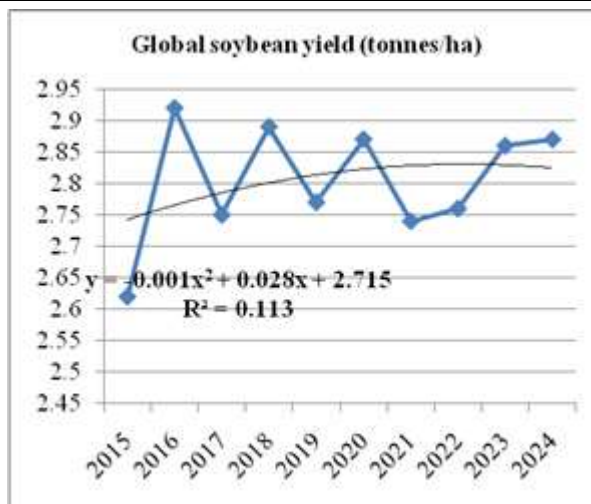


Fig.7. Soybean yield at the global level (Tonnes/ha)
Source: Own design and calculation based on the data from [35].

The increased production of soybean seeds at the world level was influenced by the growth of consumption and especially in China, USA, Brazil, the EU and Argentina whose requirements 31.5%, 17.2%, 15%, 14.2 % and 11.2 % totalize 90% in total consumption.

The descriptive statistics for the three soybean economic indicators at the global level is shown in Table 1.

Table 1. Descriptive statistics for soybean cultivated area, production and yield at the global level in the period 2015-2024

	Cultivated area (Million ha)	Soybean seeds production (Million tonnes)	Soybean yield (Tonnes/ha)
Mean	129.68	364.24	2.80
Standard Deviation	8.80	29.84	0.092
Kurtosis	-0.238	0.458	0.101
Skewness	0.836	0.461	-0.716
Minimum	120.1	316.1	2.62
Maximum	146.7	420.8	2.92
Coefficient of variation (%)	6.78	8.19	3.28

Source: Own calculations.

At the global level, the cultivated area in the period 2015-2024 had an average of 129.68 million ha. The average production accounted for 364.24 million tonnes and the average yield for 2.8 tonnes/ha.

The coefficient of variation for each studied indicator is very small, more exactly lower than 10% (Table 1).

Soybean in the European Union **Cultivated area**

In the EU, soybean registered an increased cultivated are from a year to a year from 881 thousand ha in 2015 to 1,115 thousand ha in 2024, therefore by 26.56%. This was a consequence of the attention paid by the European Commission for agriculture to apply a policy favorable to this protein and oil crop in order to stimulate the internal production and diminish the dependence on import. In the EU is cultivated only the GO-free soybean (Figure 8).

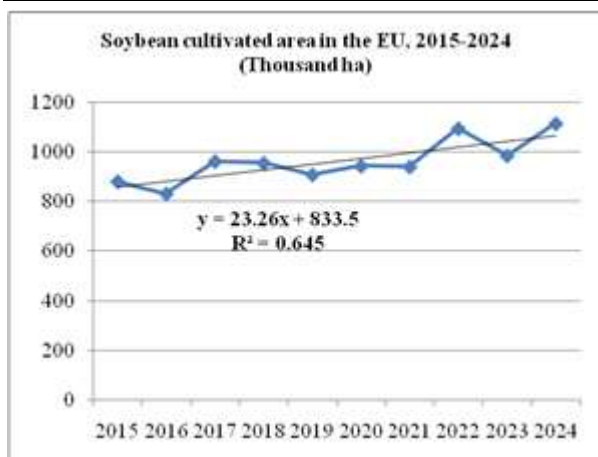


Fig. 8. The cultivated area with soybean in the EU, 2015-2024 (Thousand ha)
Source: Own design and calculations based on the data from [12].

The R square reflect that the variation of the cultivated surface was determined 64.5% by time an also the remaining of 35% variation was caused by other factors.

The regression equation allows to calculate the forecast of the cultivated area for the year 2025 which is expected to be 1,136 thousand ha.

The surface increased in the member states which have good soil and climate conditions for this crop.

The main countries dealing cultivating soybean are Italy, France and Romania with a share in the EU total cultivated surface with this crop in the year 2024 of: 30.2%, 13.7%, and,

respectively, 13%, all these three countries totalling 56.9%.

But, in the EU, there are also other counties which cultivated smaller surfaces, therefore having a smaller percentage as follows: Croatia 9.2%, Hungary 10%, Austria 8%, Slovakia 6% and Germany 3.7%. All these eight member states together account for 93.8% in the EU cultivated area with soybean in 2024 (Figure 9).

In case of Italy, the surface variation depended on time only in a small proportion accounting for 27.2%, as shown by R square and the remaining of 62.8% is determined by the change of other factors, probably the intervention policy to stimulate farmers to grow the cultivated area and climate change.

In case of France, R square tells us that 36.8% of the variation in cultivated area with soybean was influenced by time, and 64.2% variation was caused by other factors.

In Romania, R square is 0.731 showing that 73.1% of area variation was determined by time, and the remaining of 26.9% by other factors of influence like incentives offered to cultivated soybean on larger surfaces.

Based on the regression equations, the forecast for 2025 is that in Italy the cultivated area will decline from 337 thousand ha to 323.24 thousand ha.

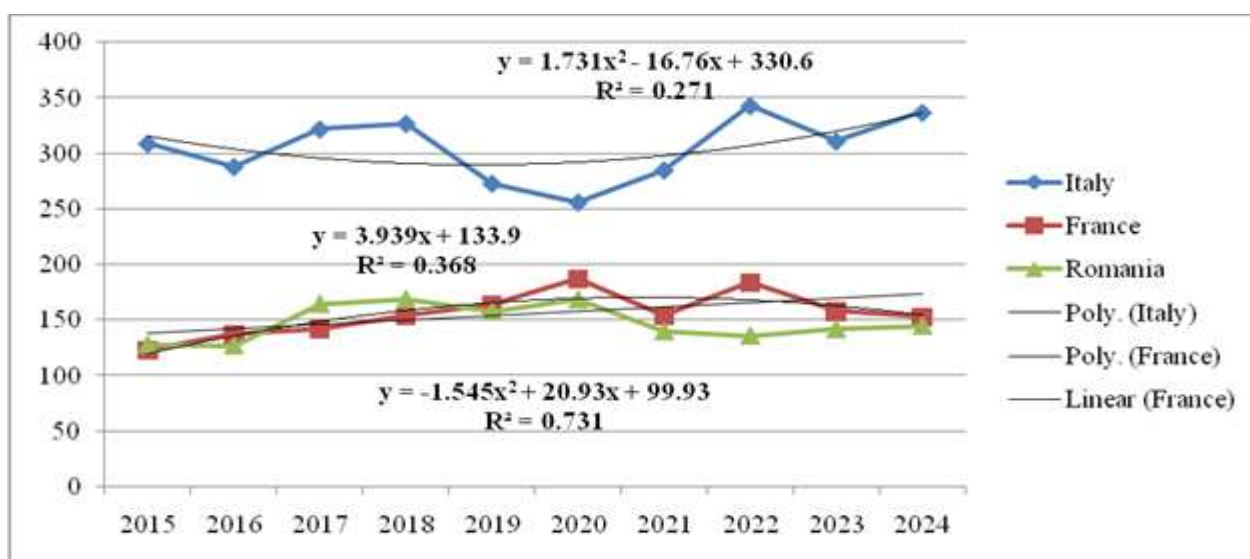


Fig. 9. The cultivated area with soybean in Italy, France and Romania, 2015-2024 (Thousand ha)
Source: Own design and calculations based on the data from [12].

Table 2. The description statistics for the EU cultivated area with soybean and also in the main producing countries Italy, France and Romania, 2015-2024

	EU	Italy	France	Romania
Mean	961.5	305.1	155.6	147.9
Standard Deviation	87.65	28.68	19.64	16.21
Kurtosis	0.146	-0.944	-0.076	-1.604
Skewness	0.638	-0.365	0.198	0.176
Minimum	831	256	123	127
Maximum	1,115	343	187	169
Coefficient of variation (%)	9.11	9.4	12.62	10.9

Source: Own calculations.

In France, it is expected that in 2025, the soybean to be sown on 156.9 thousand ha and in Romania the forecast is 164.38 thousand ha. The description statistics for the cultivated area in the EU is presented in Table 2.

At the EU level, the average cultivated area in the period 2015-2024 accounted for 961.5 thousand ha.

In the main cultivating countries the mean surface with soybean is 305.1 thousand ha in Italy, 155.6 thousand ha in France and 147.9 thousand ha in Romania.

The variation coefficient is small at the EU level and in Italy being below 10%, while in France and Romania is a little over 10%.

Soybean production

In the EU soybean gross output increased by 27.76% from 2,341 tonnes in the year 2015 to 2,992 tonnes in the year 2024. This growth was stimulated by the ascending cultivated surface and also by the improved implemented technologies based on high performance potential varieties, fertile soil and favorable climate conditions in general, except the year 2022 which was not so favorable for soybean (Figure 10).

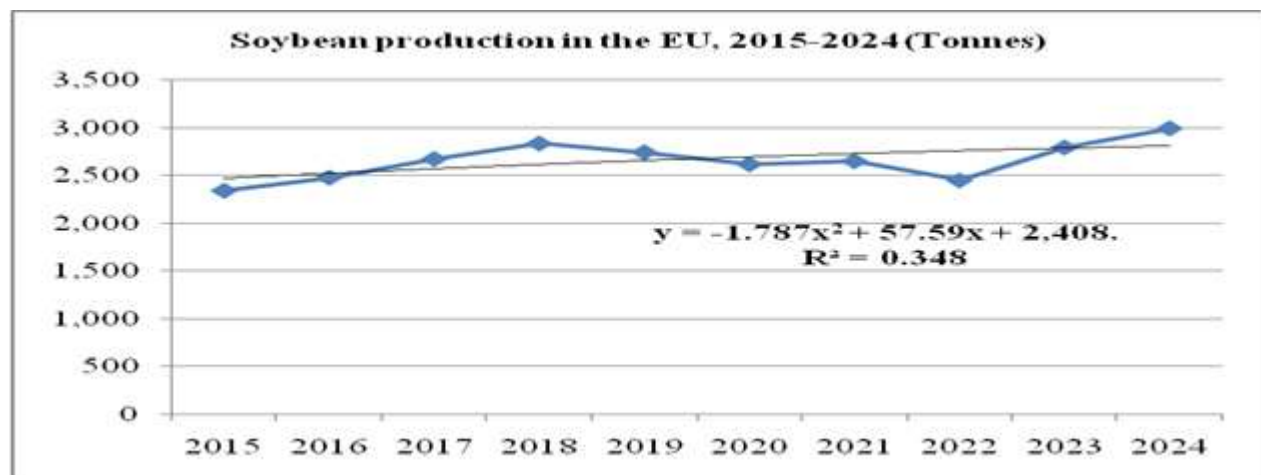


Fig. 10. The EU soybean gross output, 2015-2024 (Tonnes)

Source: Own design and calculations based on the data from [12].

R square = 0.348 reflects that 34.8% of the production variation is caused by time and 65.2% by other factors such as technologies applied and climate change.

The regression equation allows to estimate the forecast for soybean production in the EU which is expected as in 2025 to reach 3,045.39 tonnes.

In the year 2024, the contribution of the main soybean producing countries to the EU output was: Italy 36.1%, France 13.3% and Romania 9.9%, summing 59.3%. Other EU countries also contributed by in smaller proportions as follows: Croatia 8.5%, Hungary 8.3%, Austria 8.2%, Slovakia 5.5% and Germany 4.4%.

The dynamics of soybean production in Italy, France and Romania is presented in Figure 11.

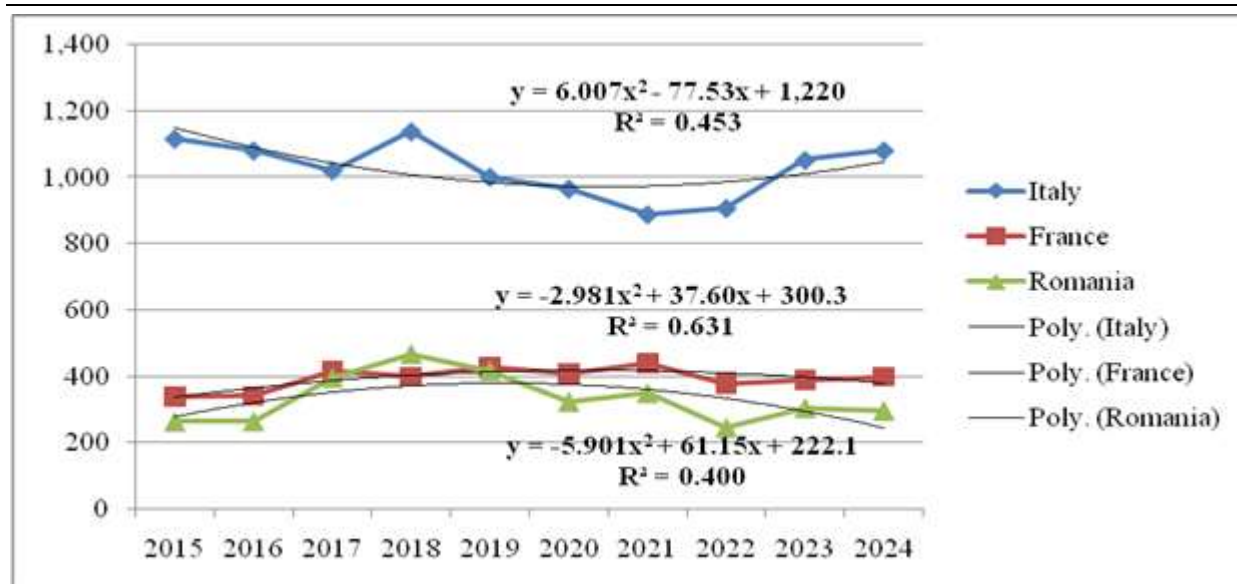


Fig. 11. The soybean gross output in the main producing countries in the EU: Italy, France and Romania, 2015-2024 (Tonnes)

Source: Own design and calculations based on the data from [12].

In Italy, soybean production had a sinuous evolution from 1,117 tonnes in 2015 to 1,081 tonnes in 2024, meaning a decline by 3.3%. The lowest productions were registered in the years 2021, the lowest level of only 887 tonnes, and also in 2020, 2022. Later, production started to recover to 1,081 tonnes in the last year of the analysis. This variation was caused mainly by the climate change bringing high temperatures and lower rainfalls which disadvantage the crop.

R square = 0.453 reflects that 45.3% of the production variation was caused by time and 54.7 % by other factors, mainly climate change.

The regression equation provides information to estimate than in the year 2025, Italy will obtain a soybean production of 1,043.7 tonnes/ha.

In case of France, soybean production also had a sinuous dynamics. But, if in 2015, France recorded the lowest soybean seeds production of only 337 tonnes, in 2024, production was by 17.8% higher, accounting for 397 tonnes. The worst climate years for France were 2015, 2016 and then 2022.

R square shows that 63.1% of the production variation was caused by time and 36.9% by other factors. The regression equation furnished useful information to determine the

production forecast for 2025 which will account for 425.71 tonnes.

In case of Romania, soybean output increased from 262 tonnes in 2015 to 295 tonnes in 2024, showing a surplus of 12.59%. After a good start from 2015 to 2018 when it achieved a peak of 466 tonnes, since 2020 soybean production declined in Romania due to the higher and higher temperatures, hot air waves and severe droughts as it happened in Eastern Europe and Balkan region. However, oil seeds crops and soybean will continue to be cultivated for their productivity and fast net return to farmers [21].

R square = 0.400 reflects that the variation of production by time accounted for 40%, while 60% of variation was caused by other factors as specified above.

Based on the regression equation, it was established the forecast for the year 2024 which is expected as Romania to carry out 321.33 tonnes soybean seeds.

The description statistics for the EU soybean seeds production and also in the main producing countries Italy, France and Romania is shown in Table 3.

The EU average soybean seeds production in the interval 2015-2024 was 2,656.1 tonnes, ranging between the minimum 2,341 tonnes and maximum 2,991 tonnes, having a small coefficient of variation of 7.57%.

Table 3. The description statistics for the EU soybean production and also in the main producing countries Italy, France and Romania, 2015-2024

	EU	Italy	France	Romania
Mean	2,656.1	1,024.9	392.4	331.3
Standard Deviation	196.01	85.54	34.07	73.65
Kurtosis	-0.389	-0.930	-0.391	-0.619
Skewness	0.0007	-0.419	-0.572	0.665
Minimum	2,341	887	337	244
Maximum	2,991	1,139	439	466
Coefficient of variation (%)	7.37	8.34	8.68	22.23

Source: Own calculations.

In Italy, the average soybean production in the last decade accounted for 1,024.9 tonnes, varying between the minimum 887 tonnes and the peak of 1,139 tonnes. The coefficient of variation is small accounting for 8.34%.

In case of France, the average production on the whole analyzed period is 392.4 tonnes varying between the lowest level 337 and the highest level 439 tonnes. The variation is 8.38%, a reasonable value.

In Romania, soybean seeds output registered a mean of 331 tonnes in the last 10 years, and ranging between 244 tonnes, the smallest level and 466 tonnes, the top production. The coefficient of variation has a value of 22.23 % reflecting that standard deviation is 22.23% of the mean, and, compared to the coefficient of variation got by Italy and France, in Romania it has a higher level.

Soybean is an important oil plant in Romania and for this reason the utilized land for this crop has grown and production increased despite that the climate change could affect productivity and farmers income in the years with high temperatures and droughts [22, 23].

Soybean seeds yield in the EU and in the main producing countries

Soybean seeds yield in the EU varied between 2,657 kg/ha in the year 2015 and 2,682 kg/ha in the year 2024, a year in which it looked to be a little higher by 0.9% than in the year at the beginning of the studied interval. Its level was determined by the gross output level and also by the cultivated area. The top average yield accounted for 3,020 kg/ha and was recorded in the year 2019. The lowest performance of 2,230 kg/ha was carried out in the year 2022, which was the worst year for soybean crop (Figure 12).

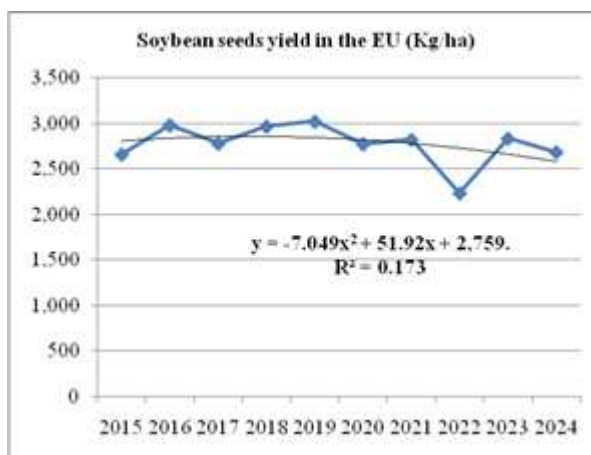


Fig. 12. The soybean seeds average yield in the EU, 2015-2024 (kg/ha)

Source: Own design and calculation based on the data from [12].

The R square value reflects that 82.7% of the yield variation is caused by other factors than time. The regression equation was used to calculate the forecast for the year 2025 and the result is 2,684.24 kg/ha with 0.02 kg more than it was in the year 2024. Practically, a neglecting difference.

The evolution of the soybean seeds yield in the main producing countries of the EU in the studied period is presented in Figure 13.

In Italy, average yield varied between 3,615 kg/ha in 2015 and 3,208 kg/ha in 2024, when it was by 11.29% smaller. The best years for soybean yield in Italy were 2020 when yield recorded the highest level of 3,769 kg/ha and also in 2016, when it was 3,753 kg/ha.

The smallest yield was registered in the year 2022, only 2,641 kg/ha.

R square = 0.251 reflects that other factors are responsible of yield variation and not time. According to the regression equation, the forecast for the year 2025 is 3,174.31 kg/ha

smaller than in the year 2024, when it accounted for 3,208 kg/ha.

In France, soybean seeds yield registered the top level of 2,915 kg/ha in the year 2017 and the smallest level of 2,043 kg/ha in the year

2022, the worst year for soybean in all the selected countries. In this case, also the yield variation was caused by the changes of other factors.

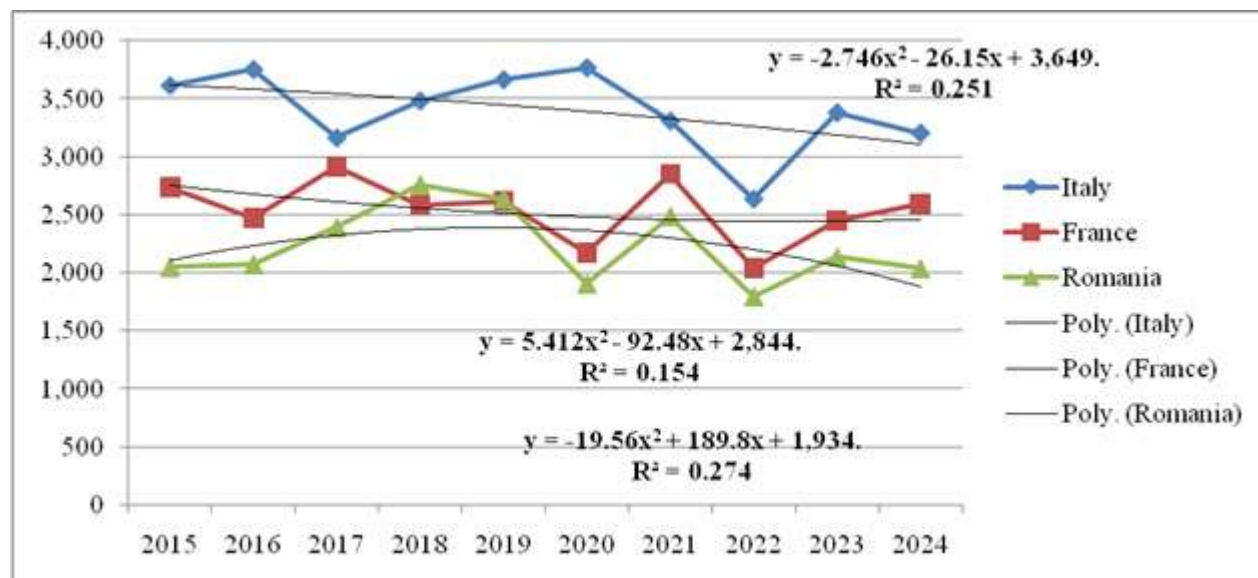


Fig. 13. The soybean seeds average yield in Italy, France and Romania, 2015-2024 (kg/ha)

Source: Own design and calculations based on the data from [12].

The forecast for 2025 is 2,528.8 kg/ha by 2.5% smaller than 2,594 in the year 2024.

In Romania, soybean seeds yield accounted for 2,047 kg/ha in 2015 and for 2,034 kg/ha in 2024 (-0.64%). Like in Italy and France, the yield variation was determined by other factors. In the year 2022, Romania registered the lowest yield, 1,794 kg/ha and in 2020 also a very low level, 2,176 kg/ha.

In 2022, per surface unit, it was obtained the lowest yield of 1,448 kg in Slovakia, 2,030 kg in Hungary, 2,143 kg in Croatia, 2,327 kg in Germany and 2,617 kg in Austria.

The main cause was climate change which had a negative impact on agriculture in the Central

and Eastern Europe and also in the Mediterranean region.

Based on the regression equation, the yield forecast for the year 2025 is 1,841.21 kg/ha, by 9.5% smaller than in 2024.

The descriptive statistics for soybean seeds yield in the EU and Italy, France and Romania is shown in Table 4.

Table 4 reflects that the mean of soybean yield at the EU level in the period 2015-2024 is 2,773.7 kg/ha, with a low variation as shown by the coefficient of variation.

Italy registered a soybean average yield in the last decade of 3,399.6 kg/ha, by 22.56% higher than the EU average yield. The variation was also small, CV being 10.09%.

Table 4. The description statistics for the soybean seeds yield in the EU, Italy, France and Romania, 2015-2024

	EU	Italy	France	Romania
Mean	2,773.7	3,399.6	2,544.6	2,224.7
Standard Deviation	227.07	343.17	274.52	321.82
Kurtosis	3,428	1.5924	-0.076	-1.059
Skewness	-1.563	-1.143	-0.603	0.464
Minimum	2,230	2,641	2,043	1,794
Maximum	3,020	3,769	2,915	2,757
Coefficient of variation (%)	8.18	10.09	10.78	14.46

Source: Own calculations.

France performed an average yield of 2,544.6 kg/ha, by 9.3% smaller than the EU average. Romania recorded an average yield of 2,224.7 kg/ha by 19.8% smaller than the EU average, by 34.6% smaller than the soybean average yield of Italy, by 12.6% lower than the average in France.

In case of Italy and France, the CV is around 10%, while in Romania is closer to 15%, reflecting a variation a little higher than the other two countries.

CONCLUSIONS

This research was destined to investigate the trends in soybean crop cultivated area, seeds production and yields and in the EU and in its major producing countries Italy, France and Romania.

First, it was presented the global status of the crop.

In 2024, soybean was cultivated on 146.7 million ha, by +22% more than in 2015. The largest areas are sown in Brazil, USA and Argentina whose share was 33.9%, 24.9% and 12.8% summing 71.6%.

The global soybean seeds gross harvest reached 420.8 million tonnes in 2024, meaning by 33.12% than in 2015. The contribution of the main producing countries was: 39.8% Brazil, 28.9% USA and 12.9% Argentina, totaling 81.6%.

In 2024, the yield accounted for 2.87 tonnes/ha, showing a surplus of +9.5% compared to 2015.

The yield level in Brazil was 3.4 tonnes/ha, while in USA 3.09 tonnes/ha and Argentina 2.90 tonnes/ha.

The EU does not cultivate a large surface with soybean, but it has also registered an increased acreage being interested to produce more seeds for internal market and reduce the dependence of imports, which is still necessary for meals.

In 2024, the EU soybean harvest area was 1,115 thousand ha, by 26.56% higher than in 2015. Italy, France and Romania had a weight in the EU cultivated area with this crop of: 30.2%, 13.7%, and, respectively, 13%, totaling 56.9%. Smaller surfaces are cultivated in other member states as follows: Croatia 9.2%,

Hungary 10%, Austria 8%, Slovakia 6% and Germany 3.7%.

Soybean seeds production reached 2,992 tonnes in the year 2024, being by 27.76% higher than in 2015. Italy, France and Romania contributed with 36.1%, 13.3% and 9.9%, summing 59.3%. Other EU countries had a smaller proportions: Croatia 8.5%, Hungary 8.3%, Austria 8.2%, Slovakia 5.5% and Germany 4.4%.

Soybean seeds yield in the EU varied has slightly grown by only 0.9% attaining 2,682 kg/ha in the year 2024 compared to 2,657 kg/ha in 2015. The best year for soybean was 2019, when yield had a peak of 3,020 kg/ha. The worst year was 2022 when, the EU recorded only 2,230 kg/ha.

Italy registered 3,208 kg/ha in 2024, by 11.29% less than in 2015. The best yield in Italy was 3,769 kg/ha in 2020 and also 3,753 kg/ha in 2016. The worst year for Italy was 2022, when yield was only 2,641 kg/ha.

In 2024, France attained 2,594 kg/ha seeds by 5.3% less than in 2015. The top level was 2,915 kg/ha in 2017 and, the worst year was 2022 when per ha there were produced only 2,043 kg.

Romania registered 2,034 kg/ha in 2024 by 0.64% less than in 2015. In 2022, it was carried out the lowest yield of 1,794 kg/ha. But, the best yield 2,757 kg/ha was achieved in 2018.

Therefore, the highest yield is produced in Italy, followed by France and Romania.

All these three countries had the smallest yield level in the year 2022 which was not favorable for soybean neither in the major producers or in the other EU countries.

The main cause was climate change which had a negative impact on agriculture in the Central and Eastern Europe and also in the Mediterranean region.

Soybean acreage, production and yield will continue to grow in the future due to the role of soybean crop in assuring high protein for human diets and animal feed, oil for biofuel and industrial purposes. More than this the plant ability to capture Nitrogen into the soil and increase its fertility leading to lower amounts of chemical fertilizers will have a beneficial effect of environment protection and

biodiversity conservation. Also, its importance in crop rotation must not be neglected. Having in mind the effects of climate change, farmers have to adopt adapted technologies concerning: early cultivation, varieties of high production potential and resistant to drought, irrigation systems, plant protection etc in order to sustain yield, but also they could grow the cultivated area to increase seeds gross output.

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