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THE IMPACT OF REDUCING THE AMOUNT OF FERTILIZERS AND PESTICIDES ON THE YIELD OF THE SOYBEAN CROP

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Abstract

The study aims to analyze the main effects of the reduction in the use of agricultural inputs in the soybean culture, according to the Farm to Fork Strategy: decrease in agricultural production, increase in price, decrease in producers income, affecting the purchasing power of consumers. We analyzed soybean cultivation in Romania and compared to seven other EU countries (Germany, Spain, France, Italy, Hungary, Poland and United Kingdom) and showed that the use of pesticides and fertilizers in Romania is below the average of the quantities used in the countries included in the study. The areas cultivated with soybeans are significant and Romania occupied the 2nd place in the top of multi-year average for the total production of soybeans compared to the other analyzed countries.

Key words**:** *consumption of fertilizers and pesticides, soybean crop, Romania*

INTRODUCTION

Soya is used in human nutrition, in animal feed and as a row material for various industries [12].

The biggest soybean producers are Brazil, USA and Argentina. The EU' s soybean production does not cover its needs, therefore it is necessary to capitalize on the community's agricultural potential [5][6].

In our country, there are 5 favorable zones for soybean cultivation, depending on the thermal potential, namely:

- *Zone I* – includes the South of the Romanian Plain and Dobrogea. In this area, it is recommended to cultivate late and semi-late soybean varieties, under irrigation conditions.

-*Zone II* – includes the Western Plain (the Plain of Banat and Crisana). In this area, it is recommended to cultivate semi-late and semi-early soybean varieties, under irrigation conditions, but also under non-irrigation conditions.

Zone III – includes the Northern part of the Romanian Plain. In this area, it is it is recommended to cultivate semi-late, semi-early and early soybean varieties in the more northern areas.

Zone IV includes the Eastern part of Moldova and North-Western Plain of the Country. In this area, it is it is recommended to cultivate semi-early, early and very early soybean varieties.

Zone V includes the Western and South-Western parts of Transylvania (the meadows of Mures, Tarnave and Somes) and North-Eastern part of Moldova. In this area, it is it is recommended to cultivate early and very early soybean varieties [9].

In the context of the transition to a sustainable agriculture, soybean culture has an important role both from the perspective of environmental quality, as well as its use in population nutrition and animal rations. Soy is a valuable crop due to the fact that it is combines in its composition a very high amount of protein on average 40% and oil 20% [3].

The specific consumption of nutrients for the formation of 100 kg of seeds and related secondary biomass is: 7.1-11 kg Nitrogen, 1.6-4.0 kg $P_2 0_5$ and 1.8-4.0kg $K_2 0$. Soybean consumes large amounts of nitrogen, due to the high content of the whole plant in this element (in protein) [9].

The Farm to Fork Strategy proposes that each country establish precise targets regarding the reduction of pesticides, fertilizers and antimicrobial substances used [2][1]. The effects generated by the reduction in the use of agricultural inputs will be evident on the one hand, through the reduction of agricultural production in the soybean crop, on the other band, through the reduction of competitiveness for export [3][4]. All these will lead to higher soybean prices, which will have a negative impact on consumers [11].

In this context, the goal of the paper was to analyze the soybean cultivation in Romania and compared to seven other EU countries: Germany, Spain, France, Italy, Hungary, Poland and United Kingdom to show if the amount of pesticides and fertilizers used in Romania is below the average quantities utilized in other EU countries selected in the study.

MATERIALS AND METHODS

In this study, the data provided by Eurostat, FAOStat and National Institute of Statistics were the basis of the processing and establishment of the impact of the use of the quantities of fertilizers and pesticides on the production of the soybean crop, in the period 2010-2019 [10].

In the article we analyzed the following indicators: cultivated area, total production, average production per hectare, multi-year average for total cultivated area, multi-year average for total production, multi-year average for average production/ha, in Romania and Germany, Spain, France, Italy, Hungary, Poland and the United Kingdom.

We used the multi-year average (2010-2019) of the amounts of chemical fertilizers and pesticides used per cultivated hectare(nitrogen fertilizers(N), potassium fertilizers(K_20), phosphorus fertilizers (P_20_5), pesticides-total), in the countries included in the analysis and the average productions per hectare(tons) made to calculate the amount (kg) of chemical fertilizers and pesticides used to obtain one ton of soybeans.

At the macroeconomic level, in the conditions where it is a high demand for soybeans worldwide, an increase in the demand for soybeans is estimated, due to lower productions, even an uncertainty in ensuring global food security. In this sense, an accelerated increase in soy process is expected, which may become unsustainable for users of soy products [7].

RESULTS AND DISCUSSIONS

The largest area cultivated with soybean can be found in Italy, in 2018, with a value of 326.59 thousand hectares and in Romania with a value of 169.45 thousand hectares [7].

In the period 2010-2018, Romania had the second largest area of land cultivated with soybean among the analyzed countries. Since 2019, the cultivated area has decreased, thus Romania occupies the third place with an area of 158.15 thousand hectares, while France has the second largest cultivated area with 163.80 thousand hectares (Fig. 1).

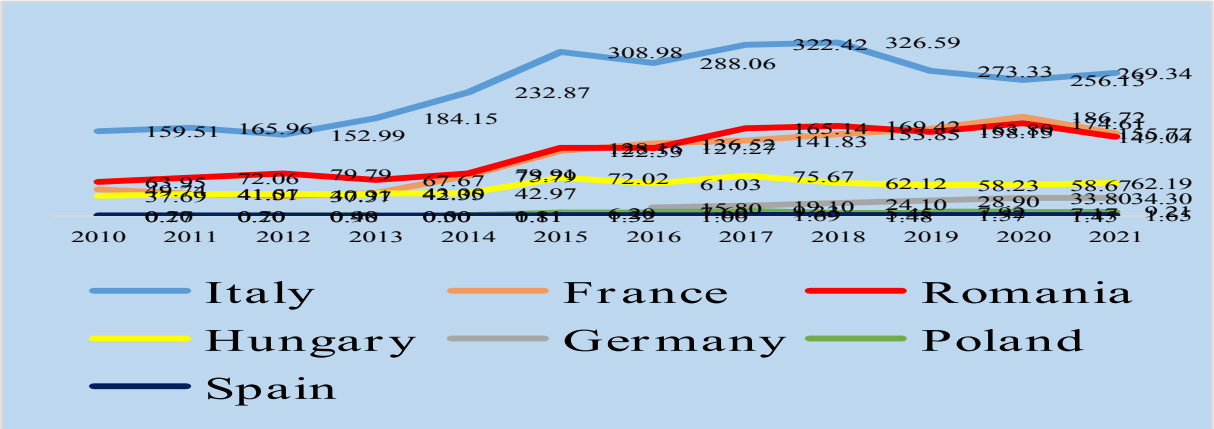


Fig. 1. The total area cultivated with soybeans (thousand ha), in the main growing states of the E.U.
Source: Created by authors based on the data from EUROSTAT, 08.11.2021 [7].

The multi-year average for the total area cultivated with soybean for the countries studied varied between 241.49 thousand ha and 1.03 thousand ha.

The multi-annual average for the total area cultivated with soybean in the analyzed period was 111.15 thousand ha for Romania.

Romania took the 2nd place in the top of multi-year average for the total area cultivated with soybeans compared to the countries studied.

Romania held 46.02% of the multi-annual average recorded by Italy, depending on the total area cultivated with soybeans (Fig. 2).

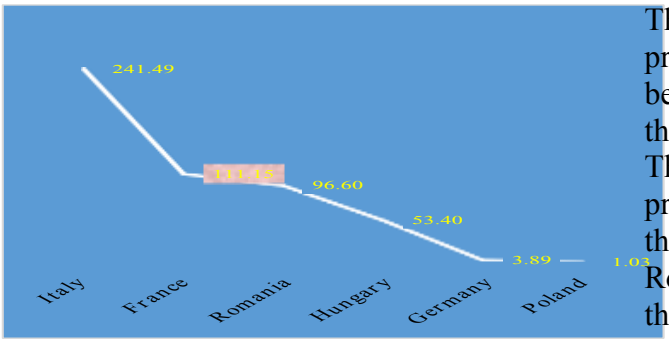


Fig. 2. Multi-annual average 2010-2019 for the total area cultivated with soybean (thousand ha) in the main growing countries in the E.U.

Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

Italy had the largest total soybean production, with a maximum of 1,186.35 thousand tons in 2018.

In 2017, the total soybean production in Romania registered an increase of 149% compared to 2016 at a value of 416.37 thousand tons. The highest total production in Romania was 492.68 thousand tons in 2018.

Between 2010-2013 and 2017-2019, Romania ranked the 2nd in total production among the analyzed countries.

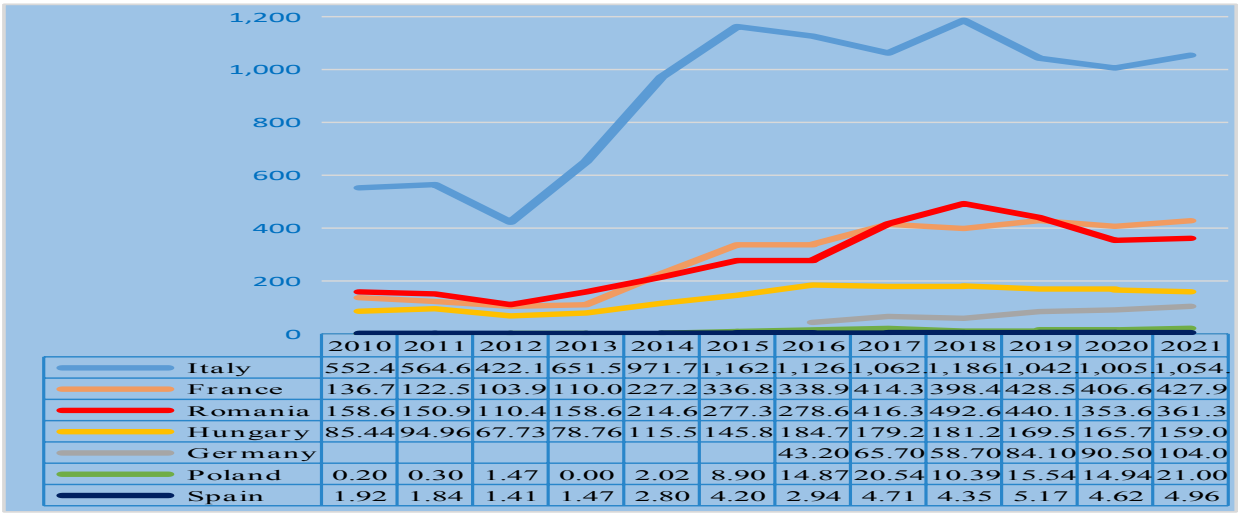
With a production of 406.67 thousand tons in 2020, France has the second largest total soybean production among the analyzed countries (Fig. 3).

The multi-year average for the total soybean production in the countries studied varied between 874.30 thousand tons- 3.08 thousand tons.

The multi-year average for total soybean production in the analyzed period was 269.85 thousand tons for Romania.

Romania came on the 2nd place in the top of the multi-year average for the total soybean production compared to the countries studied.

Romania held 30.86% of the multi-year average recorded by Italy, according to total soybean production (Fig. 4).



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Italy	552.4	564.6	422.1	651.5	971.7	1,162.	1,126.	1,062.	1,186.	1,042.	1,005.	1,054.
France	136.7	122.5	103.9	110.0	227.2	336.8	338.9	414.3	398.4	428.5	406.6	427.9
Romania	158.6	150.9	110.4	158.6	214.6	277.3	278.6	416.3	492.6	440.1	353.6	361.3
Hungary	85.44	94.96	67.73	78.76	115.5	145.8	184.7	179.2	181.2	169.5	165.7	159.0
Germany							43.20	65.70	58.70	84.10	90.50	104.0
Poland	0.20	0.30	1.47	0.00	2.02	8.90	14.87	20.54	10.39	15.54	14.94	21.00
Spain	1.92	1.84	1.41	1.47	2.80	4.20	2.94	4.71	4.35	5.17	4.62	4.96

Fig. 3. Total production of soybean obtained in the main growing states in the E. U. (thousands of tons)

Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

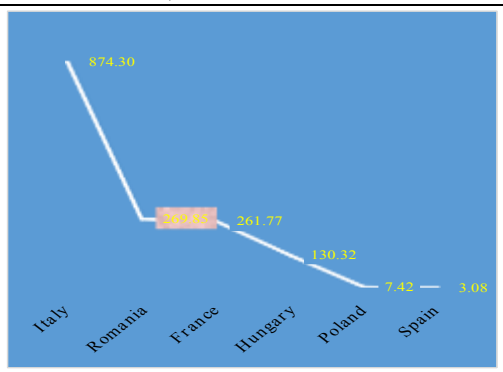
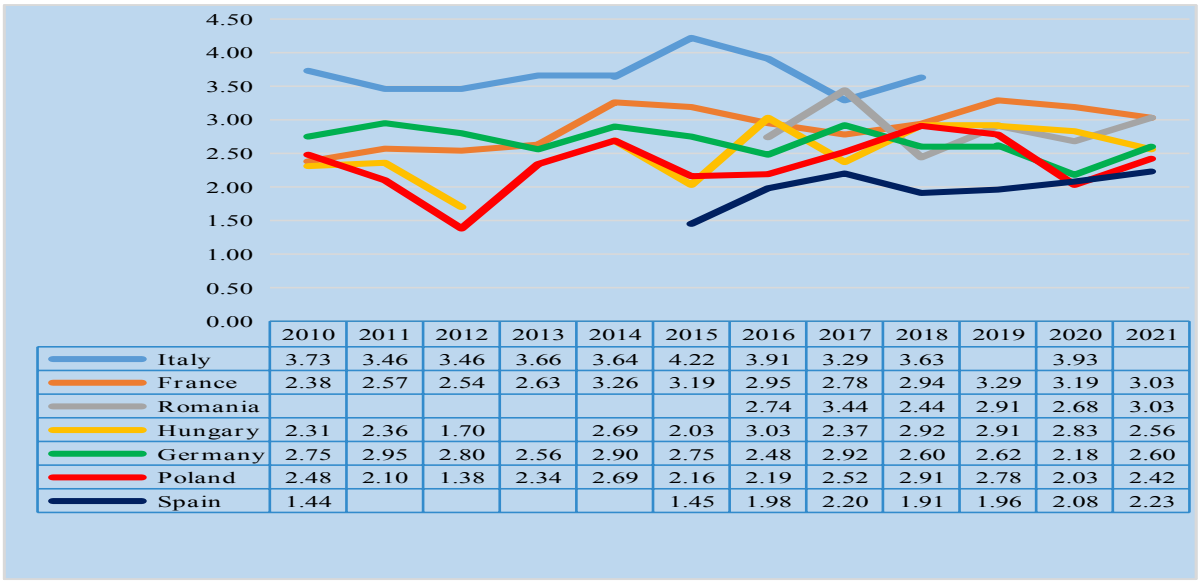


Fig. 4. Multi-annual average 2010-2019 for the total soybean production obtained in the main growing states in the E.U. (thousand tonnes)
Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

The average production per hectare was the highest in Italy, with a maximum of 4.22 tons per hectare in 2015. High productions were also recorded in Spain with 3.19 tons per hectare, France with 2.75 tons per hectare and Romania with 2.16 tons per hectare (Fig. 5).
The multi-year average for average soybean production/ha in the countries studied varied between 2.85 tons/ha and 2.36 tons/ha.
The multi-year average for average soybean production/ha in the analyzed period was 2.36 tons for Romania.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Italy	3.73	3.46	3.46	3.66	3.64	4.22	3.91	3.29	3.63		3.93	
France	2.38	2.57	2.54	2.63	3.26	3.19	2.95	2.78	2.94	3.29	3.19	3.03
Romania							2.74	3.44	2.44	2.91	2.68	3.03
Hungary	2.31	2.36	1.70		2.69	2.03	3.03	2.37	2.92	2.91	2.83	2.56
Germany	2.75	2.95	2.80	2.56	2.90	2.75	2.48	2.92	2.60	2.62	2.18	2.60
Poland	2.48	2.10	1.38	2.34	2.69	2.16	2.19	2.52	2.91	2.78	2.03	2.42
Spain	1.44					1.45	1.98	2.20	1.91	1.96	2.08	2.23

Fig. 5. Average production/ha of soybeans obtained in the main growing states in the E. U. (tons/ha)
Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

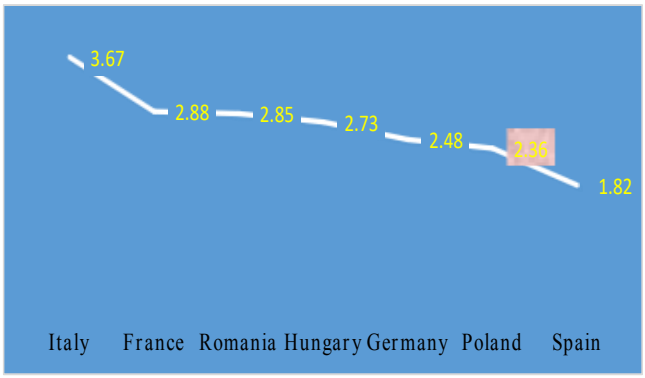


Fig. 6. Multi-year average for average production/ha of soybeans obtained in the main growing countries in the E. U. (tonnes/ha)
Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

Romania, according to the multi-year average achieved for the average soybean production/ha, ranked the 6th (2.36 tons/ha) after Italy (3.67 tons/ha), Germany (2.88 tons/ha), Spain (2.85 tons/ha) and Hungary (2.48 tons/ha) (Fig. 6).
Romania achieved 64.30% of the multi-year average recorded by Italy for the average soybean production/ha.
In 2019, the average soybean production per hectare in the studied countries varied between 3.60 tons/ha and 1.7 tons/ha.
Romania, according to the average production per hectare ranked the 8th (2.78 tons/ha) after Greece (3.60 tons/ha), Spain (3.29 tons/ha), Croatia (3.15 tons/ha), Austria (3.15 tons/ha), Slovenia (2.96 tons/ha), Hungary (2.91 tons/ha), Germany (2.91 tons/ha) (Fig. 7).

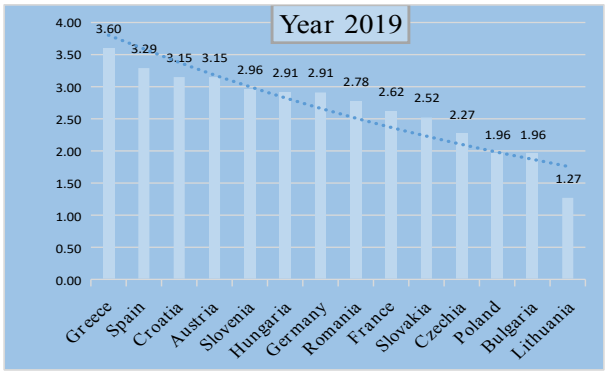


Fig. 7. Average soybean production/ha (tonnes/ha), obtained in E. U. member states, 2019
Source: Created by authors based on the data from Eurostat, 08.11.2021 [7].

The multi-year average (2010-2019) of the amounts of chemical fertilizers and pesticides used per cultivated hectare, in the countries included in the analysis, and the average productions per hectare (tons) achieved, highlighting the quantity (kg) of chemical fertilizers and pesticides used to obtain one ton of soybean is presented below [8].
Regarding to **Nitrogen** (N) fertilizers, in soybean cultivation, Romania is positioned last in terms of Nitrogen (N) consumption with an amount of 16.36 kg of Nitrogen (N) used to obtain one ton of soybean, with a negative deviation of 36.73 kg compared to Poland, which is the largest consumer of Nitrogen (N) fertilizers among the countries studied, in the soybean crop (Fig. 8).

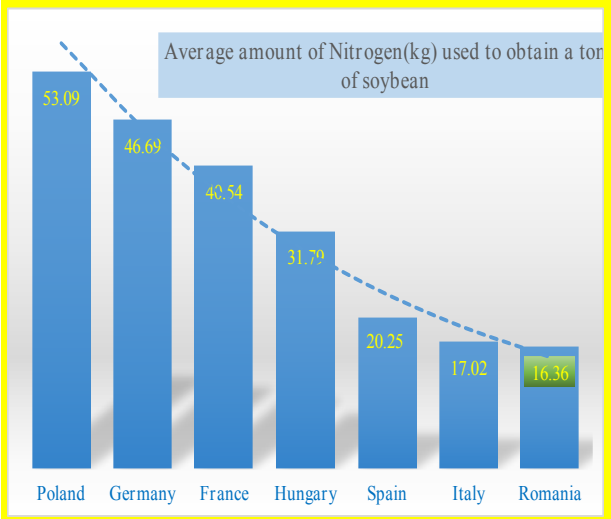


Fig. 8. Soybean crop - the average amount of Nitrogen(kg) used to obtain one ton of product
Source: Created by authors based on the data from FAO (United Kingdom– no data) [8].

Regarding phosphorus fertilizers (P_2O_5) for soybean cultivation, Romania is ranked the 6th in terms of phosphorus consumption (P_2O_5), with a quantity of 6.37 kg of phosphorus (P_2O_5) used to obtain one ton of soybeans, with a negative deviation of 10.62 kg compared to Poland, which is the largest consumer of phosphorus fertilizers (P_2O_5) among the countries under the study, in soybean cultivation (Fig. 9).

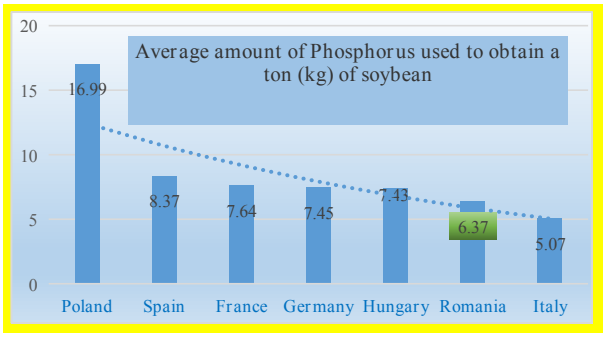


Fig. 9. Soybean crop - the average amount of Phosphorus used to obtain one ton of product (kg)
Source: Created by authors based on the data from FAO (United Kingdom– no data) [8].

Regarding Potassium fertilizers (K_2O), in soybean cultivation, Romania is positioned last in terms of Potassium (K_2O) consumption, with an amount of 2.28 kg of Potassium (K_2O) used to obtain one ton of soybeans, with a negative deviation of 22.13 kg compared to Poland, which is the largest consumer of Potassium fertilizers (K_2O) among the countries studied, in the soybean crop (Fig. 10).

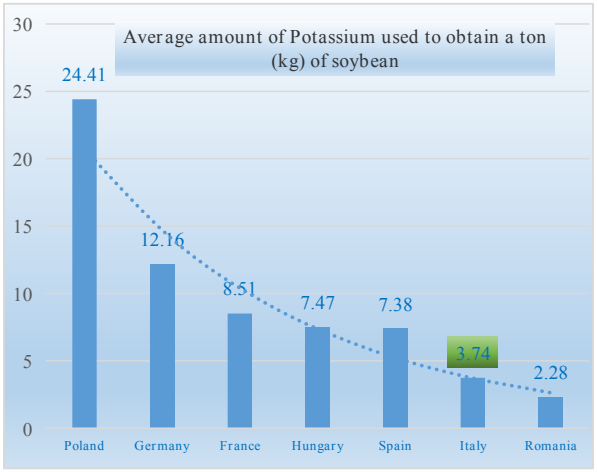


Fig. 10. Soybean crop-the average amount of Potassium used to obtain one ton of product (kg)
Source: Created by authors based on the data from FAO (United Kingdom– no data) [8].

Regarding pesticides-total, in the soybean crop, Romania is positioned on the last position in terms of pesticide consumption-total, with a quantity of 0.3 kg of pesticides-total used to obtain one ton of soybeans, with a negative deviation of 1.47 kg compared to Italy, which is the largest consumer of pesticides-total among the countries studied, in the soy crop (Fig. 11).

The multi-annual average amount of N used in France, 30.8 kg in Hungary, 19.07kg in Spain, 15.95 kg in Romania (Fig. 12).

to obtain a ton of soybeans in 2021 is 44.38 kg in Germany, 43.33 kg in Poland, 42.62 kg

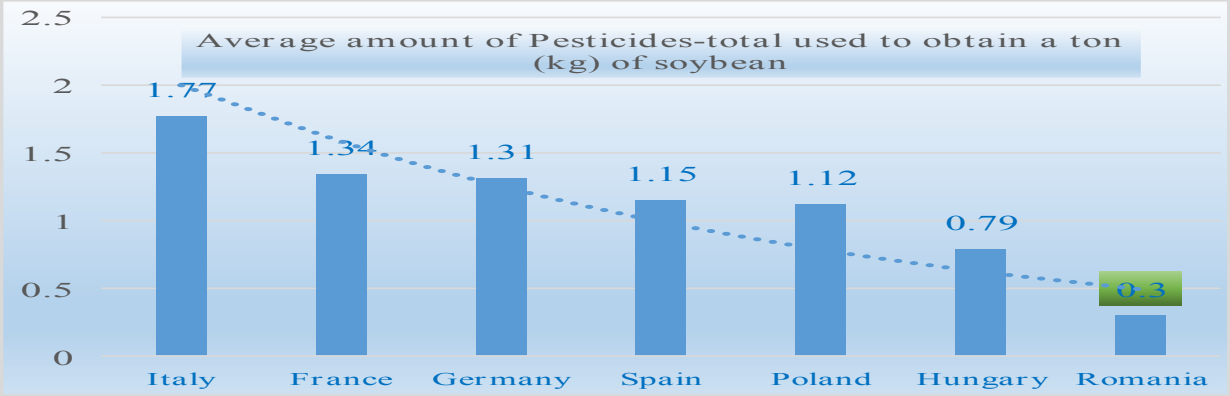
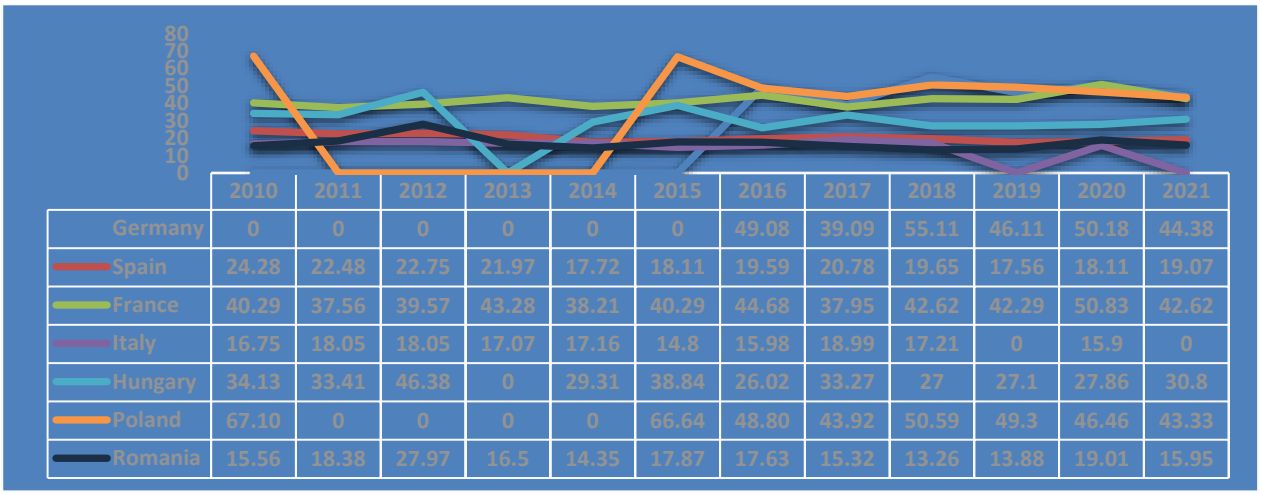


Fig. 11. Soybean crop - the average amount of Pesticides-total used to obtain one ton of product (kg)
Source: Created by authors based on the data from FAO (United Kingdom– no data) [8].



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Germany	0	0	0	0	0	0	49.08	39.09	55.11	46.11	50.18	44.38
Spain	24.28	22.48	22.75	21.97	17.72	18.11	19.59	20.78	19.65	17.56	18.11	19.07
France	40.29	37.56	39.57	43.28	38.21	40.29	44.68	37.95	42.62	42.29	50.83	42.62
Italy	16.75	18.05	18.05	17.07	17.16	14.8	15.98	18.99	17.21	0	15.9	0
Hungary	34.13	33.41	46.38	0	29.31	38.84	26.02	33.27	27	27.1	27.86	30.8
Poland	67.10	0	0	0	0	66.64	48.80	43.92	50.59	49.3	46.46	43.33
Romania	15.56	18.38	27.97	16.5	14.35	17.87	17.63	15.32	13.26	13.88	19.01	15.95

Fig. 12. Multi-annual average quantity of N fertilizers to obtain one ton of soybeans
Source: Created by authors based on the data from FAO (United Kingdom– no data) [8].

CONCLUSIONS

The European soybean growing countries are so different in terms of climate, irrigation rate, level of technological progress, consumption of inputs.

Among the analyzed countries, Romania had the second largest area of land cultivated with soybeans and occupied the second place in terms of total production.

Romania, according to the multi-year average, achieved for the average soybean production/ha ranked 6th(2.36tons/ha) after: Italy(3.67tons/ha), Germany(2.88 tons/ha); Spain (2.85 tons/ha) and Hungary(2.48 tons/ha).

In this context, it is necessary to reduce the consumption of chemical fertilizers and pesticides depending on the real situation, existing in each individual country.

To obtain a ton of soybeans in Romania:

- it is ranked last in terms of nitrogen(N) consumption, with an amount of 16.36 kg of nitrogen(N);
- it is ranked sixth in terms of phosphorus(P205) consumption, with an amount of 6.37 kg of phosphorus(P205);

- it is ranked last in terms of potassium(K20) consumption, with an amount of 2.28 kg of potassium(K20);
- it is positioned last in terms of pesticide consumption-total , with a quantity of 0.3 kg of pesticides-total.

The technical data that can be taken into account are the reporting on the reduction of the quantities of fertilizers and pesticides to the European average, the level of access/use of the elements of technological progress in the targeted country ant to take into account the impact on the average productions and respectively the total productions for soybean culture

Therefore, we consider it necessary to estimate the effects of applying the Farm to Fork Strategy on the on the beneficiaries of soy products, in the context of forecasting the increase in demand for soy products.

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