

COMPARATIVE ANALYSIS OF THE MAIN TECHNICAL INDICATORS FOR RAPESEED CROP IN ROMANIA

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Abstract

The growing demand for rapeseed oil has led to an increase in cultivated areas and the improvement of rapeseed cultivation techniques. The article analyzed the main technical indicators related to area, total production and average production of rapeseed. A comparative analysis was also carried out for the mentioned indicators, in two distinct periods, delimiting the period before accession and after accession to the European Union. The averages of the two periods were compared, using the Student Test method, and the SPEC Forecast function estimated the area, production and average rapeseed production by 2030. The aim was to identify from a statistical point of view if the averages of the two periods are dependent, as well as to predict the evolution of the main technical indicators.

Key words: rapeseed crop, agricultural potential, rapeseed production, Romania

INTRODUCTION

In the search for renewable energy solutions, rapeseed has become increasingly important, given its use in the biodiesel industry [9]. However, rapeseed is not only a renewable energy source, it is also widely used in human consumption [10]. Rapeseed oil is the raw material needed to make margarine, mayonnaise, and frying oil. Being rich in fatty acids and having valuable nutritional properties, rapeseed oil is one of the main preferences of consumers in the European Union [1].

Rapeseed meal resulting from the process of manufacturing rapeseed oil is used successfully in animal husbandry, being an important source of protein in the diet of animals specializing in milk and meat production. Along with sunflowers, rapeseed is also important for beekeeping, being a honey plant that is used in honey production. [2, 3, 4].

Rapeseed began to occupy a significant share in the rotation of the Romanian farmer's crops. If at the beginning this crop was not very successful, gradually farmers began to be attracted to such a crop, given the possibility of higher capitalization compared to the sale of cereals. However, the decision to cultivate rapeseed is an expression of the farmer's will and can be influenced by the cultivated area, knowledge of cultivation technology, but also examining the international trend regarding rapeseed areas cultivated in other states [5, 11, 6].

According to data provided by the Romanian Ministry of Agriculture and Rural Development, in 2019 the rapeseed crop occupied an area of 352.6 thousand hectares, with a total production of 798.2 thousand tons and an average production of 2.26 tons/ha. The average yields recorded for rapeseed cultivation had a significant evolution compared to 2010, when an average production per hectare of only 1.75 tons was recorded. This evolution of the average

recorded productions can be attributed to the investments made in high-performance varieties and hybrids with increased resistance to diseases and pests.

Rapeseed is the dominant oil crop in the European community, being also the world's leading producer of rapeseed and rapeseed products. The largest producers in the EU are France and Germany, followed by Poland, the United Kingdom, the Czech Republic and Romania. Demand for rapeseed exceeds domestic supply, leading to imports of large quantities of rapeseed, mainly from Ukraine, Australia and Canada.

The area cultivated with rape in the European Union has decreased with the banning of neonicotinoids in the EU. Banning treatment with neonicotinoid substances for rapeseed makes production more difficult and expensive. Higher costs and lower yields make rapeseed less competitive compared to other crops. For the time being, farmers continue to grow rapeseed despite weaker economic results because there is no equally effective alternative to building crop rotation at farm level [7, 8].

Romania's agricultural potential in terms of rapeseed cultivation is extremely high and must be analyzed in terms of internal constraints and identifying the best strategies to manage climate change to achieve higher yields and to cultivate large areas of rapeseed [12].

Romania has a great potential to produce biofuels. Increasing the area occupied by oilseeds should not have a negative impact on the environment. The policy of reducing dependence on fossil fuel imports must be associated with a social and environmental policy [13].

The aim was to identify from a statistical point of view, if the averages of the two periods are dependent, as well as to predict the evolution of the main technical indicators.

MATERIALS AND METHODS

Data about area, total production, and average production for rapeseed crop come from the platform of the National Institute of Statistics

and were analyzed quantitatively and qualitatively.

We must take into account the two periods of time when the agricultural product (oilseed rape), which is increasingly in demand, is being analyzed for bioethanol. Thus, the period 1994-2006 represents the transition period of agriculture, marked by a series of major changes that have affected the productivity of this sector, and the period 2007-2019 represents the period after accession to the European Union, when Romania, and therefore Romanian farmers, benefited from funds aimed at revitalizing the activity carried out.

The comparative analysis of data was also used for two distinct periods, before and after accession to the European Union. The tabular representation has been simplified by inserting the first and last year of the period analysed in order to facilitate the visualisation of the results obtained.

Also the estimation of area, total production and average production by 2030 was made using the Forecast function of the SPSS Statistical program.

To determine whether or not the two analysed periods are related, the Student Test was used, which is a decision method that helps us to validate or invalidate with a certain degree of certainty a statistical hypothesis, using the following formula:

$$T_{cal} = \frac{(M2 - M1)}{\sqrt{\left(\frac{var1}{n1}\right) + \left(\frac{var2}{n2}\right)}}$$

RESULTS AND DISCUSSIONS

At national level, in the period 1994-2006 the total area cultivated with rapeseed registered a positive trend. At the level of 2006, it is noted that a total area of 110.11 thousand hectares was established, while in 1994 the area occupied by rapeseed at national level was 342 hectares. Analyzing comparatively, it is observed that the area cultivated with rapeseed has increased exponentially being over 300 times larger than the area cultivated in 1994 (Table 1).

At the level of development regions, the areas cultivated with rapeseed registered an ascending trend for all development regions of Romania. The most significant evolutions of the areas established with rapeseed are registered at the level of the Bucharest-Ilfov regions (an evolution of the areas of 1,677.8% of the surface in 2006, compared to 1994), the South-West Oltenia region where a cultivated area is registered with rapeseed 29 times higher in 2006 compared to 1994.

The Western development region also records a significant evolution of the areas occupied by rapeseed, being 33 times larger than the area cultivated in 1994 (Table 1).

Table 1. Comparative analysis of the area cultivated with rapeseed in the periods 1994-2006, respectively 2007-2019 (thousand ha)

| Region | 1994 | 2006 | % | 2007 | 2019 | % |
|-------------------|------|--------|-----------|--------|--------|--------|
| Total | 0.34 | 110.11 | 32,095.90 | 364.92 | 352.62 | -3.40 |
| Northwest | - | 2.03 | - | 7.22 | 32.81 | 354.60 |
| Center | - | 0.28 | - | 2.05 | 9.20 | 349.10 |
| North East | - | 9.59 | - | 30.22 | 35.53 | 17.60 |
| South East | - | 35.74 | - | 127.17 | 64.94 | -48.90 |
| South-Muntenia | - | 53.01 | - | 159.03 | 126.38 | -20.50 |
| Bucharest - Ilfov | 0.07 | 1.28 | 1,677.80 | 4.25 | 7.53 | 77.30 |
| Southwest Oltenia | 0.23 | 6.69 | 2,874.20 | 27.27 | 32.68 | 19.90 |
| West | 0.05 | 1.49 | 3,208.90 | 7.73 | 43.55 | 463.70 |

Source: statistical data processing, Accessed on 17.01.2021.

In the period 2007-2019, the total area cultivated with rapeseed at national level registered significant oscillations during the analyzed period. At the level of 2007, an area of 364.92 thousand hectares was established, while in 2019 the area occupied by rapeseed crops decreased by 3.4%, being cultivated 352.62 thousand hectares, 12.30 thousand hectares less in 2019 compared to the area cultivated in 2007 (Table 1).

At the level of development regions, rapeseed crops have maintained their positive trend for most development regions, so that the most significant developments of the areas established with rapeseed are found in the

Western regions (an evolution of over 460% of the area in 2019, compared to 2007), the Center region where there is an increase in areas established with rapeseed of 349.1% of the area in 2019 compared to 2007. A significant positive trend in terms of cultivated area with rapeseed is also noticeable in the development region Northwest, where the cultivated area with rapeseed increased by 354.6% in 2019 compared to the cultivated area in 2007 (Table 1).

In 2019, compared to 2007, the only 2 regions that register a decrease in the cultivated area with rapeseed are the South-Eastern development regions (with a reduction of the areas established with rapeseed of 48.9%) and the South-Muntenia region (which registers a reduction of areas established with rapeseed of 20.5%) (Table 1).

At national level, the total rapeseed production in the period 1994-2006 registered a significant evolution, being also influenced by the evolution of the cultivated area at national level. Thus, at the level of 1994 a total rapeseed production of 322 tons was registered, while in 2006 the registered production was 500 times higher than the one recorded at the level of 1994, being of 175.05 thousand tons (Table 2).

With regard to total rapeseed production in development regions, it should be noted that all developmental regions recorded much higher rapeseed production in 2006 compared to 1994, whereas no data are available for all development regions. To highlight the evolution of total rapeseed production in 2006 compared to 1994, it was analyzing the existing available data for 3 of the 8 development regions. Thus, the Bucharest-Ilfov development region recorded a rape production 48 times higher than the production recorded in 1994. Regarding the South-West Oltenia development region, the rapeseed production recorded in 2006 was 9.03 thousand tons higher than the rapeseed production registered at the level of 1994. The West Development Region obtained in 2006 a production by 2.14 thousand tons higher than the existing one at the level of 1994 (Table 2).

Table 2. Comparative analysis of total rapeseed production in the periods 1994-2006 and 2007-2019, respectively (thousand tons)

| Region | 1994 | 2006 | % | 2007 | 2019 | % |
|-------------------|------|--------|-----------|--------|--------|----------|
| Total | 0.32 | 175.05 | 54,263.40 | 361.50 | 798.22 | 120.80 |
| Northwest | - | 2.97 | - | 8.72 | 76.60 | 778.30 |
| Center | - | 0.47 | - | 2.46 | 23.90 | 872.30 |
| North East | - | 13.08 | - | 34.13 | 63.71 | 86.60 |
| South East | - | 64.12 | - | 186.92 | 128.60 | -31.20 |
| South-Muntenia | - | 81.32 | - | 96.94 | 298.66 | 208.10 |
| Bucharest - Ilfov | 0.03 | 1.64 | 4,717.60 | 3.08 | 15.70 | 409.10 |
| Southwest Oltenia | 0.23 | 9.26 | 3,873.80 | 18.29 | 70.37 | 284.70 |
| West | 0.06 | 2.20 | 3,898.20 | 10.94 | 120.68 | 1,002.70 |

Source: statistical data processing, Accessed on 17.01.2021.

At national level, the total rapeseed production in the period 2007-2019 registered significant evolutions. Thus, at the level of 2007 a total rapeseed production of 361.50 thousand tons was registered, while in 2019 the registered production was 2.2 times higher than in 2007, being 798.22 thousand tons (Table 2).

Regarding the total rapeseed production registered at the level of development regions, it is noted that 7 of the 8 regions registered higher rapeseed productions in 2019 compared to the productions registered in 2007. Thus, the regions with the most significant developments of the total rapeseed production obtained in 2019 compared to 2007, are: North-West with a production of 76.60 thousand tons, compared to 8.72 thousand tons that were harvested in 2007, being a production 8.7 times higher than in 2007. The Western Development Region recorded a significant evolution of rapeseed production in 2019 compared to 2007, registering a production of 120.68 thousand tons (increasing by 1002.7% compared to of production recorded in 2007). Also, the development region of Bucharest-Ilfov had a total rapeseed production of 15.70 thousand tons in 2019, while in 2007 the total rapeseed production in this region was 3.04 thousand tons, being approximately 5 times lower than the rapeseed production recorded in 2019 (Table 2).

The only development region with a decrease in total rapeseed production recorded in 2019 compared to 2007 was the Southeast region,

where total rapeseed production decreased by 31.2% in 2019, compared to 2007 (Table 2).

At national level, the average rapeseed production in the period 1994-2006 registered an upward trend in the case of the regions for which there are data available necessary for comparison. Thus, at the level of 1994 there was an average yield per hectare in the case of rapeseed cultivation of 0.94 tons/ha, while in 2006 the average production per hectare was 68.8% higher than that since 1994, being 1.59 tons/ha (Table 3).

Analyzing the average yields obtained per hectare of rapeseed at the level of development regions, it is noted that, at the level of the 3 development regions for which there are data necessary to make the comparison, there were higher average yields per hectare in 2006 compared to 1994. Thus, the regions with the highest developments in terms of average rapeseed production per hectare obtained in 2006 compared to 1994 are the regions: Bucharest-Ilfov with an average production per hectare higher by 808 tons/ha in 2006 compared to the average production recorded in 1994 (an evolution of 171.2%), the South-West Oltenia region records an evolution of the average yield per hectare of rapeseed by 33.6% higher in 2006, compared 1994 and the western region show an evolution of the average production harvested per hectare of rapeseed, being by 20.9% higher than the average yield rat in 1994 (Table 3).

Table 3. Comparative analysis of average rapeseed production in the periods 1994-2006 and 2007-2019, respectively (tones / ha)

| Region | 1994 | 2006 | % | 2007 | 2019 | % |
|-------------------|------|------|--------|------|------|--------|
| Total | 0.94 | 1.59 | 68.80 | 0.99 | 2.26 | 128.50 |
| Northwest | - | 1.46 | - | 1.21 | 2.34 | 93.10 |
| Center | - | 1.64 | - | 1.20 | 2.60 | 116.50 |
| North East | - | 1.37 | - | 1.13 | 1.79 | 58.70 |
| South East | - | 1.79 | - | 1.47 | 1.98 | 34.70 |
| South-Muntenia | - | 1.53 | - | 0.61 | 2.36 | 287.40 |
| Bucharest - Ilfov | 0.47 | 1.28 | 171.20 | 0.73 | 2.09 | 187.20 |
| Southwest Oltenia | 1.04 | 1.38 | 33.60 | 0.67 | 2.15 | 220.90 |
| West | 1.22 | 1.48 | 20.90 | 1.42 | 2.77 | 95.60 |

Source: statistical data processing, Accessed on 17.01.2021.

At national level, the average rapeseed production in the period 2007-2019 registered a significant evolution, being influenced by the specific weather conditions in the critical vegetation phases for the rapeseed culture, as well as by the investments made. Thus, at the level of 2007 there was an average yield per hectare in the case of rapeseed cultivation of 0.99 tons/ha, while in 2019 the average production per hectare was about 2 times higher than in 2007 (2.26 tons/ha average production in 2019) (Table 3).

Analysing the average yields per hectare cultivated with rapeseed in the development regions, it is noted that all development regions recorded higher average rapeseed production per hectare in 2019 compared to the productions recorded in 2007. Thus, the regions with the highest Significant developments in terms of average rapeseed production per hectare obtained in 2019 compared to 2007 are the regions: South-West Oltenia with an average production per hectare increasing by 1.48 tons/ha in 2019 compared to average production recorded in 2007 (an evolution of 220.9%), South-Muntenia where the average production harvested per hectare in 2019 was 287.4% higher than the production obtained in 2007 and the Bucharest-Ilfov development region where the average rapeseed production was 2.8 times higher than the average production per hectare recorded in 2007 (Table 3.).

Regarding the analysis of the two averages calculated taking into account the two periods under analysis (1994-2004, respectively 2007-2019), the conclusions can be drawn studying the results presented in Table 4.

Comparing the averages of the two periods at national level, we find that the H1 hypothesis is true in their case, as the data are related to each other (are dependent) from a statistical point of view, and in terms of the critical value of the distribution of T is very significant with the value of 9.1 (probability of 0.001 ***).

Regarding the analysis of the two averages calculated taking into account the two periods under analysis (1994-2004, respectively 2007-2019) the following conclusion can be drawn (Table 5): regarding the comparison of the

averages of the two periods at national level, we find that the H1 hypothesis is true in their case, as the data are related to each other (are dependent) from a statistical point of view, and in terms of the critical value of the distribution of T is very significant with a value of 6.6 (probability of 0.001 ***).

Table 4. Comparison of the averages of the periods 1994-2006 and 2007-2019 using the Student Test method regarding the area cultivated with rapeseed

| Region | N1 | N2 | A1 | A2 | DF | S1^2 | S2^2 | tealc |
|--|---------------|----|------|-------|------------------------|---------|----------|-------|
| Total | 13 | 13 | 46.9 | 405.8 | 24 | 1,563.1 | 18,599.2 | 9.1 |
| Northwest | 11 | 13 | 1.1 | 13.0 | 22 | 0.6 | 102.8 | 4.2 |
| Center | 10 | 13 | 0.1 | 5.9 | 21 | 0.0 | 11.9 | 6.1 |
| North East | 12 | 13 | 4.1 | 33.5 | 23 | 13.0 | 131.3 | 8.8 |
| South East | 12 | 13 | 19.1 | 124.6 | 23 | 242.6 | 2,415.3 | 7.4 |
| South-Muntenia | 12 | 13 | 21.1 | 159.8 | 23 | 299.0 | 2,900.0 | 8.8 |
| Bucharest - Ilfov | 13 | 13 | 0.8 | 6.2 | 24 | 0.5 | 8.4 | 6.5 |
| Southwest Oltenia | 13 | 13 | 3.6 | 36.6 | 24 | 7.7 | 273.0 | 7.1 |
| West | 12 | 13 | 0.8 | 26.3 | 23 | 0.7 | 331.0 | 5.0 |
| Critical values of the distribution of T | Probab. 0.05 | | 2.1 | * | significant | | | |
| | Probab. 0.01 | | 2.8 | ** | distinctly significant | | | |
| | Probab. 0.001 | | 3.8 | *** | very significant | | | |

Source: statistical data processing, Accessed on 17.01.2021.

Table 5. Comparison of the averages of the periods 1994-2006 and 2007-2019 using the Student Test method regarding the total production obtained from rapeseed

| Region | N1 | N2 | A1 | A2 | DF | S1^2 | S2^2 | tealc |
|--|---------------|----|------|-------|------------------------|---------|-----------|-------|
| Total | 13 | 13 | 61.1 | 881.8 | 24 | 3,650.4 | 197,824.5 | 6.6 |
| Northwest | 11 | 13 | 1.3 | 28.6 | 22 | 0.9 | 736.4 | 3.6 |
| Center | 10 | 13 | 0.1 | 14.5 | 21 | 0.0 | 117.2 | 4.8 |
| North East | 11 | 13 | 6.8 | 65.7 | 22 | 46.1 | 763.7 | 7.4 |
| South East | 12 | 13 | 25.3 | 249.7 | 23 | 588.9 | 10,830.5 | 7.6 |
| South-Muntenia | 12 | 13 | 27.7 | 368.0 | 23 | 705.8 | 43,413.4 | 5.8 |
| Bucharest - Ilfov | 12 | 13 | 1.1 | 12.6 | 23 | 2.1 | 72.0 | 4.8 |
| Southwest Oltenia | 12 | 13 | 3.8 | 72.8 | 23 | 8.3 | 2,097.7 | 5.4 |
| West | 12 | 13 | 0.7 | 70.0 | 23 | 0.7 | 3,485.4 | 4.2 |
| Critical values of the distribution of T | Probab. 0.05 | | 2.1 | * | significant | | | |
| | Probab. 0.01 | | 2.8 | ** | distinctly significant | | | |
| | Probab. 0.001 | | 3.8 | *** | very significant | | | |

Source: statistical data processing, Accessed on 17.01.2021.

Regarding the analysis of the two averages calculated taking into account the two periods under analysis (1994-2004, respectively 2007-2019) the following conclusion can be drawn (Table 6): regarding the comparison of the averages of the two periods at national level, we find that the H1 hypothesis is true in their

case, as the data are related to each other (are dependent) from a statistical point of view, and in terms of the critical value of the distribution of T is very significant with a value of 4.4 (probability of 0.001 ***).

Table 6. Comparison of the averages of the periods 1994-2006 and 2007-2019 using the Student Test method regarding the average production obtained for rapeseed

| Region | N ₁ | N ₂ | M ₁ | M ₂ | G _L | S1 [^] ₂ | S2 [^] ₂ | tcal _c |
|--|----------------|----------------|----------------|------------------------|----------------|------------------------------|------------------------------|-------------------|
| Total | 13 | 13 | 1.2 | 2.1 | 24 | 0.2 | 0.3 | 4.4 |
| Northwest | 11 | 13 | 1.1 | 2.0 | 22 | 0.4 | 0.3 | 3.6 |
| Center | 9 | 13 | 0.8 | 2.2 | 20 | 0.5 | 0.4 | 4.6 |
| North East | 11 | 13 | 1.4 | 1.9 | 22 | 0.3 | 0.2 | 2.9 |
| South East | 12 | 13 | 1.2 | 2.0 | 23 | 0.3 | 0.2 | 3.7 |
| South-Muntenia | 12 | 13 | 1.3 | 2.2 | 23 | 0.2 | 0.5 | 3.7 |
| Bucharest - Ilfov | 12 | 13 | 1.1 | 1.9 | 23 | 0.3 | 0.4 | 3.3 |
| Southwest Oltenia | 12 | 13 | 1.0 | 1.9 | 23 | 0.1 | 0.4 | 4.1 |
| West | 12 | 13 | 1.0 | 2.4 | 23 | 0.2 | 0.4 | 6.4 |
| Critical values of the distribution of T | Probab. 0.05 | 2.1 | * | significant | | | | |
| | Probab. 0.01 | 2.8 | ** | distinctly significant | | | | |
| | Probab. 0.001 | 3.8 | ** | very significant | | | | |

Source: statistical data processing, Accessed on 17.01.2021.

Regarding the estimation of the evolution of the area cultivated with rapeseed, it shows a linear trend in the estimated period, when the cultivated area is forecasted to be 352 thousand hectares. The optimistic variant also estimates an area of 1.1 million hectares cultivated with rapeseed (Figure 1).

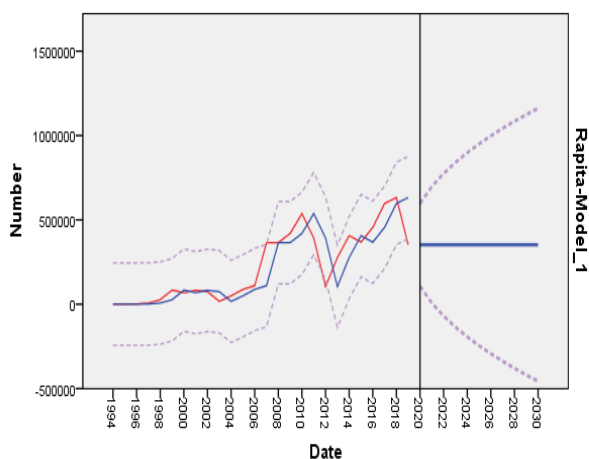


Fig. 1. Estimates of the evolution of the area cultivated with rapeseed by 2030

Source: statistical data processing, Accessed on 17.01.2021.

Regarding the estimation of the evolution of the production obtained from rapeseed, it shows a linear trend in the estimated period, when the production obtained is forecasted to be 798 tons, in a slight increase compared to 2019 (Figure 2).

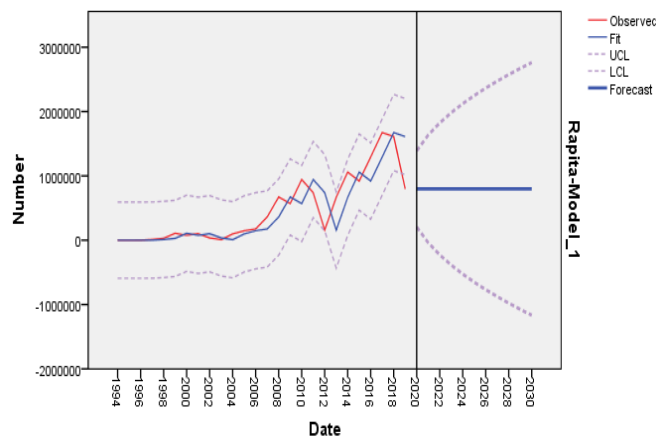


Fig. 2. Estimates on the evolution of rapeseed production by 2030

Source: statistical data processing, Accessed on 17.01.2021.

CONCLUSIONS

Rapeseed cultivation has increased significantly in recent years, being cultivated over large areas, as a result of increasing demand for rapeseed oil. A significant increase in the area cultivated with rapeseed was noticed in 1999, when an area over 3 times larger than the previous year was cultivated.

After Romania's accession to the European Union, the area and total production obtained increased significantly, due to the opening of foreign markets in Western European countries and the good price obtained by farmers for this crop, which encouraged the cultivation of rapeseed.

Analyzing the averages of the two periods, in the case of the main technical indicators (area, total production, and average production) it was found from a statistical point of view, that there is a significant link between the averages of the two periods.

Considering the average yields recorded so far by farmers for rapeseed we can estimate that the average production for this crop could

reach 3.3 tons/ha by 2030 by adapting cultivation techniques and technologies.

Regarding the area cultivated with rapeseed in the future, the estimates made indicate that the area cultivated with this technical plant remains at the same level from 2019, being 352 thousand hectares. The extension of the areas cultivated with rapeseed in Romania is limited by the favorable areas of cultivation for this crop, as well as by making the crop rotation at farm level.

ACKNOWLEDGEMENTS

We thank the referees for all the data provided for this paper. The publication of this article was possible thanks to the sectoral project ADER 23.1.1: "Technical-economic basis of production costs and estimates regarding the prices of capitalization of the main plant and animal products, obtained in conventional system and in organic farming" Subcontract no: 23.1.1./2-03.10.2019 contracted with the Ministry of Agriculture and Rural Development.

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