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OIL SEEDS CROPS CULTIVATED AREA AND PRODUCTION IN THE EU-28 - TRENDS AND CORRELATIONS, 2008-2018

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Abstract

The paper analyzed the EU-28 oil seeds sector in terms of cultivated area, production and yield for rape and turnip rape, sunflower and soybean, based on the data provided by Eurostat for the period 2008-2018. Growth rate, index method, descriptive statistics, correlations and regression equations were used to identify the trends and connections between these indicators. In 2018, the EU-28 cultivated 11.8 million ha with oil seeds crops, of which 58% rape, 33.8% sunflower and 8 % soybean. Seeds production reached 35 million tonnes, being by 30 % higher than in 2008. The average yield accounted for 3.2 t/ha in case of rape, 2.4 t/ha sunflower and 2.8 t/ha soybean seeds. The main producers of rape seeds are France, Germany, Poland, United Kingdom and Romania, and in case of sunflower are Romania, Bulgaria, Italy and France. The correlations and regression models indicated that for increasing production, yield improvement of sunflower and rape and also cultivated surface of soybean to increase. The lack of incentives for oil seeds producers in the EU and the higher payments for protein crops in order to balance the protein deficit on the EU market and reduce imports, will affect oilseeds for sure producers and production. As a result, it is expected as soybean to be cultivated on larger surfaces and sunflower cultivated area to decline.

***Key words*:** *oil seeds crops, cultivated area, yield, production, trends, correlations, regression models*

INTRODUCTION

Rape, sunflower and soybean are among the most important oil seeds crops in the world, and in the EU, they are on the top position.

Rape is cultivated for seeds and oil and other resulting products from oil extraction. Rape seeds are used as such or in various mixtures for birds feeding and also rape cakes remained from oil extraction are an excellent fodder. But, rape is mainly cultivated for seeds for extracting oil, which is consumed as such or for cooking and in food industry for producing margarine. In cosmetics, it is utilized for producing soaps and in chemical industry for obtaining lubricants for engines [14]. In the energy industry, rape oil is a valuable source for producing biodiesel. About 400 liters biodiesel could be produced from the rape seeds production harvested from one hectare. In animal growing, rape is considered a good forage crop, because it could be used as fresh fodder, silage, rape cakes and crushed seeds, being rich in protein, carbohydrates, minerals and vitamins. Also, "in crop rotation rape is utilized for shift wheat and maize and for green manure" [13, 17, 23].

Sunflower is cultivated for seeds and oil. The seeds are either consumed as such, but mainly dried, salted and roasted by humans. The oil extracted from seeds is used in salads and for cooks, and in industry for cosmetics, paints and lubricants. Also, the seeds are ingredients in various mixtures for birds feeding. The leaves are an excellent fodder for livestock and the flowers are decorative plants [15, 19].

Soybean is known as " the plant of which over than 1,000 products could be made" as it is rich in protein and oil, essential nutrients in human and animal diets. The seeds have a pleasant taste and could be consumed roasted. In food industry, from soybean seeds there are made soy milk, margarine, tofu cheese, say sauce, biscuits, chocolate etc. In the chemical industry, the oil is used for producing paints, adhesives and fertilizers. In medicine, the active substances from soybean seeds and oil

are useful in various treatments. In agriculture, soybean is a crop which enriches soil content in Nitrogen grace to the fixing bacteria and also soybean cakes are a good fodder [1].

The high demand for protein and oil has stimulated the cultivation of oil seeds crops which are so important for human diet and industry. The development of the renewable energy resources has also been a cause for which these crops have become more and more cultivated in the world [21].

The cultivated area with oil seeds crops increased and yield growth contributed to the development of oilseeds production at the global level [20].

In 2018, at the world level is was achieved 360.08 Million metric tonnes of soybean seeds, 70.91 Milllion metric tonnes of rapeseeds and 51.46 Million metric tonnes of sunflower seeds [22].

From the world oilseeds production in 2018, accounting for 596.73 Million metric tonnes, soybean seeds are ranked the first with 60.3 % market share, rapeseeds are on the second position with 11.8 % and sunflower seeds are on the third position with 8.6 % [24].

This reflected the differences in market share in the world oil seeds production compared to 2013, when soybean seeds represented 55%, rapeseeds 14 % and sunflower seeds 7.6 % [3]. In Europe, the most cultivated oil seeds crop is rape, followed by sunflower and soybean [5]. The demand/offer ratio encourages producers to extend the cultivated areas and increase yield for producing more oil seeds in the EU. In this context, the present paper aimed to study the evolution of the cultivated area with rape, sunflower and soybean, seeds production and yield in the EU-28 in the period 2008-2018 in order to identify the general trends and correlations existing between these indicators as well as the main cultivators and producers.

MATERIALS AND METHODS

Data collection

The research is based on the data provided by Eurostat Statistical Data base for the period 2008-2018.

The indicators analyzed in this study are:

(i)Cultivated surface with oil seeds crops, of which rape and turnip rape, sunflower and soybean;

(ii)Oilseeds production: Total and by crop: rape and turnip rape, sunflower and soybean;

(iii)Oil seeds yield by crop.

Methods used for processing the data

Dynamic analysis, using Fixed Index, I_{FB}, calculated according to the formula: $I_{FB}= (y_n/y_0)100$.

Descriptive statistics: Mean, standard deviation, coefficient of variation, maximum an dminimum values.

Comparison method, destined to compare surfaces and production among the EU countries;

Coefficient of correlation, r, in order to quantify the existing relationships between the indicators mentioned above.

Regression equations, Y= bX +a, in order to identify in what measure oil seeds production (Y) is influenced by cultivated surface and yield (X).

Determination coefficient, R^2, calculated in order to estimate how much of the variation of the dependent variable Y is caused by the variation of the independent variable X.

The results are graphically illustrated and also included in tables. In each case, the results are correspondingly commented, and finally, the main conclusions are drawn.

RESULTS AND DISCUSSIONS

Cultivated area with oil seeds crops

Rape and turnip rape, sunflower and soybean are the main oil seeds crops cultivated in the EU. Their importance for producing oil for consumption and industry and also as a resource of renewable energy especially in case of rape is higher and higher, reasons which led to the extend of the cultivated surface from 10,239.12 thousand ha in 2008 to 11,881.67 thousand ha in 2018, meaning a surplus of + 16.04%.

In the total cultivated area, the highest share is kept by rape and turnip rape, 58.07%, followed by sunflower, 33.88%, and soybean, 8.05 % in the year 2018 [3, 8, 9].

Compared to 2008, it was noticed a decrease of the weight of the cultivated area with rape and turnip rape from 60.20% to 58.07 % in favor of sunflower and soybean, whose share in the total cultivated surface increased from 37.03 % in 2008 to 33.88% in 2018 in case of sunflower, and from 2.68 % in 2008 to 8.05 % in 2018 in case of soybean.

The surface cultivated with rape remained on the 1st position and raised by 11.77 % in the analyzed period, from 6,173.61 thousand ha in 2008 to 6,900.62 thousand ha in 2018. The cultivated area with sunflower comes on the 2nd position and increased by 6.14 % from 3,792.49 thousand ha in 2008 to 4,025.65 thousand ha in 2018. Soybean cultivated land registered the highest growth rate in the studied interval, +249.93 %. From 273.02 thousand ha cultivated in 2008, in 2018, soybean was cropped on 955.4 thousand ha (Fig.1.)

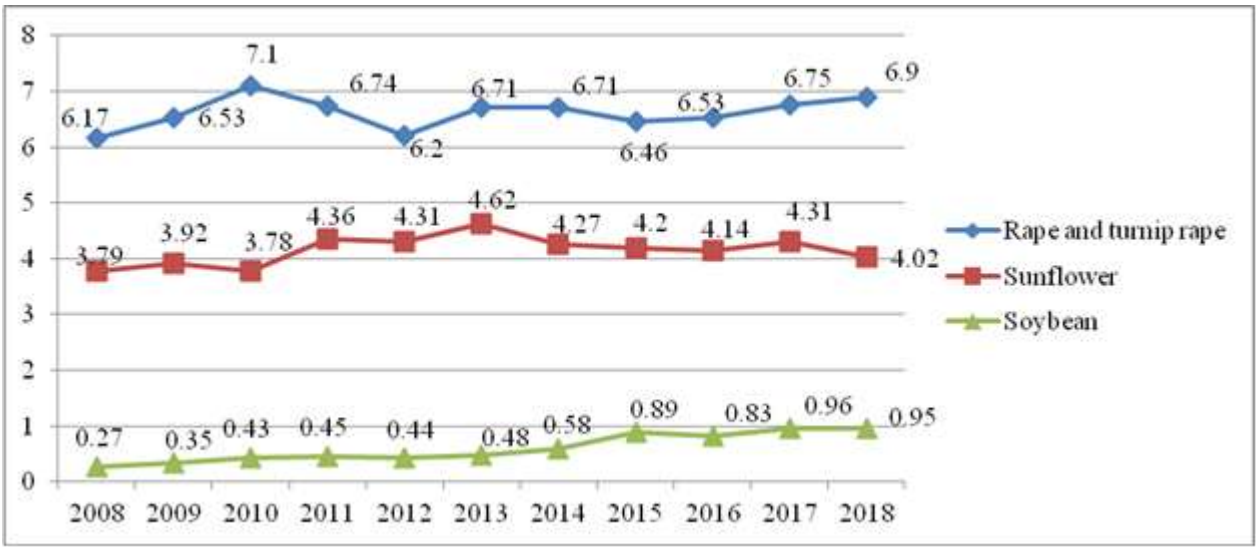

Fig.1. Dynamics of the cultivated area with oil seeds crops, EU-28, 2008-2018 (Million ha)
Source: Own design based on the data from Eurostat, 2019 [9].

In the analyzed period, the average cultivated surface by crop was 6.62 ± 0.08 thousand ha, with a maximum level, 7,105.6 thousand ha in 2010 and a minimum level, 6,173.61 thousand ha in 2008.

In case of sunflower, the mean cultivated area accounted for 4.15 ± 0.07 thousand ha, ranging between 3.78 thousand ha, the minimum level in 2010, and 4.62 thousand ha, the maximum level in 2013.

In case of soybean, the mean and the standard deviation of the cultivated area was 0.60 ± 0.07 thousand ha, varying between the minimum of 0.27 thousand ha in 2008 and the maximum of 0.96 thousand ha in 2017.

The variation coefficients of the cultivated area were very small, 6.17 % in case of rape and turnip rape, 3.78% in case of sunflower and small, 11.67% in case of soybean (Table 1).

Of the total cultivated area with rape and turnip rape in 2018 in the EU-28, accounting for 6,900.62 thousand ha, the largest surfaces are cultivated in France, Germany, Poland, Romania and Hungary, all these five countries summing 4.653.1 thousand ha, representing 67.4 %. The share of these countries in the EU area cultivated with rape is 23.4 % France, 17.7 % Germany, 12.2 % Poland, 9.2 % Romania and 4.8 % Hungary.

In the period 2008-2018, the cultivated land with rape increased by +73.3 % in Romania, +33.9 % in Hungary, +13.7 % in France, +9.5% in Poland and declined by -10.5 % in Germany [2, 3, 9].

In 2018, of the total surface cultivated with sunflower in the EU-28, accounting for 4,025.65 thousand ha, about 90.8 % is in five countries as follows: Romania 25 %, Bulgaria 19.5 %, Spain 17.2%, Hungary 15.3 % and France 13.7%. In the analyzed period 2008-

2018, the cultivated area with sunflower increased by +23.7 % in Romania, +12.2 % in Hungary, +9.2 % in Bulgaria, and declined by -12.3 % in France and by -5.5 % in Spain [2, 9].

Table 1. Mean, standard deviation and variation coefficients for cultivated area, seeds production and yield by crop, EU-28, 2008-2018

	Mean	Std. Deviation	Coefficient of variation (%)	Minimum	Maximum
Cultivated area (Million ha)					
Rape and turnip rape	6.62	0.08	1.20	6.17	7.1
Sunflower	4.15	0.07	1.68	3.78	4.62
Soybean	0.60	0.07	11.67	0.27	0.96
Oil seeds production (Million tonnes)					
Rape and turnip rape	20.72	0.43	2.07	19.02	24.13
Sunflower	8.27	0.37	4.47	6.97	10.44
Soybean	1.62	0.23	14.19	0.76	2.74
Oil seeds yield (tonnes/ha)					
Rape and turnip rape	3.15	0.06	1.90	2.85	3.59
Sunflower	1.97	0.06	3.04	1.67	2.42
Soybean	2.81	0.08	2.84	2.25	3.32

Own calculations based on Eurostat Data, 2019 [9].

In the same year 2018, of the total area cultivated with soybean in the EU-28, 83.2 % was situated in five countries: Italy 34.2 %, Romania 17.7%, France 16.1 %, Croatia 8.1 %, Austria 7.08 %. In the analyzed interval, the cultivated area with soybean registered a high growth rate in almost all these countries: + 239.8 % in Romania, + 267.5 % in Austria, +202.9 % in Italy, +115.4 % in Croatia and +26.3 % in France [2, 9].

In the near future it is expected a higher rape seed cultivated area in France and Romania, but a reduced surface in Germany and Poland. The cultivated area with sunflower is expected to continue to grow in Romania and Spain, while soybean area will be larger in Italy, France, Croatia, and Austria [24, 25].

Oil seeds production

The oil seeds production from these three crops has recorded an ascending trend in the analyzed period. From 27 million tonnes in 2008, it reached 35.09 million tonnes in 2017, being by 29.96 % higher than in the 1st year of the study.

Fig.2. Dynamics of the oil seeds production, EU-28, 2008-2017 (Million tonnes)
Source: Own design based on the data from Eurostat, 2019 [7, 10, 11].

On the top position is rape and turnip rape. But, its share in the total oil seeds production decreased from 70.44 % in 2008 to 62.43 % in 2017.

Sunflower production is ranked the 2nd, and its weight grew up from 26.74 % in 2008 to 29.75% in 2017, while the share of soybean in the total oil seeds production registered the highest increase of its weight, from 2.82 % in 2008 to 37.82 % in 2017.

All the three oil crops recorded an ascending trend of seeds production. In case oof rape and turnip rape, the production of seeds raised by 15.19 % from 19.02 million tonnes in 2008 to 21.91 million tonnes in 2017. Sunflower seeds production grew up by 44.59 % in the same interval, from 7.22 million tonnes in 2008 to 10.44 million tonnes in 2017.

Soybean seeds registered the highest production growth rate, +260.5%, from 0.76 million tonnes in 2008 to 2.74 million tonnes in 2017 (Fig. 2).

The mean for seeds production and its standard deviation in the period 2008-2017 #accounted for 20.72 ± 0.43 million tonnes in case of rape and turnip rape, for 8.27 ± 0.37 million tonnes in case of sunflower and 1.61 ± 0.23 million tonnes in case of soybean.

Rape registered the highest production of seeds, 24.13 million tonnes in 2014 and the lowest production, 19.02 million tonnes, in 2008.

Sunflower recorded the highest level of production, 10.44 million tonnes, in 2017 and the lowest one, 6.97 million tonnes in 2010.

Soybean production had the lowest level, 0.76 million tonnes, in 2008 and the highest one, 2.74 million tonnes, in 2017.

The variation coefficients were very small in case of rape and sunflower production and moderate, 14.19 %, in case of soybean (Table 1).

The main rape seeds producers in the EU-28, in the decreasing order, are: France, Germany, Poland, United Kingdom, Romania and Czechia, which all together produced 15.9 million metric tonnes in 2018, representing 79.3 % of the EU-28 rapeseed production. The contribution of these countries to the EU rape seeds production was: France 24.7%, Germany 18.3%, Poland 10.8%, United Kingdom 10.3%, Romania 8% and Czechia 7% [2, 7].

Romania is also an important producer of rape seeds taking into account their importance in biodiesel production and also for other purposes as presented above, and also for the attractive subsidies coming from the EU for this crop. Another reason is the opportunity for sustaining export to the EU market where it is a high demand [6].

The main sunflower and soybean seeds producers in the EU-28 are: Romania, Bulgaria, Italy, France and Hungary [2].

The key sunflower seeds producers are Romania and Bulgaria where the cultivated area and production registered a high growth rate during the last decade [4, 12, 16, 18, 19].

Oil seeds yield resulted from the evolution of seeds production and cultivated area by crop. Its dynamics reflected a relatively continuous ascending trend in each case.

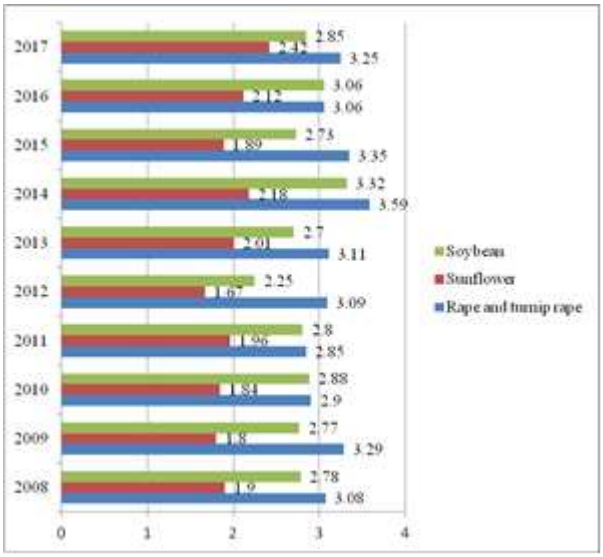

Fig.3. Dynamics of the oil seeds yield, EU-28, 2008-2017 (tonnes/ha)

Source: Own design based on the data from Eurostat, 2019.

Rape seeds yield increased by 5.35 % from 3.08 tonnes/ha in 2008 to 3.25 tonnes/ha in 2017. The maximum level was 3.59 tonnes/ha in 2014 and the minimum level 2.85 tonnes/ha in 2011.

Sunflower yield recorded the highest growth rate in the analyzed period, 27.15 %, ranging between 1.9 tonnes/ha in 2008 to 2.42 tonnes/ha in 2017. The maximum level was 2.42 tonnes/ha in 2017 and the minimum 1.67 tonnes /ha in 2012.

The lowest growth rate was 2.26 % registered by soybean seeds yield. From 2.78 tonnes/ha in 2008, it reached 2.85 tonnes/ha in 2017, but the top level, 3.32 tonnes/ha was noticed in 2014, and the lowest level, 2.25 tonnes/ha in 2012 (Fig. 3).

The variation coefficients had low values, below 3 %, reflecting a good dispersion of variables around the mean (Table 1).

Correlations between the three considered indicators: cultivated surface, seeds production and yield

In case of rape and turnip rape, the lowest correlation coefficient, r = 0.024, was found between the cultivated area and seeds yield, reflecting a very weak relationship, practically lacked of importance.

Between the cultivated area and rape seeds production it was found a moderate and positive relationship, r = 0.413, reflecting a relatively good influence of the cultivated surface on the production of seeds.

But, the highest correlation coefficient, r = 0.823 is between seeds yield and production, reflecting that the higher the yield, the higher seeds production.

In case of sunflower crop, it was found a correlation coefficient r = 0.328, positive and relatively weak, between the cultivated area and seeds yield, a moderate and positive relationship, r = 0.467 between the cultivated area and seeds production, and a high and positive connection, r = 0.913 between seeds yield and production, reflecting, like in case of rape, that the improvement of the average production is the key item which could led to a higher production of seeds.

In case of soybean, the correlation coefficients between the cultivated area and seeds production was very high and positive, r = 0.980, showing that the growth of production was deeply influenced by the extend of the cultivated land.

Between seeds yield and the cultivated area it was found a low and positive correlation, r = 0.258, reflecting that the cultivated area has a weak importance in increasing yield. Therefore, farmers have to improve yield using modern technologies to raise yield.

Between, seeds production and yield of soybean, it was found a moderate and positive correlation, r = 0.439, reflecting that yield is partially responsible of an increased production, and, obviously, the cultivated area sustained production (Table 2).

Table 2. Regression equations and correlation coefficients between the three indicators characterizing seeds production by crop

	Pair of indicators	Regression equation	Correlation coefficient, r	Determination coefficient, R^2
Rape and turnip rape crop				
1	Seeds production (Y) and Cultivated area (X)	Y= 2.045 X + 7.2418	r = 0.413	R^2 = 0.413
2	Seeds yield (Y) and Cultivated area (X)	Y = - 0.122 X+ 3.966	r = 0.024	R^2 = 0.154
3	Seeds production (Y) and Seeds yield (X)	Y = 5.136 X + 4.501	r = 0.823	R^2 = - 0.678
Sunflower crops				
1	Seeds production (Y) and Cultivated area (X)	Y = 3.018 X - 4.317	r =0.467	R^2 = 0.683
2	Seeds yield (Y) and Cultivated area (X)	Y = 0.263 X + 0.879	r = 0.328	R^2 = 0.108
3	Seeds production (Y) and Seeds yield (X)	Y = 5.027 X - 1.678	r = 0.913	R^2 = 0.834
Soybean crop				
1	Seeds production (Y) and Cultivated area (X)	Y = 2.981 X - 0.072	r = 0.980	R^2 = 0.961
2	Seeds yield (Y) and Cultivated area (X)	Y = 0.292 X + 2.647	r = 0.258	R^2 = 0.067
3	Seeds production (Y) and Seeds yield (X)	Y = 1.180 X - 1.701	r = 0.439	R^2 = 0.192

Source: Own calculation.

Regression equations where the dependent factor was seeds production (Y) depending on the independent factor, X, cultivated surface and seeds yield

The resulted equations of regression pointed out the following aspects:
In case of rape crop:
- an increase by one tonnes/ha seeds yield will determine a growth of rape production by 5.13 units;
- an increase by one ha of the cultivated area with rape and turnip rape could raise seeds production by 2.04 units.
In case of sunflower crop:
- an increase by one tonnes/ha yield could led to a seeds production by 5.02 units higher;
- the growth of the cultivated area with sunflower by one ha could also increase seeds production, but by 3.018 units.
In case of soybean:
-an increase of the cultivated land with this crop by one ha could raise seeds production by 2.981 units;
- a growth by one tonnes/ha of the seeds yield will raise production by 1.18 units.
The determination coefficients allowed to identify the percentage of variation caused by the variation of the independent factor taken into consideration, as follows:
-in case of rape crop, 67.8 % of the variation of seeds production is determined by yield;
-in case of sunflower, 83.4 5% of the production variation is caused by yield variation;
-in case of soybean, 96.1 5 of the production change is sustained by the variation of the cultivated surface (Table 2).

CONCLUSIONS

Both cultivated area, seeds yield and production of rape and turnip rape, sunflower and soybean increased in the EU-28 in the period 2008-2018.
Rape and turnip rape looks to be the most important oil crop as proved by its high share in cultivated surface and seeds production. Sunflower comes on the second position both in cultivated area and production, and finally, soybean is ranked the third.
Yields are different from a crop to another, the highest yield being achieved by rape and turnip rape, followed by soybean and sunflower is on the third position.
For increasing oil seeds production in the EU, it is very important to grow yield mainly in case of sunflower and rape and also to increase cultivated surface with soybean.
The key intensive factor is yield, as it is unanimous proved, the higher yield, the higher production and, in consequence, the efficiency of production will also be higher, because, per one Euro spent per ha, the revenue will be higher.
However, the green measures recently adopted by the EU Commission for Agriculture will affect farmers taking into account the incentives offer to plant more soybean and pulses for extending agricultural practices with a beneficial effect on climate and environment.
Also, the fact that the oilseeds producers do not receive any direct payments, but CAP provides to offer higher payments for protein crops production in order to balance the protein deficit on the EU market and reduce imports, will also affect oilseeds producers and production. As a result, it is expected as soybean to be cultivated on larger surfaces and sunflower cultivated area to decline.

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