RAPE PRODUCTION AND ITS GEOGRAPHICAL CONCENTRATION IN ROMANIA

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Abstract

The paper analyzed the concentration of rape cultivated area and seed production in Romania in the period 2009-2018. using Herfindahl-Hirchman Index (HHI) and Gini -Struck Index (GSI), as well the regression and correlation between these indicators. In 2018, Romania had 633 thousand ha cultivated with rape and produced 1,673,327 tons seeds, 2.8 times more than in 2009. All the eight micro-regions are involved in rape cropping. but the largest surfaces are situated in the South Muntenia (39.07%), South-East (24.69), South-West Oltenia (10.03), West (9.07%). The highest contribution to rape seed output is given by South Muntenia (42.36%), South-East (22.89%), West (11.33) and North-East (6.43%). The HHI values > 0.25 reflected a relative high concentration of the cultivated area and seed production, mainly in four micro-regions: South Muntenia, South-East, South-West Oltenia and West. The Gini-Struck Index indicated a moderate concentration of the cultivated area and also of the seeds production, GS = 0.371-0.468 for surface, and GS = 0.379- 0.477 for production. The correlation coefficient r = 0.888 proved a positive and strong relationship between the two indicators, and the regression model, Y = 2.694 X - 163.83 reflected that one thousand more ha cultivated with rape will produce 2.534 thousand tons seeds in addition. Rape production is expected to continue to grow and to be more concentrated in the micro-regions mentioned above.

Key words: rape, production, concentration, territorial distribution, Romania

INTRODUCTION

The development of rape seed production during the last 30 years is obviously linked to the multiple uses of rape seeds for producing oil (edible, for biodiesel, lubricants), fodder for animals (rape meal), plastic materials, chemicals (varnishes and paints, detergents).

Of 100 kg rape seeds, it could be achieved 30-35 high quality oil and 50-55 kg rape meal for cattle feeding [3].

Rape comes on the 2nd position in the world among the oilseeds crops after soybean. In 2017, the global oil seeds production reached 479 million tons, of which soybean 73% and rape 16%.

The main rape seeds producers are the EU, Canada, China, India and Australia whose market share in the world output was 28.7%, 27.4%, 17%, 10.3% and, respectively, 5.6%, all these five countries summing 89% [12, 19, 37, 39, 44].

The EU is the top rape seeds producer in the world and in 2017 it carried out 22 million tons, but in 2018, the output was lower, 19.9 million tons because of the climate change [11].

The key rape seeds producers in the EU were are France, Germany, Poland, Romania, and United Kingdom [7, 44].

Being focused in assuring a healthy environment by reducing green house emissions, the EU issued the Biofuels Directive (2003) which provides that in 2020 about 20% of the energy for transport to be supplied from renewable sources like biodiesel and bioethanol. This was an incentive to stimulate rapeseeds production in the EU [10, 14, 17, 36, 38, 40, 41].

The energy productivity for rapeseed biodiesel output was estimated in research works at 24.41 MJ/ka and 7,084.45 MJ/ha cultivated with rape [20].

The importance of rape seed in oil production is given by its chemical composition consisting of fats (mainly oleic fatty acid 65%, etc), protein and Nitrogen-Free Extracts [1, 14].

Romania is recognized as an oilseeds producing and exporting country, being ranked the fourth in the EU. About 73% of Romania's

oilseeds production is representing by sunflower seeds and 25% by rapeseeds [22, 23, 24, 25, 35].

The high growth rate of rape seeds output was registered after Romania's access into the EU in 2007. The producers considered this an opportunity to extend the cultivated surface and to start applying new cropping technologies to get more income and contribute to the alignment of the country to the new orientation in biodiesel production [26].

Concentration aspects have been studied in many countries for many years, but just a few were done in Romania using Herfindahl-Hirschman Index and Gini-Struck coefficient. A few studies approached the development of the economy in the micro-regions in terms of GDP [2, 13, 16, 21, 31] and also concerning the concentration in tourism and agro-tourism [29, 33, 34].

The main studies regarding the concentration in Romanian agriculture approached the following topics: concentration of the farms cultivating maize [27], the concentration in pork production [28], concentration in milk market [30], concentration in apple production [32], concentration in sunflower seeds production [35].

In this context, the goal of the paper was to evaluate the geographical distribution of the rape crop in Romania in its eight micro-regions of development by means of two criteria: cultivated area and seeds production, trying to find out if the share of the micro-regions was converging or there were still discrepancies regarding the concentration of output in the country territory during the last decade, 2009-2018.

MATERIALS AND METHODS

The study area

Romania has a surface of 238, 297 km^2, of which agricultural 13,9 million ha, of which 60% arable land. The main cultivated crops are cereals, technical plants, oilseeds crops, vegetables etc.

The climate is a temperate continental one with some Mediterranean influences, characterized by territorial differences given by latitude and altitude of the relief forms.

The average annual temperatures accounts for 10-11^{0}C in the South to 8-9^{0}C in the North, the maximum level being reached in summer season, 22-24^{0}C, and the minimum in winter, -3 -5^{0}C.

The average annual precipitations are 637 mm, but they are lower in the Eastern part of the country (400-500 mm) and higher in the mountain area (1,000-1,400 mm).

Summers are usually hot in the plains of the South East, South Muntenia and West, with more than 25^{0}C for about three months. Autumn is short, characterized by dry and rainy periods. Winter is cold, the temperatures going down up to about -20^{0}C sometimes, and snow layer is not so thick. Spring is short and summer could start even at the end of April [43].

The favorable climate conditions and the diversity of soil types and quality stimulate the development of agricultural production, except the years when the effects of global warming are seen (long periods of drought and other extreme phenomena).

Data collection

The research work is based on the time series of data regarding the last decade, more exactly, 2009-2018, for which the National Institute of Statistics provides official information.

The studied indicators were: the cultivated area with rape and rape seed production.

The methodology used to characterize the concentration of rape seeds production in the territory of Romania consisted of:

-*Herfindahl-Hirschman Index, HHI*, commonly used to express the dispersion of an indicator in a geographical area or on a market [4, 42].

The calculus of HHI was made using the formula:

$$HHI = \sum_{i=1}^{n}(g_i)^2$$

where: $g_i = \frac{X_i}{\sum_{i=1}^{n} X_i} = \frac{X_i}{X_j}$

i = the micro-region of development, i = 1,2,....8;
X_i = the cultivated area with rape or rape seed production in the micro-region I;
X_j = the total surface cultivate with rape or the total rape seeds production in Romania;

g_i = the share of the micro -region i in the total area cultivated with rape or the rape seed production at the country level, X_j.

Gini - Struck Coefficient, GSI, was also used for reflecting the concentration of an indicator analyzed in a specific territory [9].

The mathematical formula was:

$$GSI = \sqrt{\frac{n\sum_{i=1}^{n}g_i^2 - 1}{n-1}}$$

The coefficient of structural change, CSC, whose formula is:

$$CSC g_i\text{-}g_0 = = \sqrt{\frac{\sum_{i=1}^{n}(g_{1i}-g_{0i})_i^2}{n}}$$

where:
g_{1i} = the shares of the micro-regions i in the moments 1 in the analyzed period;
g_{0i} = the shares of the micro-regions i in the moments 0 in the analyzed period.

The trend method was also used in order to establish the general tendency for the two indicators: cultivated area and production of seeds. In this purpose, taking into account the dispersion of the points in the graph, the polynomial equation, $Y = ax^2 + bx + c$ was chosen ad being considered the most suitable to describe the trend line.

The linear regression model was also utilized, in its classic form, $Y = bx + a$, to reflect the relationship between these two indicators, Y, the rape seed production, the dependent variable and X, the cultivated area with rape, the independent variable. In the formula given above, b = the regression coefficient and a = constant. *The correlation coefficient* was determined according to the well know Bravais-Pearson formula, and the *R square* for assessing how much of the variation of seed production is determined by the change in rape cultivated surface. The obtained results were illustrated in tables and graphics and finally the main conclusions were drawn.

RESULTS AND DISCUSSIONS

The cultivated area with rape in Romania increased by 50.6% in the period 2009-2019, reflecting the interest of the producers to extend the rape culture in the territory and to carry out a higher production of seeds. In 2018, in Romania it was cultivated the largest area cultivated with rape, 632,679 ha compared to 419,900 ha in 2009 (Fig.1).

For assuring a constant and efficient production from a year to another, like for any other agricultural crop, rape cropping requires a harmonized combination between:

(i) the natural resources (relief form, soil, water, heat, lightness, nutrients, microorganisms existing in the ground),

(ii) the biological material (varieties and hybrids adapted to the climate conditions, resistant mainly to drought, pests and diseases, and weeding), and

(iii) the cropping technologies (crop rotation, tillage system, sowing systems, fertilization, maintenance of the culture, machinery and equipments), and

(iv) the economic aspects reflected by production management, organization and optimization of the allotted resources for rape cultivation [5, 15].

In Romania, rape culture is advantaged by climate and soil conditions, by the existence of a large range of cultivars and hybrids well adapted to the plain regions and with a high production potential which allow to produce even more than 4,000 kg seeds per ha.

In general, rape requires relatively moderate rainfalls, 450-650 mm in summer season, an annual average temperature of 7-10^{0}C, mild winters and a thick snow layer for protection. Also, it prefers the soils like alluvial and reed soils, chernozem and the reddish-brown soil, which are rich in humus and chalk, with a neutral pH 6-7 and high capacity to maintain moisture. Taking into consideration these aspects, the most suitable areas for rape cropping in Romania are the plains from the South-East, South Muntenia, South-West, North-West, and South Moldova [3, 5, 6, 8].

The territorial distribution of the cultivated area with rape differs from a micro-region to another, depending on the soil and climate conditions. The largest surfaces cultivated with rape are situated in the South Muntenia, South-East, South-West Oltenia, West and North-East of Romania. In the analyzed interval 2009-2018, there were noticed some changes regarding the share of the cultivated area with rape by micro-region in the total surface cultivated at the national level.
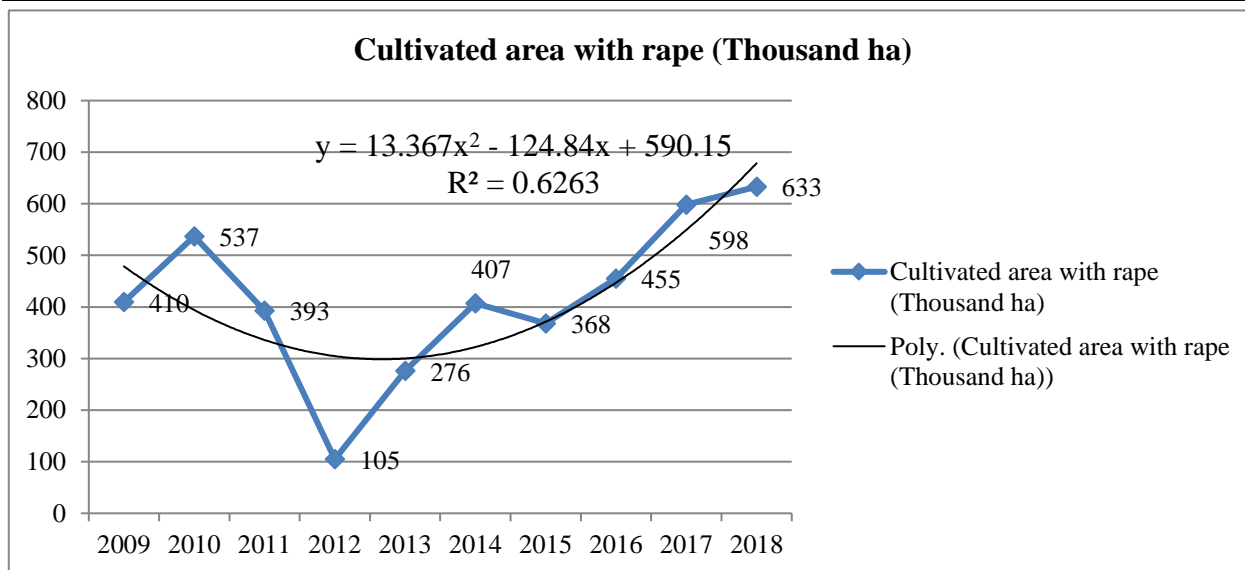
Fig.1. The rape cultivated area, 2009-2018, Romania (Thousand ha).
Source: Own design based on the data from NIS, 2020 [18].

Table 1. The geographical dispersion of the rape cultivated area by micro-region, in Romania, in 2018 versus 2009 (%)

Micro-region	2009	2018
North-West	1.94	4.82
Center	0.63	1.76
North-East	11.86	8.05
South-East	38.30	24.69
South Muntenia	35.21	39.07
Bucharest-Ilfov	0.70	1.88
South-West Oltenia	8.47	10.03
West	2.89	9.70

Source: Own calculation based on the data from NIS, 2020.

The South Muntenia micro-region is in the top and its share increased from 35.21% in 2009 to 30.07 % in 2018. In case of the South-East micro-region, its share declined from 38.3% in 2009 to 24.69 % in 2018. The share of the North-East micro-region decreased from 11.86% in 2009 to 8.05% in 2018, while in the South West Oltenia micro-region the weight increased from 8.47% to 10.03%.
The highest growth rate of the cultivated area with rape was registered in the West micro-region, and as a result, its share in the national cultivated area with rape recorded a significant growth from 2.89 % in 2009 to 9.7% in 2018 (Table 1).

Rape seed production registered variations from a year to another in the last decade, but the general trend is an increasing one. In 2018, Romania produced 1,610,907 tons rape seeds, 2.82 times more than in 2009. However, in 2018, the seed production was by 3.8% lower than in 2017, when Romania performed the highest level: 1,673,327 tons. The most critical year in the analyzed interval was 2012, when, besides the smallest cultivated area with rape, only 105,295 ha, the seed output was the lowest one, 157,511 tons, due to the long drought which affected not only rape but also agricultural crops (Fig. 2).
The geographical distribution of rape seed production in Romania, follows in general the territorial dispersion of the cultivated surface. The highest seed productions are achieved in the South Muntenia, South-East, West, South-West Oltenia and North-East.
Due to the change in the cultivated land and climate from a year to another, the share of the micro-regions in the rape seed output at the country level has also changed. In the South Muntenia, the share of the seed production increased from 36.74% in 2009 to 42.36% in 2018, but in the South-East, it diminished from 35.595 to 22.89% in the same interval. In the West, the weight of seed production increased from 3.48% in 2009 to 11.33% in 2018.
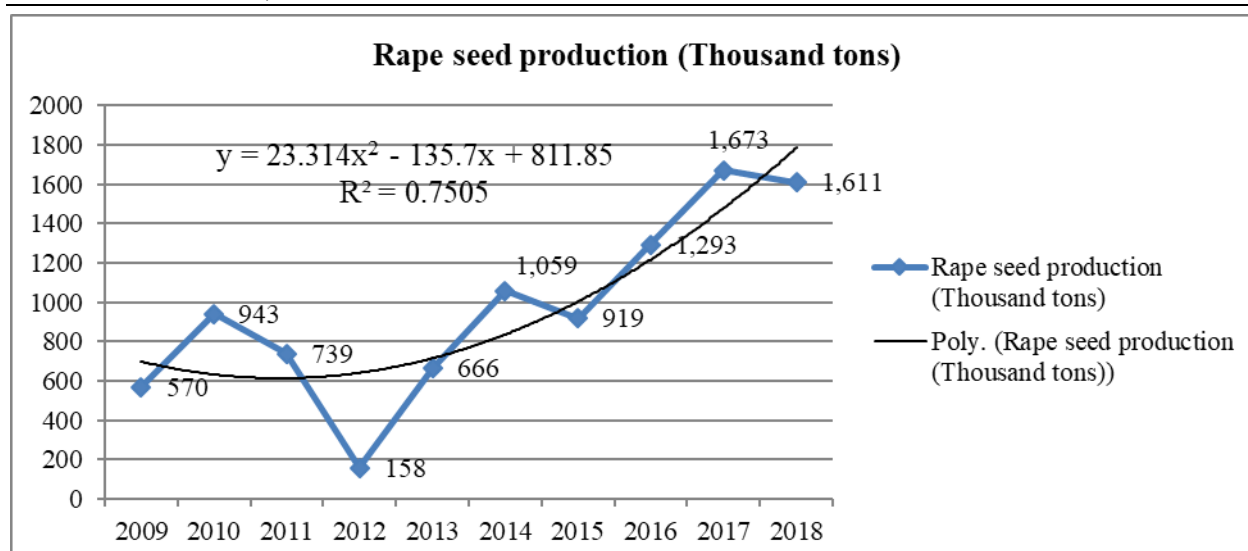
Fig.2. The rape seed production, 2009-2018, Romania (Thousand tons).
Source: Own design based on the data from NIS, 2020.

Table 2. The geographical dispersion of the rape seed production by micro-region, in Romania, in 2018 versus 2009 (%)

Micro-region	2009	2018
North-West	1.65	4.65
Center	0.66	1.88
North-East	12.40	6.43
South-East	35.59	22.89
South Muntenia	36.74	42.36
Bucharest-Ilfov	0.60	1.77
South-West Oltenia	8.88	8.69
West	3.48	11.33

Source: Own calculation based on the data from NIS, 2020.

Table 3. The coefficients of structural changes in rape cultivated area and seed production in the interval 2009-2018 (percentage points)

Micro-region	Rape cultivated area	Rape seed production
North-West	3.74	7.96
Center	4.18	7.99
North-East	1.02	1.47
South-East	3.13	1.81
South Muntenia	1.67	3.26
Bucharest-Ilfov	4.01	8.32
South-West Oltenia	1.78	2.76
West	5.13	9.24

Source: Own calculation based on the data from NIS, 2020.

The most affected micro-region was North-East where its share declined from 12.40 % to 6.43%. The share of the South-West Oltenia also went down from 8.88% in 2009 to 8.69% in 2018. The other micro-regions, North-West, Center and Bucharest-Ilfov had the smallest contribution to the national output: 4,65%, 1.88% and, respectively, 1.77% in 2018 (Table 2).

The coefficient of structural changes by micro-region in the last decade, regarding the cultivated surface with rape reflects that the highest increase was registered by the West micro-region 5.13%, followed by the Center micro-region 4.18% and Bucharest-Ilfov, while the lowest was in the North-East 1.02 % and in South-West Oltenia 1.78%.

Regarding the rape seed output, the highest changes were noticed in the West micro-region, 9.24%, in Bucharest-Ilfov 8.32%, in the Central area 7.99% and North-West 7.96%. The small structural variation reflects a constant level maintained along the analyzed interval (Table 3).

The Herfindahl-Hirschman Index values reflected the following aspects:

(i)regarding the cultivated area with rape:

- In the years 2012 and 2018, HHI < 0.25, which indicates the existence of a moderate concentration among the micro-regions of development of Romania;

-In the other years, HHI > 0.25 which means a movement to a relative high concentration of the cultivated surface in some regions

compared to the others. It is about the South Muntenia, South-East, South-West Oltenia and West.

(ii)regarding the rape seed production, in all the years of the studied period, HHI recorded higher values than 0.25 meaning that it is a relative high concentration of production in some regions, more exactly in South Muntenia, South-East, West, South-West Oltenia and North-East versus other micro-regions (Table 4).

Table 4. Herfindahl-Hirschman Index for rape cultivated area and seed production in Romania, 2009-2018

	Rape cultivated area	Rape seed production
2009	0.2932	0.2865
2010	0.3167	0.3248
2011	0.2757	0.2704
2012	0.2459	0.2508
2013	0.3161	0.3597
2014	0.2874	0.2915
2015	0.2867	0.3029
2016	0.2690	0.2861
2017	0.2528	0.2715
2018	0.2425	0.2650

Source: Own calculation.

Gini-Struck Index values are presented in Table 5. For the cultivated surface with rape, GS values are different from a year to another reflecting the structural variations in the micro-regions.

The highest GS was recorded in 2013, GS = 0.4673, while the smallest one, GS = 0.3664 was registered in 2018. These values indicate a moderate concentration of the cultivated area in a few micro-regions compared to the other zones.

Regarding the rape seed production, the GS values vary between 0.3791, the lowest level in 2012 and 0.5179 in 2013, the highest level. This reflects that in 2013, it was registered a trend of production concentration in a few regions, more exactly in South Muntenia and South-East and also in the West part of Romania, creating inequalities versus other micro-regions (Table 5).

Table 5. Gini-Struck Index for rape cultivated area and seed production in Romania, 2009-2018

	Rape cultivated area	Rape seed production
2009	0.4384	0.4296
2010	0.4680	0.4778
2011	0.4150	0.4076
2012	0.3717	0.3791
2013	0.4673	0.5179
2014	0.4308	0.4362
2015	0.4298	0.4509
2016	0.4056	0.4290
2017	0.2821	0.4091
2018	0.3664	0.4021

Source: Own calculation.

Regression and correlation between the rape cultivated surface and seed production reflects that between the two indicators, Y, the seed output considered as dependent variable and X, the cultivated area with rape, the independent variable, it is a strong and positive relationship, shown by the high correlation coefficient, r = 0.888.

The coefficient of determination, R^2 = 0.788, which attests that 78.85% of the variation of rape seed production is caused by the change in the cultivated area with rape. The difference up to 100% belongs to other influencing factors such as: yield, applied technologies, etc.

The regression model, Y = 2.694 X - 163.83 reflects that if X, the cultivated surface will increase by one thousand ha, seed production will raise by 2.534 thousand tons.

The regression coefficient is statistically assured, and confirm that the regression model is suitable to express the relationship of determination between rape seed output and the cultivated area with rape.

The availability of the regression model is confirmed by F-statistic whose value is higher that the tabled value, as well as by the null risk degree as given by Sign. F.

The lower 95% and Upper 95% thresholds reflect that the parameters of the linear regression model belong to the following intervals:

-668.044298 < a < 340.374146
 and 1.557143 < b < 3.832312
as shown in (Table 6).

Table 6. Regression model, coefficient of correlation and coefficient of determination between the cultivated surface with rape and seed production, Romania, 2009-2018

Regression statistics						
Multiple R	0.888018					
R square	0.788577					
Adjusted R square	0.762149					
Standard Error	229.0580					
Observations	10					
ANOVA						
	df	SS	MS	F	Sign. F	
Regression	1	1565574	1565574	29.83888	0.000599	
Residual	8	419740.7	52467.59			
Total	9	1955315				
	Coefficients	Standard Error	t-stat	p-value	Lower 95%	Upper 95%
Intercept	-163.8350761	218.6506	-0.7493	0.475126	-668.044298	340.374146
X Variable 1	2.694627	0.493314	5.462498	0.000599	1.557143	3.832312

Source: Own results.

CONCLUSIONS

The research pointed out the trends in concentration of rape cultivated area and seed production in the territory of Romania in the last decade, 2009-2018. In 2018, Romania had 633 thousand ha cultivated with rape. In the analyzed interval, the cultivated land with rape increased by more than 50%, while seed production was almost 2.82 higher in 2018 versus 2009. This reflect a continuous improved performance in rape seed yield by using integrated technologies with a high positive economic impact in rape cropping.

Romania comes on the 4th position in the EU for its production of rape seed production of 1,673,327 tons achieved in 2017. However, production was sometimes affected by climate change, especially by the long drought as proved in 2012.

Rape is cultivated in all the micro-regions of Romania, but the largest surfaces are situated in the South Muntenia (39.07%), South-East (24.69), South-West Oltenia (10.03), and West (9.07%) and production performance is carried in these regions as well.

The highest share of production by micro-region in Romania's rape seed output was found in South Muntenia (42.36%), South East (22.89%), West (11.33) and North East (6.43%).

In general, seed production increased in almost all the regions in the last decade, but with different growth rates.

Herfindahl-Hirchman Index proved that in Romania the concentration of the surface cultivated with rate is relative high, HHI > 0.25, as the largest areas are cropped by four micro-regions: South Muntenia, South-East, South-West Oltenia and West. Also, the concentration of rape seed production is relative high, as South Muntenia, South-East, West, South-West Oltenia and North-East produce the highest quantities of seeds compared to other micro-regions.

Also, Gini-Struck Index indicated a moderate concentration of the cultivated area and also of the seeds production, with values ranging between GS = 0.3717 and 0.4680 for surface, and GS = 0.3791 and 0.4778, for production.

The correlation coefficient between cultivated land and rape seed production was high and positive, r = 0.888, and the linear regression model, Y = 2.694 X - 163.83 pointed out that an increase by one thousand ha cultivated with rape will determine a production growth by 2.534 thousand tons.

As a final conclusion, rape production is Romania performed well during the last decade and it is expected to raise in the coming years, continuing to apply the modern integrated technologies in rape cropping.

The farmers have to pay a special attention to high value hybrids, crop rotation, tillage

system, sowing period and depth, plant density and the distance between rows, fertilization ratio between nutrients NPK and also to the phytosanitary protection measures to carry out a higher rape seed output.

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