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ANALYSIS OF THE AVERAGE YIELD PER HECTARE FOR THE MAIN AUTUMN CROPS AND DETERMINATION OF THE INFLUENCING FACTORS

PETRE IONUȚ LAURENȚIU¹

Summary: *In this paper we will analyze the average yield per hectare for the main field crops, autumn, in order to determine the development regions with a higher potential. It will be analyzed from a statistical point of view whether regions with higher productivity differ significantly from the national average. This analysis will be determined by testing the hypotheses using the t test. Determining the region with the best yield for autumn crops will be analyzed and possible factors that led to this distancing in that region, also with the help of the t test it will be possible to see if certain inputs differed quantitatively in that region from the national average.*

Keywords: *field crops, autumn crops, yield, hypothesis testing, inputs.*

JEL Classification: *Q10, Q15*

INTRODUCTION

The present study wants to analyze the average production per hectare in Romania, both the national average and the average of the eight development regions in order to determine the performing regions in this regard, but also the possible factors that may influence this yield. In the analysis, the main autumn crops were taken into account, depending on the cultivated areas, respectively, wheat, barley and rapeseed.

Studying the literature, Bouregaa (2019) conducted one of the first studies that analyzed the impact of future climate change on the need for water and the yield of harvested crops in the Setif region. Among the main findings of the research, it results that the average temperature will increase by 0.73 to 3.42 ° C, and rainfall will decrease by 1 to 52.7 percent. Winter wheat and olive production is expected to decline and barley yields to decline only under light soil (ShalekBriski et al., 2020).

A similar research was conducted by Hesam Arefi et al. (2017), which aimed to simulate the impact of climate change on winter wheat production and to evaluate the possibilities of using different varieties and changing the planting date as two strategies for adapting to climate change in Kerman Province, Iran. The simulated results indicated that the wheat production of the common variety (with average maturation) of winter wheat will decrease, ranging from -0.27 to -18.71% depending on future climate change. The earlier planting date (October 20) increased the yield of wheat cereals in future climatic conditions than the usual planting date (November 5). Conversely, subsequent planting (November 20) would accelerate the harmful effects of climate change on wheat cereal yields.

Zhang and Wang (2010) conducted research to assess the production risk for winter wheat producers in Beijing, China. They found that the loss rates of wheat production in the districts of Beijing are between 6 and 15%, which is considered the average range in most regions. The highest production risks are located in the western regions of Beijing (Mentougou and Fengtai), while the lowest production risk is located in the southeastern region of Beijing (Daxing District).

The purpose of Wang et al. (2014) is to explore the impact of climate change on net crop income by region. In particular, the authors focus on the differences in impact between the northern and southern regions. The authors' results show that, on average, the increase in annual temperature will affect farms in the north or south. The impact of climate change on both rainfall and temperatures has different seasonal impacts on producers in northern and southern China. Consequently, the impact on farm net income varies depending on the farms in the north and south, being negatively affected (to varying degrees) by an increase in temperature, but both benefiting from an anticipated increase

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in rainfall. Also, that irrigation is a key measure of adaptation to climate change management (Khuu and Juerg, 2013).

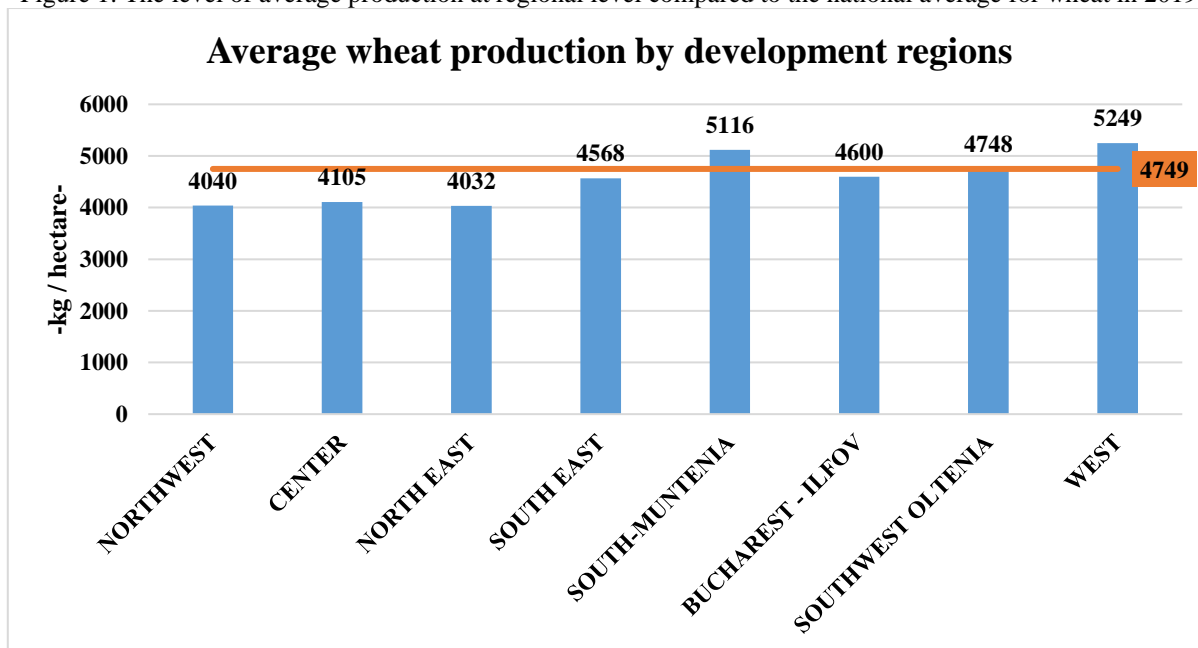
MATERIAL AND METHOD

In this paper we want to analyze the average yields per hectare for the main autumn crops in order to analyze them comparatively between development regions and the national average. For this analysis, data on the average production per hectare will be used with the help of the national databases, respectively those of the National Institute of Statistics. Following this quantitative analysis, a statistical analysis of the averages between the yields recorded in the counties of the regions with the highest productivity and the average yield at national level will be performed, using the bilateral hypothesis test, respectively the t test. Finally, if there are statistically significant differences, the influencing factors of these differences will be determined.

RESULTS AND DISCUSSIONS

The average yield per hectare can be influenced by several factors both endogenous and exogenous, thus, the average yields per hectare for the main three autumn crops (wheat, barley and rapeseed) by development regions were analyzed, compared to the average national.

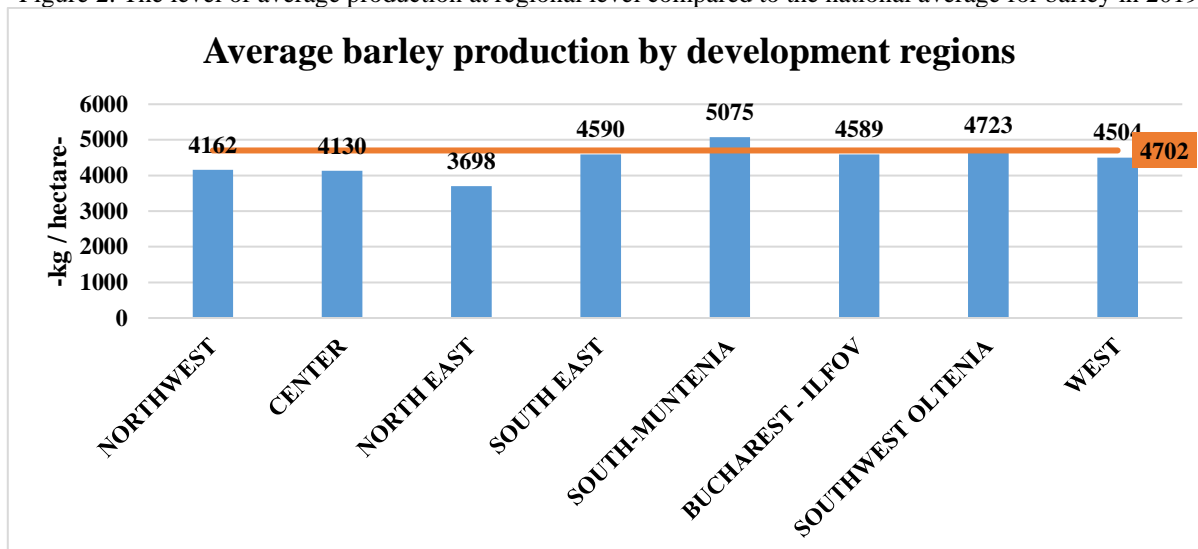
Figure 1. The level of average production at regional level compared to the national average for wheat in 2019



Source: own processing based on NIS data

Figure 1 shows the average yields per hectare for wheat cultivation, from 2019, for all eight development regions of Romania, but also the national average. It can be seen from the graph that the latter is at the level of 4,749 kilograms per hectare. Of the eight development regions, five have an average yield per hectare below this threshold, and three of the regions exceed this national average. Among the regions with a lower level of average production, the North-East region stands out, with the largest gap between its yield and the national yield, the average wheat production in this region being 4,032 kilograms per hectare, lower than the average with 15.1%. Among the regions with an average level of production per hectare higher than the national average, the West region stands out, with an average wheat crop yield of 5,249 kilograms per hectare, with a surplus of 500 kilograms compared to the national average, respectively with 10.5%.

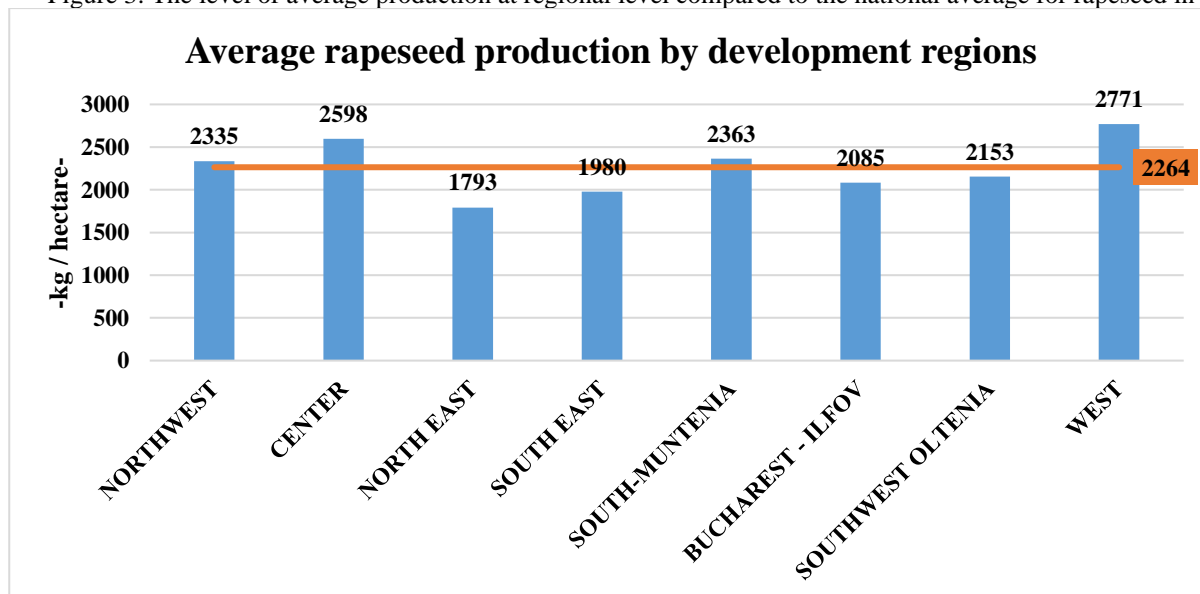
Figure 2. The level of average production at regional level compared to the national average for barley in 2019



Source: own processing based on NIS data

Figure 2 shows the average yields per hectare for barley cultivation, from 2019, for all eight development regions of Romania, but also the national average. It can be seen from the graph that the latter is at the level of 4,702 kilograms per hectare. Of the eight development regions, six have an average yield per hectare below this threshold, and two of the regions exceed this national average. Among the regions with a lower average production level, the North-East region stands out, with the largest gap between its yield and the national yield, the average barley production in this region being 3,698 kilograms per hectare, lower than the average with 21.35%. Among the regions with an average level of production per hectare higher than the national average, the South-Muntenia region stands out, with an average barley yield of 5,075 kilograms per hectare, with a surplus of 373 kilograms compared to the national average, respectively by 7.93%.

Figure 3. The level of average production at regional level compared to the national average for rapeseed in 2019



Source: own processing based on INS data

Figure 3 shows the average yields per hectare for rapeseed cultivation, from 2019, for all eight development regions of Romania, but also the national average. It can be seen from the graph that the latter is at the level of 2,264 kilograms per hectare. Of the eight development regions, four have an average yield per hectare below this threshold, and four of the regions exceed this national average. Among the regions with a lower average level of production, the North-East region stands

out, with the largest gap between its yield and the national yield, the average rapeseed production in this region being 1,793 kilograms per hectare, lower than the average with 20.8%. Among the regions with an average level of production per hectare higher than the national average, the West region stands out, with an average yield of rapeseed cultivation of 2,771 kilograms per hectare, with a surplus of 507 kilograms compared to the national average, respectively with 22.4%.

In order to determine whether there are significant differences between the average yield per hectare in the case of the leading regions for this indicator and the national average, the statistical analysis on the comparison of averages by testing the hypotheses using the t test was used. The yields recorded in the first two development regions were compared with the average yield at national level, in order to determine whether there is a statistically significant difference between these variables.

Table 1. Testing of average wheat yields between the first two regions and the national average

<i>Average production South-Muntenia</i>		<i>Average production West</i>	
Mean	4934.714286	Mean	4797.25
Variance	329090.5714	Variance	419678.9
Observations	7	Observations	4
Hypothesized Mean		Hypothesized Mean	
Difference	4749	Difference	4749
df	6	df	3
t Stat	0.856518233	t Stat	0.14896
P(T<=t) one-tail	0.212296253	P(T<=t) one-tail	0.445518
t Critical one-tail	1.943180281	t Critical one-tail	2.353363
P(T<=t) two-tail	0.424592505	P(T<=t) two-tail	0.891035
t Critical two-tail	2.446911851	t Critical two-tail	3.182446

Source: own processing using MS Excel

The first two regions to record the highest average yield per hectare of wheat were the Southern region and the Western region. Thus, the recorded yield was compared with the national average yield. Following the testing of the hypothesis, according to which, in the mentioned regions, the yield is statistically significantly different than the national average, from table 1 it can be seen that this hypothesis is rejected, registering a level of the statistical parameter t (t State) below the critical threshold (t Critical) in both cases and the significance level is above the minimum accepted threshold of 0.05. Therefore, it can be stated that the higher average yield per hectare in the two regions does not differ significantly from the national average.

Table 2. Testing of average barley yields between the first two regions and the national average

<i>Average production South-Muntenia</i>		<i>Average production Southwest</i>	
Mean	4732.857	Mean	4376.6
Variance	473609.5	Variance	150866.3
Observations	7	Observations	5
Hypothesized Mean		Hypothesized Mean	
Difference	4702	Difference	4702
df	6	df	4
t Stat	0.11863	t Stat	-1.8733
P(T<=t) one-tail	0.45472	P(T<=t) one-tail	0.067159
t Critical one-tail	1.94318	t Critical one-tail	2.131847
P(T<=t) two-tail	0.909441	P(T<=t) two-tail	0.134318
t Critical two-tail	2.446912	t Critical two-tail	2.776445

Source: own processing using MS Excel

The first two regions with the highest average yield per hectare for barley cultivation were the South region and the South-West region. Thus, the recorded yield was compared with the national average yield. Following the testing of the hypothesis, according to which, in the mentioned regions, the yield is statistically significantly different than the national average, from table 1 it can be seen that this hypothesis is rejected, registering a level of the statistical parameter t (t State) below the

critical threshold (t_{Critical}) in both cases and the significance level is above the minimum accepted threshold of 0.05. Therefore, it can be stated that the higher average yield per hectare in the two regions does not differ significantly from the national average.

Table 3. Testing the average yields for rapeseed between the first two regions and the national average

	<i>Average production Center</i>		<i>Average production West</i>
Mean	2401.833333	Mean	2817.5
Variance	129339.3667	Variance	82143
Observations	6	Observations	4
Hypothesized Mean Difference	2264	Hypothesized Mean Difference	2264
df	5	df	3
t Stat	0.938781493	t Stat	3.862445
P(T<=t) one-tail	0.195471414	P(T<=t) one-tail	0.015341
t Critical one-tail	2.015048373	t Critical one-tail	2.353363
P(T<=t) two-tail	0.390942829	P(T<=t) two-tail	0.030682
t Critical two-tail	2.570581836	t Critical two-tail	3.182446

Source: own processing using MS Excel

The first two regions with the highest average yield per hectare for rapeseed were the Center region and the West region. Thus, the recorded yield was compared with the national average yield. Following the testing of the hypothesis, according to which, in the mentioned regions, the yield is statistically significantly different than the national average, from table 1 it can be seen that this hypothesis is rejected in the case of the Center region, registering a level of statistical parameter t (t_{Stat}) below the critical threshold (t_{Critical}), and the significance level is above the minimum accepted threshold of 0.05. Therefore, it can be stated that the higher average yield per hectare in the Center region does not differ significantly from the national average. Instead, analyzing the West region and the yield obtained in this area, it can be seen that the statistical parameter t ($t_{\text{Stat}} = 3.86$) is higher than the critical level ($t_{\text{Critical}} = 2.35$), and the significance level (p value = 0.015) is lower than the maximum accepted threshold of 0.05, therefore it can be seen that in the Western region the level of average yield per hectare differs statistically significantly from the national average.

Analyzing the factors that can influence this significant difference between the average yield per hectare at national level and the yield in the West region, for rapeseed, we can identify the main factors influencing agriculture in Romania, namely rainfall and average temperature. The latter indicator did not show different values in this region compared to the national average or compared to other regions, but analyzing the level of precipitation can be seen differences in the West region compared to other regions, in the period (months) when this rapeseed requires an additional supply of water (April-May), so it can be considered that this difference in yield may be due to this. (World climate guide).

CONCLUSIONS

In this paper we wanted to analyze the average yields per hectare for the main autumn crops and identify any significant differences between development regions, compared to the national average. After studying the average yields per hectare, for the three selected crops (wheat, barley and rapeseed) the following can be found: for cereals the areas where average yields per hectare were almost coincided, both for wheat and barley, the highest production was registered in the South-Muntenia region, and the second region was in the western part of the country, respectively the Western region for wheat cultivation and the South-Western region for barley cultivation. Regarding the average production per hectare of rapeseed, the region with the highest potential was the West region, followed by the Center. At the opposite pole, there is a similarity for all three crops, respectively the lowest level of yield is recorded in the North-East region. Among the main reasons that may explain this phenomenon, considers that two of them are essential, namely the limitation or low level of resources, on the one hand agricultural resources, especially soil, less fertile, in these

areas, but also financial resources, being a less developed region from an economic point of view, and on the other hand there is also pressure from the meteorological conditions, as it is known in this region the temperature being lower.

Comparing the average level of yield at the national level with the yields recorded in the first two development regions, it was found that there were no significant differences between these regions and the national average for wheat and barley crops. However, analyzing the rapeseed crop, there was a significant difference between the level of average production per hectare in the Western region and the national average yield. This statistically significant difference was explained by the fact that in April-May there was a higher level of precipitation in this area compared to other areas of the country, and these precipitations occurred at the right time to increase the yield in the stage of plant development. Comparing the national average yield for rapeseed, with the one registered for the second development region according to the average production, respectively the Center region, there were no significant differences.

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