

The Main Statistical Indicators Analysis of Cereal Production in Romania and In Development Regions for the Period 1990-2014

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Abstract

This paper aims at analyzing the evolution over time of the cereal crops, crops which are representative for overall Romania and for each Development Region. The indicators analysis that characterize the cereals production was split across two time periods: 1990-2006 and 2007-2014. It is considered that the period 1990-2006 marked a historic transition for Romania, with deep economic repercussions, following that, immediately with the start of the second period 2007-2014, with the integration into the European Union, to be assessed this change by the overall impact on the economy and default on the agriculture. The analysis by comparison of the two periods was carried out with the help of statistical indicators relating to: the cultivated surfaces evolutions, the total productions and average productions evolutions, as well as their trends for the period 2015-2020.

Cereals production fluctuated greatly. Thus, in the first period 1990-2006 has a coefficient of variation of 21%, while in the second period from 2007 to 2014, has an oscillation of 38%, which is considered by other studies as "a chaotic tendency" as it shows a FTAP project from 2012.

The conclusions resulting from this work suggests that cereals sector development is an essential element for strengthening the economy and ensuring the food security, being responsible for the stability and the availability of internal food products supply.

Keywords : cereal production, statistical indicators, the grain production trend

Introduction

Cereals have been throughout history and are unquestionably the most important sources of plant food for humans and livestock. All of the original ancestors of cereals have been lost over the millennia that they have been cultivated. The development of all the major cereals occurred long before recorded history for all the oldest civilizations were already familiar with several kinds of barley, wheat and other grains(Hill 1952).

The annual growth rate of world demand for cereals fell from 2.5% a year in 1970 and 1.9% per year in the 1980s to only 1% per year in the 1990s. In the 1990s, the decline was accentuated by a number of temporary factors, including serious recessions in the transition countries and some countries in Southeast Asia and East.

The growth rate of demand for cereals is expected to stagnate at 1.2% per year after 2015. In developing countries overall, cereals production is not expected to keep pace with demand. The net cereal deficits of these countries, which amounted 103 million tonnes, or 9% of consumption in 1997-1999 could amount up to 265 million tons by 2030, when they will be 14% of consumption. These gaps can be covered by increasing the traditional grain exporters surplus and new exports from developing countries, which are expected to become from being net importers to net exporters (FAO report, 2002).

Nationally, agriculture is one of the most important branches of the Romanian economy. The share of this sector in GDP was 4.8% in 2015, knowing a slight increase compared to 2014, when it recorded a share of 4.7%, but relating to the start of the period, decreased by about 15 percentage points. Regarding the vegetable sector of agriculture, the crop structure in Romania and crop production is dominated by cereals, areas under these crops representing about 66% of the area cultivated annually. In this context, due to its agricultural favorable resources (fertile arable land), agriculture could return to a much higher GDP and Romania could play an important role in ensuring food security in the European Union by increasing production and cereal sector productivity (Paun I,2012).

Materials and methods

The main indicator of total cereal production is total production in tonnes. In the cereal production analysis it is also used the acreage and average production per hectare. In Romania the main cereals are: wheat, barley and two row barley, maize and sorghum.

The data used in this paper are from the Statistical Yearbook of Romania, published by the National Institute of Statistics and cover the period 1990 to 2014. From the methodological point of view for the two time periods analysis taken into study were used statistical indicators of evolution, extrapolation and correlation: the average and the average main indicators (standard deviation, mean square deviation, coefficient of variation, the average significance, the confidence limits for a given probability), trend line equations of order two and three, the equation significance and the trend extrapolation, the calculation of the Pearson correlation coefficient.

Average $X = \sum N_k / k$

The significance of the average and of the equation (Snedecor, 1968), was conducted by comparing t calculated with t theoretical $t_{calc} = (x_1 - x_2) / (S_{(x_1 - x_2)})$, where: the numerator - the samples averages difference and the denominator - the standard error of the difference between averages, a measure of variability within samples.

The T_{cal} is compared to t theoretical (Ex. $GL=23$; $+t_{teor}$ (0.001: 3.76; 0.01 : 2.81; 0.05: 2.07); N : not significant)

As statistical indicators were calculated: the average for some periods of time, comparison indicators with fixed base and chained base and the annual growth rhythm = $r_{2000 - 2012} = 12 \sqrt{\prod (p_1 / p_0) - 1}$; where:

$\prod p_1 / p_0$ = the chain indicators product for the analyzed period.

For the mean square deviation and standard deviation (σ) it is calculated as a square average form the deviation of all series elements from their arithmetic mean.

$$\sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$$

The mean square deviation is a basis indicator, that is used in the variation analysis and the errors selection estimation in the correlation calculation.

The variation coefficient (ν) is calculated as a report between the mean square deviation and the arithmetic mean.. It is expressed as a percentage:

$$\nu = \frac{\sigma}{\bar{x}} \cdot 100$$

The variation coefficient significance. As its value is close to zero the variation is weaker so the community is homogeneous, the average having a high degree of representativeness. If the value of coefficient is bigger, the variation is more intense, more heterogeneous the community is and the average has a low level significance. It is estimated that at a rate of more than 35-40%, the average is no longer representative and the data must be separated into a series of components, groups, depending on the variation of other grouping characteristics.

The calculation equation and the trend extrapolation. One of the most used methods in finding the trend is adjusting the data series. By adjusting operation are obtained calculated time series, highlighting the trends and replacing empirical series.

A widely used method is adjusting using equations according to time: linear , $Y = a + bt$; second degree , $Y = a + bt + ct^2$; third degree, $Y = a + bt + ct^2 + dt^3$ etc. As in the case of correlation, for finding the regression function parameters necessary to series adjustment is applied the least squares method: $\Sigma(y_i - Y_{ti})^2 = \min$ (Anghelache, 2012).

Confidence limits for a giver probability = $X \pm \sigma * t_p$ (transgression probability calculated based on the degrees of freedom and risk).

In determining the significance of the equations trend it was used the **Pearson correlation coefficient**:

$$r = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{N \sum x^2 - (\sum x)^2} * \sqrt{N \sum y^2 - (\sum y)^2}}$$

Results and discussions

The statistical indicators interpretation of cereal production for the analyzed periods were gradually realized, thus:

- Statistical indicators of total cereals production at country level and by Development Regions
- Statistical indicators of cereals cultivated surfaces at country level and by Development Regions
- Statistical indicators of cereals average productions at country level and by Development Regions
- Statistical trend indicators of cereals production at country level and by Development Regions
 - Statistical trend indicators of total cereals production
 - Statistical trend indicators of cereals cultivated surfaces
 - Statistical trend indicators of cereals average productions
- The annual growth rate and the correlation between total productions, average productions and cultivated surfaces.

Based on the analysis by comparison of the two time periods, they were made plausible scenarios on the evolution of the cultivated surfaces, total and average productions for the period 2015-2020.

The statistical indicators interpretation of cereal production

1. Statistical indicators of total cereals production at country level and by Development Regions

The total cereals production analysis at the country level and by development region was achieved in two periods, the first covering the years 1990-2006 respectively, and the second since joining the European Union by 2014 (Tables 1 and 2 respectively).

In the first period, total cereals production at the country level recorded a minimum of 10,477 million tons and a maximum of 24,403 million tons, with an increasing annual rate 0.8% and a coefficient of variation of 21%, which means a large data oscillation.

Table 1. The total cereals production evolution at the country level and by Development Regions, period 1990-2006

No.	Country, Region	1990	1995	2000	2005	2006	Average	Compared to 1990 (%)	Min.	Max.
		Th. To	Th. to	Th. to	Th. to	Th. to	Th. to		Th. to	Th. to
1	TOTAL	17,173	19,882	10,477	19,345	15,759	16,899.6	91.8	10,477	24,403
2	NORTH-WEST	1,604	1,994	1,047	2,013	1,538	1,665.7	95.9	1,047	2,494
3	CENTER	1,198	1,391	844	1,19	972	1,134.3	81.1	844	1,57
4	NORTH-EAST	2,129	2,351	1,43	2,518	2,139	2,212.2	100.5	1,43	2,731
5	SOUTH-EAST	2,808	3,064	2,127	3,653	2,856	3,088.7	101.7	2,127	4,937
6	SOUTH-MUNTENIA	4,5	4,901	2,318	4,114	3,489	3,829.8	77.5	2,051	5,588
7	BUCHAREST-ILFOV	244	265	90	216	177	203.9	72.5	90	309
8	SOUTH-WEST-OLTENIA	2,789	3,34	1,246	3,228	2,449	2,562.5	87.8	1,117	3,721
9	WEST	1,898	2,572	1,371	2,409	2,135	2,198.9	112.5	1,068	3,39

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time. During this period, from the 8 regions of the country, only three registered increases in total production in 2006 compared to 1990, ie by 12.5% the West Region, South East with 1.7% and North-East by 0.5%. Of the eight regions of Romania, we observe the South-Muntenia Region with a largest area with fertile land and favorable climate for the grain crops. The South-Muntenia Region had the highest total production with an average of 3.8298 million tonnes in 2006, but registering a production 22.5% lower compared to 2006. The region with the lowest production is as we expect, Bucharest-Ilfov Region, agricultural land is a at a smaller share in this area, and this decrease from 244 thousand tons to 177 thousand tons, is of course due to lower acreage.

Table 2. The total cereals production evolution at the country level and by Development Regions, period 2007-2014

No.	Country, Region	2007	2010	2013	2014	Average	Compared to 2007(%)	Min	Max
		Th. To	Th. To	Th. To	Th. To	Th. To		Th. To	Th. To
1	TOTAL	7,814	16,712	20,897	22,07	16,607.1	282.4	7,814	22,07
2	NORTH-WEST	1,34	1,606	1,779	1,955	1,540.9	145.9	1,161	1,955
3	CENTER	834	994	1,096	1,293	1,023.8	155	732	1,293
4	NORTH-EAST	1,087	2,229	2,705	2,973	2,188.5	273.5	1,087	2,973
5	SOUTH-EAST	1,095	3,506	4,267	4,51	3,266.9	411.9	1,095	4,571
6	SOUTH-MUNTENIA	1,308	3,878	5,426	5,386	4,047.1	411.8	1,308	5,426
7	BUCHAREST-ILFOV	47	116	160	153	106.3	325.5	47	160
8	SOUTH-WEST-OLTENIA	668	2,347	2,777	2,907	2,246.9	435.2	668	2,907
9	WEST	1,432	2,034	2,683	2,891	2,183.6	201.9	1,432	2,891

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time

In the second period, 2007-2014, total grain production at the country level increases until the period final, with an annual growth rhythm of 0.8%. During this period all developing regions recorded increases in total grain production, the most significant being in South-West Oltenia, South-East and North-East, as evidenced by statistical data analysis in Table 2. It is noteworthy the year 2007 compared to other years, as it was a year with very low yields, this being due to environmental conditions, the drought in that year disfavored crop field productions.

Table 3 The total cereals production evolution at the country level and by Development Regions , for the period 1990-2006 and 2007-2014

Country, Region	1990-2006				2007-2014				Deviations (2007-2014)-(1990-2006)				
	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	
	Th. ha	%	Th. ha	%	Th. ha	%	Th. ha	%	Th. ha	tcal*	%	Th. ha	%
TOTAL	16,9	0.80	3,618	21	16,607	1,48	4,749	28,6	-292,5	0.15 N	0.68	1131,2	7.19
NORTH-WEST	1,666	1.53	343	21	1,541	-0.32	254	16,5	-124,8	1.01 N	-1.85	-88,6	-4.08
CENTER	1,134	-0.04	195	17	1,024	0.93	183	17,9	-110,5	1.38 N	0.97	-11,5	0.73
NORTH-EAST	2,212	1.13	376	17	2,189	1.86	621	28,4	-23,7	0.11 N	0.74	245,5	11,4
SOUTH-EAST	3,089	-0.60	811	26	3,267	2,37	1,195	36,6	178,2	0.38 N	0.60	384,4	10,34
SOUTH-MUNTENIA	3,83	-0.81	1,022	27	4,047	3,04	1,354	33,5	217,3	0.40 N	3.63	331,8	6,77
BUCHAREST - ILFOV	204	0.98	64	31	106	-3.76	37	34,6	-97,7	4.83***	-2.95	-26,9	3,42
SOUTH-WEST OLTENIA	2,562	-0.76	961	38	2,247	-1.16	772	34,4	-315,6	0.88 N	-2.14	-188,8	-3.13
WEST	2,199	1.60	511	23	2,184	2,05	486	22,3	-15,3	0.07 N	0.45	-25	-0.98

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time t_{teor} (0.001: 3.76; 0.01: 2.81; 0.05: 2.07); N: not significant; GL=23 (liberty degree)

Comparing the two analyzed periods (Table 3), we see that both for the country and for the regions have large reductions in the period 2007-2014 average compared to the average of 1990-2006. At the country level is a decrease of 292.5 thousand tons, but the highest decrease is observed in the South-West Oltenia, 315.6 thousand tons. There are also increases in two of the regions, South-East and South-Muntenia, where the average of the second period is higher by 178.2 thousand tons and 217.3 thousand tons respectively, from the first period analyzed. Moreover in the two regions it is most part of arable land known for the fertility and natural conditions that help achieve significant productions. The standard deviation and variation coefficients have higher oscillations in the first period compared with the second one, and regarding the average significance, it was noticed that for Bucharest-Ilfov region $t_{cal} = 4,83 > t_{teor} = 3.76$ its value is very significant, proving the productions homogeneity in the second period. The reason for this homogeneity is not so joyful, because the small constant productions from the last years are due to small acreage, a big part of the arable land transformed its destination into industrial or for constructions land.

2. Statistical indicators of cereals cultivated surfaces at country level and by Development Regions

Regarding the statistical indicators of the cultivated surface with cereals, were analyzed the same two periods, as for total productions 1990-2006 and 2007-2014.

In the first analyzed period (table 4) the surfaces cultivated with cereals at the country level decreased by 10.3% in 2006 compared to 1990.

Table 4 The total cereals surface evolution at the country level and by Development for the period 1990-2006

No.	Country, Region	1990	1995	2000	2005	2006	Average	Compared to 1990 (%)	Min.	Max.
		Th. Ha	Th. Ha	Th. Ha	Th. Ha	Th. Ha	Th. Ha		Th. Ha	Th. Ha
1	TOTAL	5,704	6,444	5,655	5,865	5,114	5,949.6	89.7	5,114	6,557
2	NORTH-WEST	622	660	553	592	490	603.2	78.8	490	665
3	CENTER	423	451	362	381	337	409	79.7	337	468
4	NORTH-EAST	807	926	827	827	721	851.6	89.3	721	926
5	SOUTH-EAST	1,048	1,212	1,107	1,043	906	1,121.2	86.5	906	1,254
6	SOUTH-MUNTENIA	1228	1356	1237	1312	1135	1,279.7	92.4	1,135	1,412
7	BUCHAREST - ILFOV	66	71	60	63	46	65.7	69.7	46	81
8	SOUTH-WEST OLTENIA	831	962	866	966	863	905.2	103.9	774	1
9	WEST	675	803	639	677	614	710.5	91	606	805

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time On Development Regions it is observed a decrease of the surface , the most significant decreases are for Bucharest-Ilfov Region with 30.3% , North-East Region with 21.2% and Central Region with 20.3%.

An increase of the surfaces cultivated with cereals we can see in the South-West Oltenia Region with 3.9% in year 2006 compared with year 1990.

Table 5 The total cereals surface evolution at the country level and by Development for the period 2007-2014

No.	Country, Region	2007	2010	2013	2014	Media	Compared to 2007(%)	Min.	Max.
		Th. Ha	Th. Ha	Th. Ha	Th. Ha	Th. Ha		Th. Ha	Th. Ha
1	TOTAL	5,129	5,04	5,421	5,443	5,273.6	106.1	5,04	5,443
2	NORTH-WEST	540	459	464	476	463.5	88.1	430	540
3	CENTER	317	294	301	306	308.8	96.5	294	329
4	NORTH-EAST	733	659	679	689	695.1	94	659	750
5	SOUTH-EAST	977	1,105	1,203	1,179	1,118.8	120.7	977	1,203
6	SOUTH-MUNTENIA	1,156	1,183	1,268	1,263	1,242	109.3	1,156	1,348
7	BUCHAREST - ILFOV	51	35	38	35	35.3	68.6	29	51
8	SOUTH-WEST OLTENIA	801	747	819	817	800	102	747	824
9	WEST	550	555	646	675	606.6	122.7	550	675

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time

In the second analyzed period (table 5), can be observed increases of the surfaces , in year 2014 compared to 2007, at country level with 6.1%, and by Development Regions, West with 22.7%. South-east with 20.7%, South-Muntentia with 9.3% and South-West Oltenia with 2%. In the other regions it is maintained the decrease tendency from the first period. Comparing the two analyzed periods, 1990-2006 and 2007-2014 respectively, we observe that deviations averages for the two periods are very significant in the most of the regions, and also at the country level, t_{cal} having a higher value then t_{teor} . Also, it is observed a smaller variation coefficient in the second period that demonstrates a lower oscillation of data, in the most of regions and at country level, excepting Bucharest-Ilfov region where the variation coefficient has increased in the second period with 7.69%. Besides, this region has suffered an important reduction of surfaces, many land changing their land use.

Table 6. The cereal cultivated surface evolution at the country level and by Development Regions for the period 1990-2006 si 2007-2014

Country, Region	1990-2006				2007-2014				Deviations (2007-2014)-(1990-2006)				
	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	
	Th. Ha.	%	Th. Ha.	%	Th. Ha.	%	Th. Ha.	%	Th. Ha.	%	Th. Ha.	%	
TOTAL	5950	0.19	395	7	5274	-0.83	175	3.3	-676	5.94***	-1.01	-217.9	-3.28
NORTH-WEST	603	-0.33	58	10	464	-2.39	32	7	-139.7	7.71***	-2.07	-25.6	-2.62
CENTER	409	-0.69	41	10	309	-2.41	10	3.4	-100.3	9.44***	-1.71	-30.6	-6.63
NORTH-EAST	852	0.16	52	6	695	-2.01	33	4.8	-156.5	9.09***	-2.17	-18.2	-1.26
SOUTH-EAST	1121	-0.05	95	8	1119	1.37	69	6.2	-2.5	0.07N	1.40	-25.7	-2.28
SOUTH-MUNTENIA	1280	0.44	87	7	1242	-0.42	63	5	-37.7	1.23 N	-0.86	-24.1	-1.73
BUCHAREST - ILFOV	66	-0.31	8	12	35	-6.32	7	19.3	-30.5	10.04***	-6.01	-0.8	7.69
SOUTH-WEST OLTENIA	905	1.01	39	6	800	-1.84	31	3.8	-105.2	5.87***	-2.83	-28	-2.64
WEST	711	0.02	66	9	607	-0.03	49	8.1	-103.9	4.42***	-0.05	-16.6	-1.16

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 $*t_{teor}$ (0.001: 3.76; 0.01 : 2.81; 0.05: 2.07); N: not significant; GL=23 (liberty degree)

3. *Statistical indicators of cereals average productions at country level and by Development Regions*
 Our analysis is continued by determining the average production evolution for period 1990-2006 also for years 2007-2014.

In the period 1990-2006,(table 7) were noticed increases of productions at the country level with 2.4% in 2006 compared with the first year, and on development regions , significant increases we can observe in West with 23.7%, North-West with 21.7% and South-East with 17.7%. The regions that had a decrease of average productions is South-Muntenia Region and South-Oltenia Region, with approx. -16% in 2006 compared to 1990.

Table 7. The cereals average productions evolution at the country level and by Development Regions for the period 1990-2006

No.	Country, Region	1990	1995	2000	2005	2006	Average	Compared to 1990(%)	Min	Max
		to/ha	to/ha	to/ha	to/ha	to/ha	to/ha		to/ha	to/ha
1	TOTAL	3.01	3.09	1.85	3.3	3.08	2.83	102.4	1.85	3.9
2	NORTH-WEST	2.48	3.02	1.89	3.4	3.14	2.76	121.7	1.82	3.95
3	CENTER	2.83	3.08	2.33	3.12	2.88	2.78	101.8	2.2	3.73
4	NORTH-EAST	2.64	2.54	1.73	3.04	2.97	2.6	112.5	1.73	3.04
5	SOUTH-EAST	2.68	2.53	1.92	3.5	3.15	2.77	117.7	1.88	4.27
6	SOUTH-MUNTENIA	3.66	3.61	1.87	3.14	3.07	2.96	83.9	1.78	4.15
7	BUCHAREST - ILFOV	3.7	3.73	1.5	3.43	3.85	3.09	104.1	1.5	4.41
8	SOUTH-WEST OLTENIA	3.36	3.47	1.44	3.34	2.84	2.81	84.6	1.22	3.76
9	WEST	2.81	3.2	2.15	3.56	3.48	3.07	123.7	1.76	4.26

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 An explanation for the decrease of the average productions in this region , is the unpredictable character of the climate conditions, and for increasing the productions the specialists recommend that in order of the exploitation size to be cultivated at least 3-5 variety of wheat or other cereal. With different reaction to the environment. Also, they highlight that it must be taken into account that between the grains productions and the grains content in protein it's a negative correlation (Racz,2013). For example, at the wheat culture, the plants productivity is dependent of the hereditary factor, on which in the phenotypic express a major role have the environment conditions, as the interaction genotype – environment (Knežević, 2008).

Table 8. The cereals average productions evolution at the country level and by Development Regions for the period 2007-2014

No.	Country, Region	2007	2010	2013	2014	Average	Compared to 2007(%)	Min	Max
		to/ha	to/ha	to/ha	to/ha	to/ha		to/ha	to/ha
1	TOTAL	1.52	3.32	3.85	4.05	3.14	266.1	1.52	4.05
2	NORTH-WEST	2.48	3.50	3.83	4.11	3.33	165.5	2.48	4.11
3	CENTER	2.63	3.38	3.64	4.23	3.32	160.6	2.46	4.23
4	NORTH-EAST	1.48	3.38	3.98	4.31	3.18	291.0	1.48	4.31
5	SOUTH-EAST	1.12	3.17	3.55	3.83	2.89	341.3	1.12	4.10
6	SOUTH-MUNTENIA	1.13	3.28	4.28	4.26	3.24	376.9	1.13	4.28
7	BUCHAREST - ILFOV	0.92	3.31	4.21	4.37	3.13	474.3	0.92	4.37
8	SOUTH-WEST OLTENIA	0.83	3.14	3.39	3.56	2.81	426.7	0.83	3.59
9	WEST	2.60	3.66	4.15	4.28	3.57	164.5	2.60	4.28

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 In the second period under analyze, the average productions are increasing, thus, at the country level form 1.52 to/ha in 2007 reaches at 4.05 to/ha in year 2014, and on Development Regions the most important increases are in Bucharest-Ilfov Region from 0.92 to/ha in 2007 at 1.37 to/ha and South-West Oltenia from 0.83 to/ha at 3.56 to/ha.

Comparing the two periods analyzed , as we can see in table 9, the second period has annual growth rhythms significant bigger that the first period.

Table 9. The cereals average productions evolution at the country level and by Development Regions for the periods 1990-2006 and 2007-2014

Country, Region	1990-2006				2007-2014				Deviations (2007-2014)-(1990-2006)				
	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	Average	Annual Rhythm	Standard Deviation	C%	
	To/ha	%	To/ha	%	To/ha	%	To/ha	%	To/ha	tcal*	%	To/ha	%
TOTAL	2.83	0.61	0.54	19.1	3.14	2.32	0.88	27.9	0.31	0.91N	1.71	0.33	8.75
NORTH-WEST	2.76	1.86	0.52	18.7	3.33	2.12	0.58	17.5	0.57	2.36*	0.26	0.06	-1.27
CENTER	2.78	0.65	0.4	14.3	3.32	3.42	0.59	17.9	0.54	2.35*	2.76	0.2	3.62
NORTH-EAST	2.6	0.96	0.42	16	3.18	3.95	0.97	30.6	0.58	1.61 N	2.99	0.56	14.64
SOUTH-EAST	2.77	1.80	0.72	25.8	2.89	0.98	0.99	34.4	0.12	0.29 N	-0.82	0.28	8.55
SOUTH-MUNTENIA	2.98	-1.03	0.73	24.6	3.24	3.48	1.07	32.8	0.27	0.63 N	4.51	0.33	8.2
BUCHAREST - ILFOV	3.09	-0.50	0.87	28.2	3.13	2.74	1.11	35.5	0.04	0.08 N	3.24	0.24	7.29
SOUTH-WEST OLTENIA	2.81	-0.03	0.98	35	2.81	0.70	0.96	34.3	-0.01	0.01 N	0.73	-0.02	-0.65
WEST	3.07	1.58	0.56	18.2	3.57	2.08	0.58	16.2	0.5	2.08*	0.50	0.02	-1.94

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time $*t_{teor}$ (0.001: 3.76; 0.01 : 2.81; 0.05: 2.07); \leq N: not significant; GL=23 (liberty degree)

The deviations of the two period's averages turned to be significant for the regions North-west, Center and West. The variations on years between productions are big, the calculated coefficients demonstrate that have increased in the second period the oscillations between productions on years, due to the lack of an organized agriculture, lack of irrigation in the most part of arable land. If at the 1990's level there were around 3 million hectares that had irrigations, the surfaces have decreased dramatically, gathering at the period's end a surface around 10% from the initial surface to beneficiate of irrigation. There are rehabilitations projects for the irrigations system and as the representatives of Ministry of Agriculture sustain, the infrastructure for irrigation has a chance to be rehabilitated until 2020.

4. Statistical trend indicators of cereals production at country level and by Development Regions

Next were calculated the trend line equations on total productions, cultivated surfaces and average productions, equations that helped to extrapolate the productions until year 2020. The calculated equations were second and third degree polynomial equations, the tendency being illustrated in the figures that complete the tables.

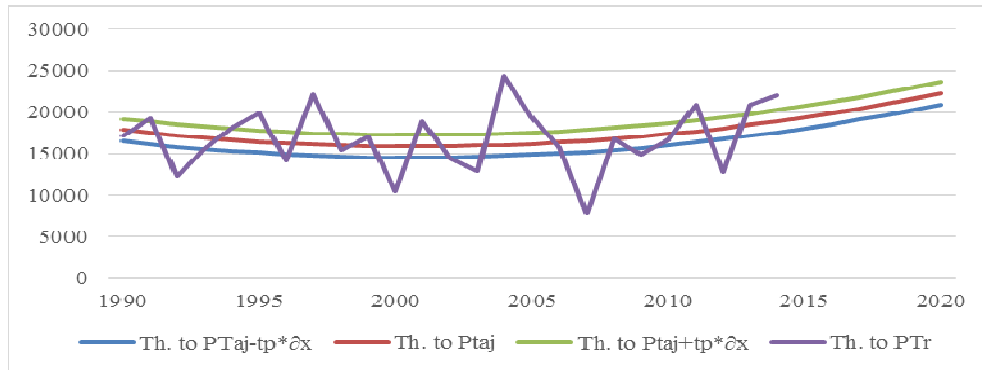
4.1. Statistical trend indicators of total cereals production

Table 10. The trend line equation coefficients for total productions at the country level and for Development Regions.

No.	Country, Region	Average 1990-2014	Mean square deviation	Variation coefficient		Equation coef., period 1990-2014				R2	r	
		Th. to	Th. to	%	significance	d	c	b	a	value	value	significance
1	TOTAL	16,806	783.4	4.7	small		17.12	-401	18.236	0.05	0.461	*
2	NORTH-WEST	1,625.8	66.1	4.1	small		-0.69	20.1	1.517	0.012	0.73	***
3	CENTER	1,098.9	39.6	3.6	small		0.02	-4.7	1.155	0.023	0.803	***
4	NORTH-EAST	2,204.6	90.7	4.1	small		1.42	-29.3	2.271	0.038	0.713	***
5	SOUTH-EAST	3,145.7	188.3	6	small		4.99	-105.9	3.419	0.098	0.11	N
6	SOUTH-MUNTENIA	3,899.4	222.5	5.7	small		9.23	-223.6	4.768	0.166	0.042	N
7	BUCHAREST - ILFOV	172.7	14.7	8.5	small	0.0327	-1.2	5.8	224	0.361	0.816	***
8	SOUTH-WEST OLTENIA	2,461.5	173.5	7	small		2.17	-69.3	2.883	0.026	0.359	*
9	WEST	2,194	101.7	4.6	small		-0.11	19.6	1.964	0.059	0.287	N

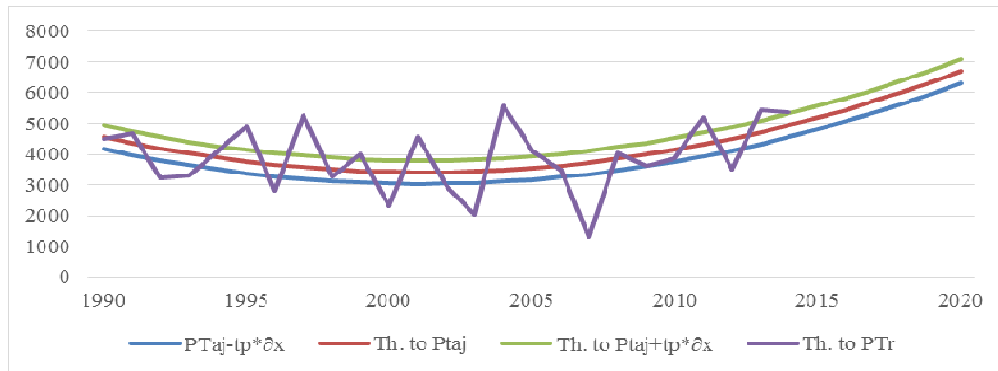
Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time $K*r_{teor}$ (0.005 : >0.505***; 0.01 : > 0.462**; 0.05:>0.337*; <0.337 : N= not significant); GL=23 (freedom degrees)

At the country level for the period 1990-2014 it is registered an average of total production of 16,806 thousand tonnes, with a standard deviation of productions for the entire period of 783.3 thousand tonnes, the variation coefficient demonstrating a small variation, 4.7% (table 10). The equation coefficients for the production at the country level are $Y = 18.236 - 401x + 17.12x^2$, the next table (table 11) is illustrating the adjusted productions for the whole period for the country level and also for the regions. There were calculated equations coefficients for all Development Regions, the equation turning to be very significant for the Regions North-West, Centre, North-East and Bucharest-Ilfov.



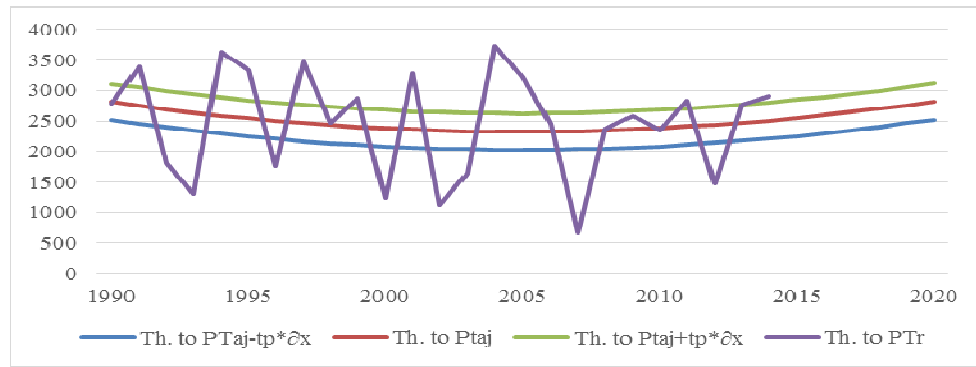
* Ptaj= total adjusted production; tp= transgression probability; Th. To= Thousand tonnes

Figure 1. Graphical representation of the total cereal production, productions equation calculated for the period 1990-2014 and production equation extrapolation by 2015-2020 at the country level.



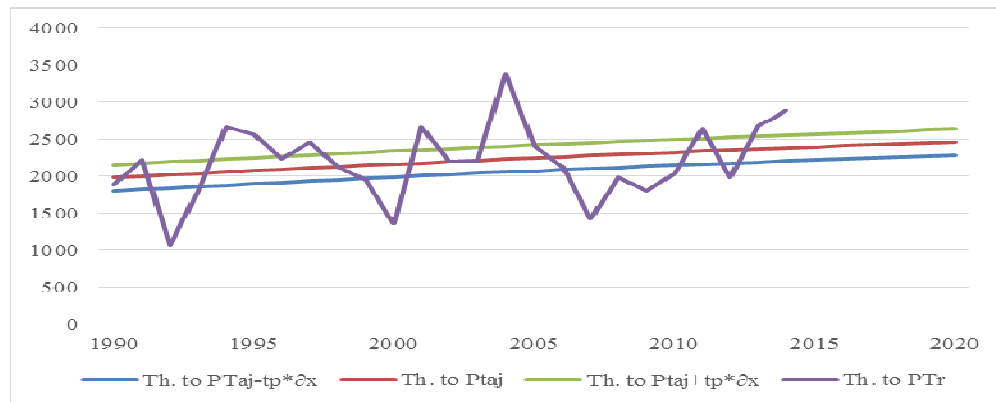
* Ptaj= total adjusted production; tp= transgression probability; Th. To= Thousand tonnes

Figure 2 Graphical representation of the total cereal production, productions equation calculated for the period 1990-2014 and production equation extrapolation by 2015-2020 for the South-Muntenia Region



* Ptaj= total adjusted production; tp= transgression probability; Th. To= Thousand tonnes

Figure 3. Graphical representation of the total cereal production, productions equation calculated for the period 1990-2014 and production equation extrapolation by 2015-2020 for the South- West Oltenia Region



* Ptaj= total adjusted production; tp= transgression probability; Th. To= Thousand tonnes

Figure 4. Graphical representation of the total cereal production, productions equation calculated for the period 1990-2014 and production equation extrapolation by 2015-2020 for the West Region

Table 11. The total cereal production tendency, for the period 2015-2020, at the country level and by Development Regions.

COUNTRY, REGION	UM		The total production 1990-2014					Total production by 2015-2020, trendline equations						
			1990	1995	2000	2005	2010	2014	2015	2016	2017	2018	2019	2020
TOTAL	Th. to	PTaj+tp*δx	16512	15106	14556	14862	16024	17570	18042	18548	19089	19663	20272	20916
	Th. to	Ptaj	17852	16446	15896	16202	17364	18910	19382	19888	20429	21004	21613	22256
	Th. to	Ptaj+tp*δx	19192	17787	17237	17543	18705	20250	20723	21229	21769	22344	22953	23596
	Th. to	PTr	17173	19882	10477	19345	16712	22070						
NORTHWEST REGION	Th. to	PTaj+tp*δx	1423	1500	1541	1549	1522	1475	1460	1443	1426	1406	1386	1364
	Th. to	Ptaj	1536	1613	1655	1662	1635	1588	1573	1556	1539	1519	1499	1477
	Th. to	Ptaj+tp*δx	1650	1726	1768	1775	1748	1701	1686	1670	1652	1632	1612	1590
	Th. to	PTr	1604	1994	1047	2013	1606	1955						
CENTRAL REGION	Th. to	PTaj+tp*δx	1082	1059	1037	1017	997	982	979	975	972	968	965	961
	Th. to	Ptaj	1150	1127	1105	1084	1065	1050	1047	1043	1039	1036	1033	1029
	Th. to	Ptaj+tp*δx	1218	1195	1173	1152	1133	1118	1114	1111	1107	1104	1100	1097
	Th. to	PTr	1198	1391	844	1190	994	1293						
NORTHEAST REGION	Th. to	PTaj+tp*δx	2088	1991	1966	2011	2128	2273	2316	2362	2411	2463	2517	2575
	Th. to	Ptaj	2243	2147	2121	2166	2283	2428	2471	2517	2566	2618	2673	2730
	Th. to	Ptaj+tp*δx	2399	2302	2276	2322	2438	2583	2626	2672	2721	2773	2828	2885
	Th. to	PTr	2129	2351	1430	2518	2229	2973						
SOUTHEAST REGION	Th. to	PTaj+tp*δx	2996	2641	2536	2681	3075	3570	3719	3877	4046	4225	4414	4612
	Th. to	Ptaj	3318	2963	2858	3003	3397	3892	4041	4200	4368	4547	4736	4934
	Th. to	Ptaj+tp*δx	3640	3285	3180	3325	3719	4214	4363	4522	4690	4869	5058	5256
	Th. to	PTr	2808	3064	2127	3653	3506	4510						
SOUTH-MUNTENIA REGION	Th. to	PTaj+tp*δx	4173	3377	3043	3171	3759	4562	4809	5074	5358	5661	5981	6320
	Th. to	Ptaj	4553	3758	3424	3551	4140	4943	5190	5455	5739	6041	6362	6701
	Th. to	Ptaj+tp*δx	4173	3377	3043	3171	3759	4562	4809	5074	5358	5661	5981	6320
	Th. to	PTr	4500	4901	2318	4114	3878	5386						
BUCHAREST-ILFOV REGION	Th. to	PTaj+tp*δx	203	197	161	119	95	106	115	126	140	158	178	202
	Th. to	Ptaj	228	222	186	144	120	132	140	151	166	183	203	227
	Th. to	Ptaj+tp*δx	253	248	211	169	146	157	165	177	191	208	229	253
	Th. to	PTr	244	265	90	216	116	153						
SOUTH-WEST OLTENIA REGION	Th. to	PTaj+tp*δx	2519	2248	2086	2033	2088	2211	2252	2298	2348	2403	2461	2525
	Th. to	Ptaj	2815	2545	2383	2330	2385	2507	2549	2595	2645	2699	2758	2822
	Th. to	Ptaj+tp*δx	3112	2842	2680	2626	2682	2804	2846	2892	2942	2996	3055	3118
	Th. to	PTr	2789	3340	1246	3228	2347	2907						
WEST REGION	Th. to	PTaj+tp*δx	1810	1904	1992	2075	2152	2210	2224	2237	2251	2264	2277	2290
	Th. to	Ptaj	1984	2078	2166	2249	2326	2384	2398	2411	2425	2438	2451	2464
	Th. to	Ptaj+tp*δx	2158	2252	2340	2423	2500	2558	2572	2585	2599	2612	2625	2638
	Th. to	PTr	1898	2572	1371	2409	2034	2891						

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 * Ptaj= total adjusted production; tp= transgression probability; Th. To= Thousand tonnes

In the table no. 11 were calculated the total adjusted productions for the period 1990-2014 and also the tendency extrapolation until 2020. To these calculations were added the confidence limits for a given probability (95%), with a transgression probability of 2.711 (23 freedom degrees) and a significance threshold of 0.05%. As it can be observed from the table and figure 1, the productions tendency at the national level is to increase, the year 2020 could bring a total cereal production of 22,256 thousand tonnes, production ranging between 20,916 thousand tonnes lower limit and 23596 thousand tonnes upper limit, as it resulted from the confidence interval calculation.

Regarding the Development Regions, the trend is to increase in the North-East Regions 2,730 thousand tonnes respectively in the year 2020, 4,934 thousand tonnes in the South-East Region, South-Muntenia with an important increase, ie 6,701 thousand tonnes in 2020 and West Region with a slight increase up to 2,464 thousand tonnes in the same year (Figures 2-4).

According the extrapolations we can see decreases until the period final for the Regions North-West and Centre and small fluctuations for Bucharest-Ilfov and South-West Oltenia Regions.

4.2. Statistical trend indicators of cereals cultivated surfaces

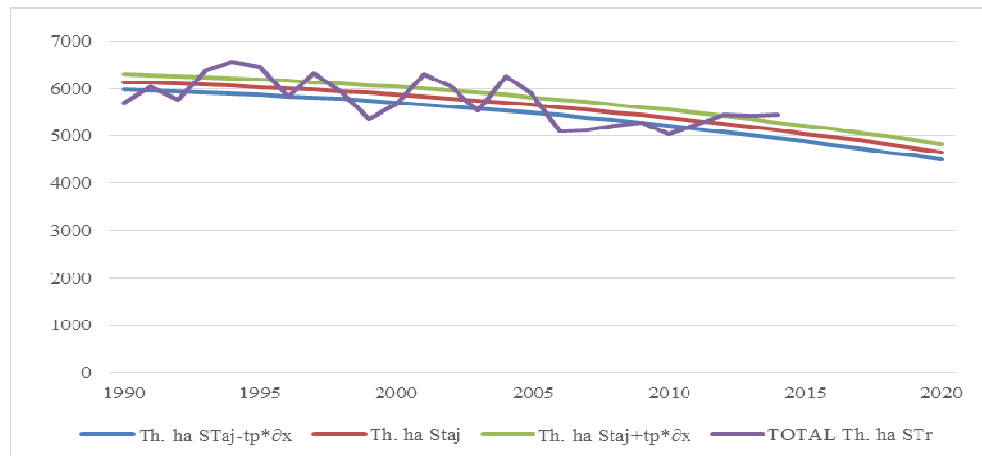
Tables 12 and 13 and also figures 5-8 present the analysis on the calculated equation for the cultivated surfaces with cereals and their tendency for the period 2015-2020.

Table 12. The trend line equation coefficients for the total cereals surface at the country level and for Development Regions

No.	Country, Region	Average 1990-2014	Mean square deviation	Variation coefficient		Equation coef., period 1990-2014				R2	r	
		Th. Ha	Th. Ha	%	significance	d	c	b	a	value	value	significance
1	TOTAL	5,733.3	95.8	1.7	small		-1.1141	-13.474	6154.7	0.4607	0.68	***
2	NORTH-WEST	558.5	17.1	3.1	small		-0.2296	-3.5743	655.73	0.7295	0.85	***
3	CENTER	376.9	12	3.2	small		-0.0908	-5.0061	459.88	0.803	0.9	***
4	NORTH-EAST	801.5	18.1	2.3	small		-0.5665	5.3698	856.91	0.7134	0.84	***
5	SOUTH-EAST	1,120.4	17.5	1.6	small		0.5112	-15.47	1208.6	0.1103	0.33	N
6	SOUTH-MUNTENIA	1,267.6	16.6	1.3	small		0.0736	-4.1546	1305.4	0.0419	0.2	N
7	BUCHAREST - ILFOV	56	3.4	6.1	small	0.0084	-0.4141	3.8374	62.08	0.8156	0.9	***
8	SOUTH-WEST OLTENIA	871.5	14.5	1.7	small		-0.5435	9.4794	868.4	0.3586	0.6	***
9	WEST	677.3	15.9	2.4	small		-0.1921	-0.4784	725.95	0.2868	0.54	***

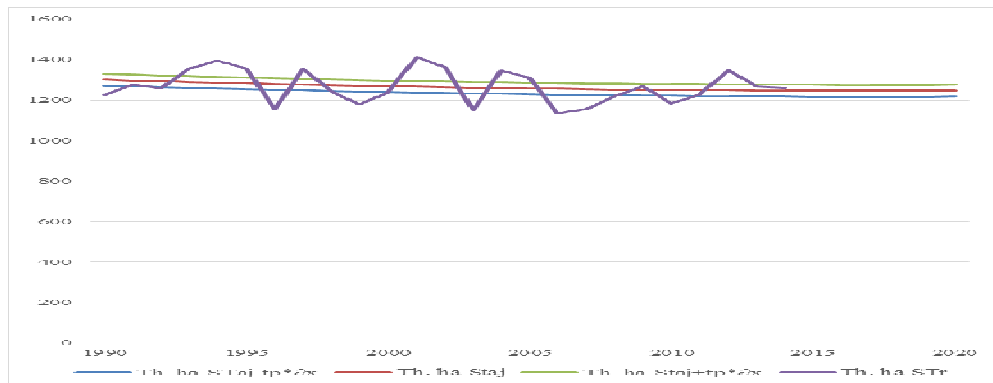
Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time $*r_{teor}$ (0.005 : >0.505***; 0.01:>0.462**; 0,05:>0.337*; <0.337 : N, not significant); GL=23

According to data from table 12, the equations are significant for total country and many regions , with exception the South-Est and South-Muntenia Regions.



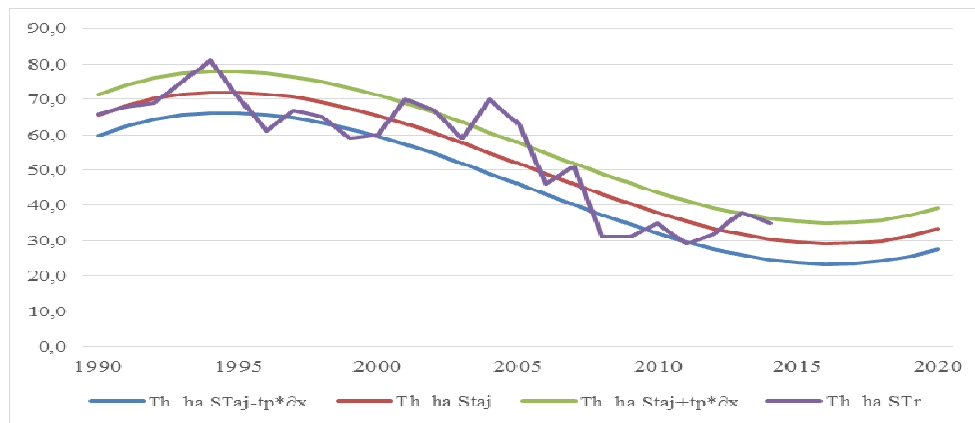
*Staj= adjusted surface, th. Ha= thousand hectares, tp= transgression probability

Figure 5. Graphical representation of the total cereal surface, surfaces equation calculated for the period 1990-2014 and surfaces extrapolation by 2015-2020 at the country level



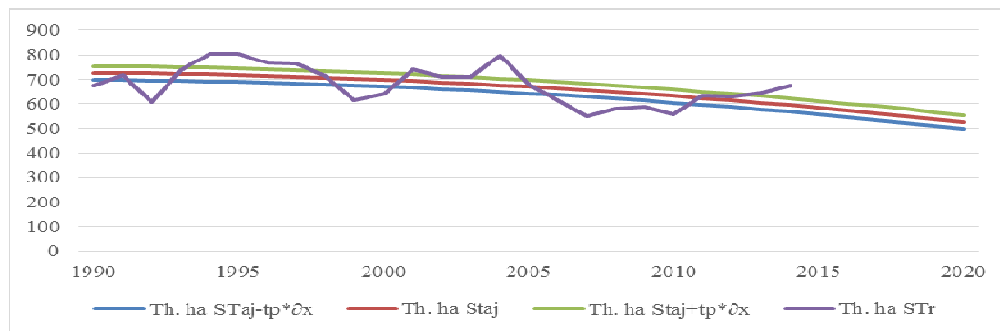
*Staj= adjusted surface, th. Ha= thousand hectares, tp= transgression probability

Figure 6. Graphical representation of the total cereal surface, surfaces equation calculated for the period 1990-2014 and surfaces extrapolation by 2015-2020 for the South-Muntenia Region



*Staj= adjusted surface, th. Ha= thousand hectares, tp= transgression probability

Figure 7 Graphical representation of the total cereal surface, surfaces equation calculated for the period 1990-2014 and surfaces extrapolation by 2015-2020 for the Bucharest -Ilfov Region



*Staj= adjusted surface, th. Ha= thousand hectares, tp= transgression probability

Figure 8. Graphical representation of the total cereal surface, surfaces equation calculated for the period 1990-2014 and surfaces extrapolation by 2015-2020 for the West Region

Data from table 13 aren't presenting a very happy situation for the surfaces cultivated with cereals , on the contrary, also nationally as on regions we have decrease tendency.

Thus, the surface at national level, has a continuous drop until 2020, at 4,666 Th. Ha, dramatic decreases also in the other regions, excepting the South-East Region that has a small increase and South-Muntenia with almost the same surface.

The confidence intervals were calculated for a $tp=1.711$, and a significance threshold of 0.05% The results showed very close limits with the extrapolation.

Table 13. The cereals surfaces tendency, for the period 2015-2020, nationwide and by regions

COUNTRY, REGION	MU		Cultivated Areas 1990-2014					Cultivated Areas by 2015-2020, trendline equations						
			1990	1995	2000	2005	2010	2014	2015	2016	2017	2018	2019	2020
TOTAL	mii ha	STaj-tp* $\hat{c}x$	5976	5870	5708	5490	5217	4958	4887	4815	4740	4663	4584	4503
	mii ha	Staj	6140	6034	5872	5654	5380	5122	5051	4979	4904	4827	4748	4666
	mii ha	Staj+tp* $\hat{c}x$	6304	6198	6036	5818	5544	5285	5215	5143	5068	4991	4912	4830
	mii ha	STr	5704	6444	5655	5865	5040	5443						
NORTHWEST REGION	mii ha	STaj-tp* $\hat{c}x$	652	626	589	540	479	423	408	392	376	359	342	324
	mii ha	Staj	652	626	589	540	479	423	408	392	376	359	342	324
	mii ha	Staj+tp* $\hat{c}x$	652	626	589	540	479	423	408	392	376	359	342	324
	mii ha	STr	622	660	553	592	459	476						
CENTRAL REGION	mii ha	STaj-tp* $\hat{c}x$	434	406	373	336	294	257	248	238	228	218	207	197
	mii ha	Staj	455	427	394	357	315	278	268,3	258,5	248,5	238,3	228	217,4
	mii ha	Staj+tp* $\hat{c}x$	475	447	414	377	335	298	289	279	269	259	248	238
	mii ha	STr	423	451	362	381	294	306						
NORTHEAST REGION	mii ha	STaj-tp* $\hat{c}x$	831	838	817	767	689	606	583	558	532	505	477	448
	mii ha	Staj	862	869	847	798	720	637	613,6	588,9	563,1	536,2	508,2	479
	mii ha	Staj+tp* $\hat{c}x$	893	900	878	829	751	668	644	620	594	567	539	510
	mii ha	STr	807	926	827	827	699	689						
SOUTHEAST REGION	mii ha	STaj-tp* $\hat{c}x$	1164	1104	1070	1062	1079	1111	1122	1134	1146	1160	1175	1190
	mii ha	Staj	1194	1134	1100	1092	1109	1141	1152	1163,6	1176,2	1189,9	1204,6	1220,3
	mii ha	Staj+tp* $\hat{c}x$	1224	1164	1130	1122	1139	1171	1182	1194	1206	1220	1235	1250
	mii ha	STr	1048	1212	1107	1043	1105	1179						
SOUTH-MUNTENIA REGION	mii ha	STaj-tp* $\hat{c}x$	1273	1255	1240	1229	1222	1219	1219	1219	1218	1218	1219	1219
	mii ha	Staj	1301	1283	1269	1258	1251	1248	1247,1	1246,9	1246,8	1246,8	1247	1247,3
	mii ha	Staj+tp* $\hat{c}x$	1330	1311	1297	1286	1279	1276	1276	1275	1275	1275	1275	1276
	mii ha	STr	1228	1356	1237	1312	1183	1263						
BUCHAREST-ILFOV REGION	mii ha	STaj-tp* $\hat{c}x$	59,7	66,2	59,5	46	32	24,6	23,7	23,3	23,4	24,1	25,5	27,5
	mii ha	Staj	65,5	72	65,4	51,9	37,8	30,5	29,6	29,1	29,3	30	31,3	33,3
	mii ha	Staj+tp* $\hat{c}x$	71,3	77,8	71,2	57,7	43,7	36,3	35,4	35	35,1	35,8	37,1	39,2
	mii ha	STr	66	71	60	63	35	35						
SOUTH-WEST OLTENIA REGION	mii ha	STaj-tp* $\hat{c}x$	853	881	882	856	803	741	723	703	683	661	639	615
	mii ha	Staj	877	906	907	881	828	766	747,5	728,1	707,7	686,2	663,6	640
	mii ha	Staj+tp* $\hat{c}x$	902	931	932	906	853	791	772	753	733	711	688	665
	mii ha	STr	831	962	866	966	747	817						
WEST REGION	mii ha	STaj-tp* $\hat{c}x$	698	689	670	642	604	567	556	546	535	523	511	499
	mii ha	Staj	725	716	697	669	631	594	583,7	573	561,9	550,5	538,7	526,5
	mii ha	Staj+tp* $\hat{c}x$	753	743	725	696	658	621	611	600	589	578	566	554
	mii ha	STr	675	803	639	677	555	675						

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time *Staj= adjusted surface, th. Ha= thousand hectares, tp= transgression probability

4.3. Statistical trend indicators of cereals average productions

The trend line indicators calculation finalizes with the average production for the same periods as the past indicators.

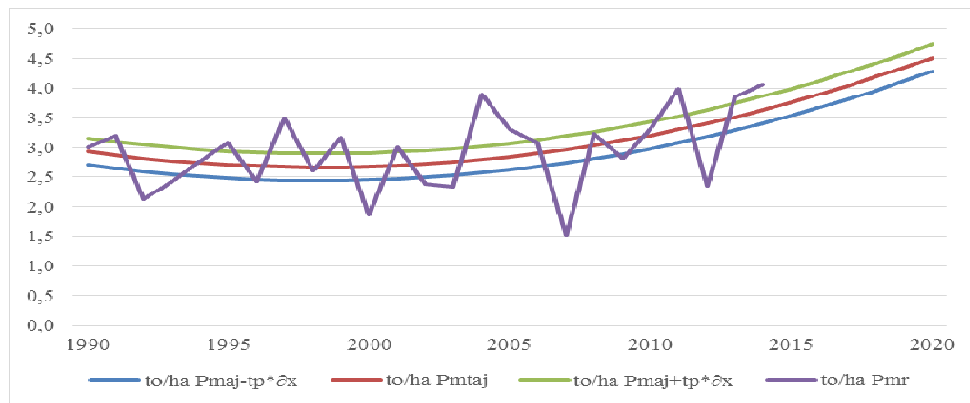
In table 14 we see the calculation coefficients of the second degree equation, equation that resulted to be very significant for the North-West, Centre, North-East and West Regions.

Table 14. The trend line equation coefficients for the average cereals production at the country level and on Development Regions.

No.	Region	Average 1990-2014	Mean square deviation	Variation coefficient		Equation coef., period 1990-2014			R1	r	
		To/ha	To/ha	%	significance	c	b	a	value	value	significance
1	NORTH-WEST	2.945	0.124	4.2	mică	0.0009	0.0317	23.307	0.4545	0.67	***
2	CENTER	2.949	0.108	3.7	mică	0.0018	0.0007	25.531	0.4246	0.65	***
3	NORTH-EAST	2.784	0.138	5	mică	0.0045	-0.0697	27.065	0.3442	0.59	***
4	SOUTH-EAST	2.806	0.162	5.8	mică	0.0031	-0.0546	28.382	0.0847	0.29	N
5	SOUTH-MUNTENIA	3.064	0.166	5.4	mică	0.0075	-0.176	3.701	0.2087	0.46	*
6	BUCHAREST - ILFOV	3.105	0.184	5.9	mică	0.0073	-0.1783	38.084	0.1503	0.39	*
7	SOUTH-WEST OLTENIA	2.810	0.182	6.5	mică	0.0046	-0.1193	33.369	0.0583	0.24	N
8	WEST	3.231	0.124	3.8	mică	0.001	0.0256	26.736	0.3877	0.62	***

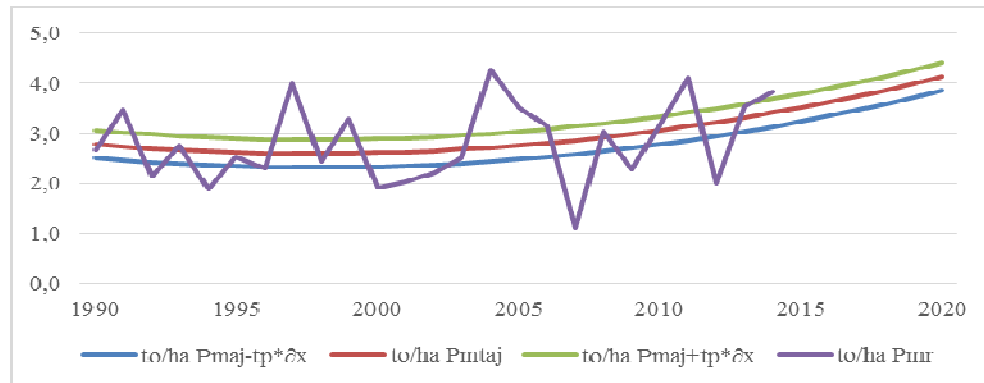
Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time * r_{teor} (0.005 : >0.505***; 0.01:>0.462**; 0,05:>0.337*; <0.337 : N, not significant); GL=23

As it can be observed from table 15 and figures 9-12, the tendency for all regions is of increase, the figure exemplifying the higher increase.



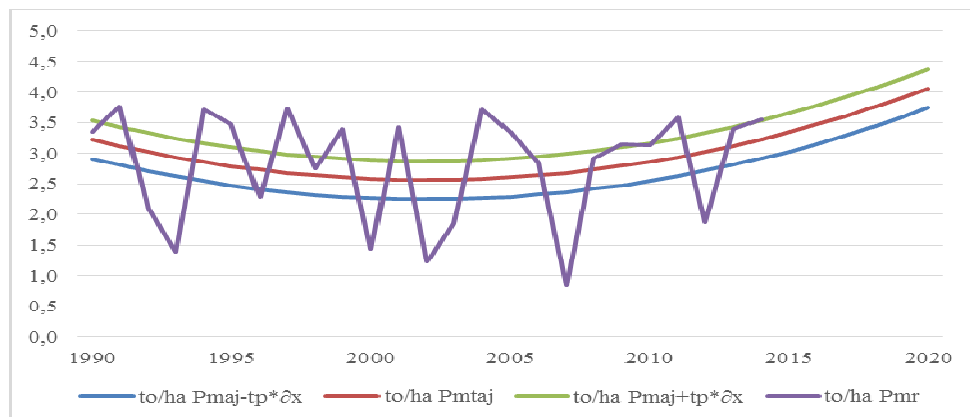
* Pmaj= Average adjusted production, tp= transgression probability

Figure 9. Graphical representation of the total cereal average production, equation calculated for the period 1990-2014 and production extrapolation by 2015-2020 at the country level



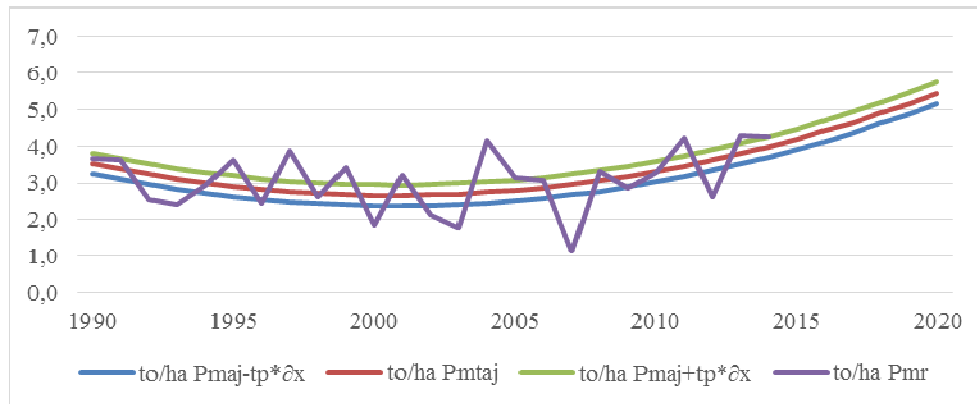
* Pmaj= Average adjusted production, tp= transgression probability

Figure 10. Graphical representation of the total cereal average production, equation calculated for the period 1990-2014 and production extrapolation by 2015-2020 for South-East Region



* Pmaj= Average adjusted production, tp= transgression probability

Figure 11. Graphical representation of the total cereal average production, equation calculated for the period 1990-2014 and production extrapolation by 2015-2020 for South- West Oltenia Region



* Pmaj= Average adjusted production, tp= transgression probability

Figure 12. Graphical representation of the total cereal average production, equation calculated for the period 1990-2014 and production extrapolation by 2015-2020 for South-Muntenia Region.

From the regions with an important increase we observe South-Muntenia and Bucharest-Ilfov; plausible scenarios considering the natural conditions and also that a part of surfaces have irrigations in this areas.

Table 15. The average cereals production tendency, for the period 2015-2020, nationwide and on development regions

COUNTRY, REGION	MC		Average productions :1990-2014					Average productions by 2015-2020, trendline equations						
			1990	1995	2000	2005	2010	2014	2015	2016	2017	2018	2019	2020
TOTAL	to ha	Pmaj-tp*δx	2.7	2.5	2.5	2.6	3	3.4	3.5	3.67	3.8	4	4.1	4.3
	to ha	Pmtaj	2.9	2.7	2.7	2.8	3.2	3.6	3.76	3.9	4.04	4.19	4.35	4.51
	to ha	Pmaj-tp*δx	3.2	2.9	2.9	3.1	3.4	3.9	4	4.14	4.3	4.4	4.6	4.7
	to ha	Pmr	3.01	3.085	1.853	3.298	3.315	4.055						
NORTHWEST REGION	to ha	Pmaj-tp*δx	2.2	2.3	2.5	2.9	3.2	3.5	3.6	3.63	3.7	3.8	3.9	4
	to ha	Pmtaj	2.4	2.6	2.8	3.1	3.4	3.7	3.76	3.84	3.92	4.01	4.09	4.18
	to ha	Pmaj-tp*δx	2.6	2.8	3	3.3	3.6	3.9	4	4.05	4.1	4.2	4.3	4.4
	to ha	Pmr	2.779	3.021	1.893	3.4	3.499	4.107						
CENTRAL REGION	to ha	Pmaj-tp*δx	2.4	2.4	2.5	2.8	3.2	3.5	3.6	3.7	3.8	3.9	4	4.1
	to ha	Pmtaj	2.6	2.6	2.8	3	3.4	3.7	3.79	3.88	3.98	4.09	4.19	4.3
	to ha	Pmaj-tp*δx	2.7	2.8	3	3.2	3.5	3.9	4	3.7	4.2	4.3	4.4	4.5
	to ha	Pmr	2.832	3.084	2.331	3.123	3.381	4.225						
NORTHEAST REGION	to ha	Pmaj-tp*δx	2.4	2.2	2.2	2.5	3	3.5	3.7	3.87	4	4.2	4.4	4.6
	to ha	Pmtaj	2.6	2.5	2.5	2.7	3.2	3.8	3.94	4.11	4.28	4.47	4.67	4.87
	to ha	Pmaj-tp*δx	2.9	2.7	2.7	3	3.5	4	4.2	4.34	4.5	4.7	4.9	5.1
	to ha	Pmr	2.638	2.539	1.729	3.045	3.382	4.315						
SOUTHEAST REGION	to ha	Pmaj-tp*δx	2.5	2.3	2.3	2.5	2.8	3.1	3.2	3.3	3.5	3.6	3.7	3.8
	to ha	Pmtaj	2.8	2.6	2.5	2.8	3.1	3.4	3.51	3.62	3.74	3.86	3.99	4.12
	to ha	Pmaj-tp*δx	3.1	2.9	2.9	3	3.3	3.7	3.8	3.9	4	4.1	4.3	4.4
	to ha	Pmr	2.679	2.528	1.921	3.502	3.173	3.825						
SOUTH-MUNTENIA REGION	to ha	Pmaj-tp*δx	3.2	2.6	2.4	2.5	3	3.7	3.9	4.1	4.4	4.6	4.9	5.2
	to ha	Pmtaj	3.5	2.9	2.7	2.8	3.3	4	4.2	4.42	4.65	4.9	5.17	5.45
	to ha	Pmaj-tp*δx	3.8	3.2	3	3.1	3.6	4.3	4.5	4.7	4.9	5.2	5.5	5.7
	to ha	Pmr	3.664	3.514	1.874	3.136	3.278	4.264						
BUCHAREST-ILFOV REGION	to ha	Pmaj-tp*δx	3.3	2.7	2.4	2.5	3	3.6	3.8	4	4.2	4.5	4.7	5
	to ha	Pmtaj	3.6	3	2.7	2.8	3.3	3.9	4.11	4.32	4.54	4.78	5.03	5.3
	to ha	Pmaj-tp*δx	4	3.3	3	3.1	3.6	4.2	4.4	4.62	4.9	5.1	5.3	5.6
	to ha	Pmr	3.697	3.732	1.5	3.429	3.314	4.371						
SOUTH-WEST CLITENIA REGION	to ha	Pmaj-tp*δx	2.9	2.5	2.3	2.3	2.5	2.9	3	3.16	3.3	3.4	3.6	3.7
	to ha	Pmtaj	3.2	2.8	2.5	2.6	2.9	3.2	3.34	3.47	3.6	3.75	3.9	4.06
	to ha	Pmaj-tp*δx	3.5	3.1	2.9	2.9	3.2	3.5	3.7	3.78	3.9	4.1	4.2	4.4
	to ha	Pmr	3.356	3.472	1.439	3.342	3.142	3.558						
WEST REGION	to ha	Pmaj-tp*δx	2.5	2.7	2.9	3.1	3.4	3.7	3.8	3.88	4	4	4.1	4.2
	to ha	Pmtaj	2.7	2.9	3.1	3.3	3.7	3.9	4.02	4.09	4.17	4.26	4.34	4.43
	to ha	Pmaj-tp*δx	2.9	3.1	3.3	3.6	3.9	4.2	4.2	4.3	4.4	4.5	4.6	4.6
	to ha	Pmr	2.812	3.203	2.145	3.558	3.665	4.283						

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 * Pmaj= Average adjusted production, tp= transgression probability

4.4. The annual growth rate and the correlation between total productions, average productions and cultivated surfaces.

Our analysis is finalized through the annual growth rhythm calculation and the correlation between the surfaces and average productions for the period 1990-2014, where we can observe annual decrease rhythms for the surfaces and annual increase rhythms for the average and total productions. The highest increases are at average productions, influencing of course the increases for total productions, The correlation made with Pearson coefficient shows a distinct significant correlation between the 2 indicators for North-East Region and significant for North West and Centre Regions.

Table 16. The annual growth rhythms and correlation between surfaces and average productions for the period 1990-2014.

Country, Region	Annual growth rhythm (%) (1990-2014)			Surface-Average production correlation (1990-2014)	
	Surface	Average production	Total production	r (Pearson)	Significance*
TOTAL	-0.19	1.25	1.05	-0.020	
NORTH-WEST	-1.11	1.96	0.83	-0.389	*
CENTER	-1.34	1.68	0.32	-0.422	*
NORTH-EAST	-0.66	2.07	1.40	-0.467	**
SOUTH-EAST	0.49	1.49	1.99	0.027	
SOUTH-MUNTENIA	0.12	0.63	0.75	0.240	
BUCHAREST - ILFOV	-2.61	0.70	-1.93	-0.074	
SOUTH-WEST OLTENIA	-0.07	0.24	0.17	0.204	
WEST	0.00	1.77	1.77	0.124	

Source: Own calculation based on data from INSSE and Romania Statistical Yearbook, series of time
 *GL=23; p=0.05, $r_t=0.337$; p=0.01, $r_t=0.462$

Conclusions

The cereals grain are the most important vegetable source of food for both humans and animals. An indispensable part of human food consumption is provided by cereals, it is therefore very important to know the evolution of grain production indicators.

The total cereal production analysis has highlighted major differences between the two periods both in the country and in the regions. Total production fell 0.5% on average over the period 1990-2006 and had a slight increase in the period 2007-2014, 1.48% per year. Comparing total production averages, for those two periods, in regions and at country level, we see that they are not significantly different.

In order to capture the trend equations for the period 1990-2014, which to have a significant correlation report, were used equations of the second degree for eight situations and third degree for one situation. Country-wide trend is that total cereal production to increase to 22,256 million tons, with limits for a 95% probability between 20,916 million tonnes and 23,595 million tonnes.

Analyzing the cultivated areas these were of 5, 95 thousand hectares in 1990-2006 and 5,274 thousand ha during 2007-2014. Differences between surfaces were large, that statistically are very significant.

From extrapolation using trend equations, grain acreage will fall to 5,122 thousand ha in 2014 to 4,666 thousand ha in 2020, with limits between 4,503 thousand ha and 4,830 thousand ha.

Analyzing the average productions compared to both periods, we find that they had a growth rate of 0.61% over 1990-2006 and 2.32% for the period 2007-2014.

Average production extrapolation with equations trend for the period 2015-2020, presents an upward trend, the average cereal production to be 4.51 t / ha, with limits between 4.3 t / ha and 4.7 to /Ha. The highest yields to be obtained in South Muntenia 5.45 tons / ha. This is possible to achieve if the improve technologies trend will maintain and continue in the next period.

Through the presented study it can be considered that the developed scenarios for the period 2015-2020 may constitute useful tools in the development of some measures to promote the development methods of strategic marketing initiatives. In addition, the knowledge of the current position and development trends of the cereal sector can provide scientific bases for the elaboration and adoption of the best policies and development strategies of which we have or can have comparative advantages. The objectives and results of this study are of topical interest and can be used by the cereals markets analysts in order to elaborate, strengthen and implement the agricultural public policies regarding the agriculture development.

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