

## RESEARCH ON THE EVOLUTION OF EXPENDITURE WITH AGRICULTURAL LAND FERTILIZATION BY ECONOMIC SIZE CLASSES IN ROMANIA DURING THE PERIOD 2007-2021

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### Abstract

*The chemical fertilizers applied to Romania's soils represent a particularly important aspect in ensuring a qualitative and quantitative production. The expenditures that farmers have to be able to fertilize the soil correctly and with a sufficient amount have become over the years increasingly higher. The paper analyzes in evolution, over two periods of time, 2007-2014 and 2014-2021, 2 aspects: the surfaces of agricultural holdings, by classes of economic size; the main technical-economic indicators of the use of chemical fertilizers in agricultural holdings, namely the expenditures per hectare of agricultural land with chemical fertilizers, in total and by types: N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O fertilizers, and the expenditures with chemical fertilizers to obtain 100 euros of plant production. The data were retrieved from the FADN platform and statistically interpreted using mean, standard deviation, coefficient of variation, growth rate, t-test of significance. The conclusion that emerges from the analysis undertaken is that there are big differences between the two analyzed periods, in both of them are signs of variations over the years and increases in chemical fertilizer expenses, but the second period, 2014-2021, shows a greater homogeneity of data, even decreases in the higher classes, while the classes (1) 2,000 - < 8,000 EUR and (2) 8,000 - < 25,000 EUR have increased expenditures per ha.*

**Key words:** expenditure, evolution, chemical fertilizers, Romania, economic size classes

### INTRODUCTION

In Romania, experiments with chemical fertilizers began in 1962, and the effect of nitrogen fertilizers on wheat, corn, sunflower and sugar beet crops was studied [2, 5] continued by experiments using radioactive isotopes [5]. The studies from INCDA Fundulea monitored both the production and its quality [1]. The optimal doses recommended in the 1971s for the culture of corn, on the calcic chernozem from Ileana, were between 100 and 150 kg N/ha and between 60 and 80 kg/ha P<sub>2</sub>O<sub>5</sub> [4].

In the European Union, the quality of chemical fertilizers obtained from inorganic materials, by extraction or by chemical processes, is regulated at the level of each member state [8].

Although the reduction of fertilizers applied to crops is a general concern, the shortage of chemical fertilizers and the very high increase

in their prices from 2023, caused the European Parliament to adopt a resolution that emphasizes their role in ensuring sufficient food production and quality. The resolution shows that despite the increase in the price of nitrogen-based fertilizers, by 149%, it is necessary to ensure the availability of all types of fertilizers to farmers, even in the short term, being essential for the food supply of EU citizens [6].

One reason for the reduction of the quantities of chemical fertilizers used in agriculture is the need to increase food safety [10], through the development of ecological agriculture, which in 2018 included a number of 10,000 operators [12].

Studies show that one of the causes of the inefficient use of chemical fertilizers is soil erosion, which along with the loss of soil particles caused by the slope of the land, wind and water also carries away the applied chemical fertilizers [11].

In this context, the purpose of this study is to analyze an indicator of fertilization, i.e. the expenditures, a very important factor in the process, that very much influences the quantity of fertilizers applied and also their quality.

## MATERIALS AND METHODS

The indicators used to analyze the use of chemical fertilizers were: chemical fertilizers N, P, K expressed in kg of active substance per hectare of agricultural land (kg a.s./ha), and their structure ; fertilization expenditures per hectare of agricultural land (euro/ha); the share of chemical fertilizer expenditures in the total of inputs at the level of the agricultural holding; expenditures with chemical fertilizers to obtain 100 euros of vegetable production.

To determine the degree of dispersion of the indicators over the analyzed period, the coefficient of variation was used, calculated

as follows:  $Cvar (\%) = (\text{Standard deviation}/\text{Average}) * 100$

To find out the trend of the analyzed indicators, the annual growth rhythm was used calculated with the formula:  $\text{Growth rhythm } (\%) = ((\text{geomean}(\text{analyzed period}) - 1) * 100)$ . To determine the significance of the difference between the calculated averages, the t-test was used, the interpretation of which was for probabilities of 95%, 99% and 99.9% ( $t_{cal} > t_{theoretical}$ )[9].

## RESULTS AND DISCUSSIONS

### Comparative analysis of the areas of agricultural holdings, by economic size classes, at the level of Romania for the periods 2007-2013 and 2014-2021

The 2023-2027 PAC Plan for Romania emphasizes the reduced consumption of nitrogen fertilizers in Romania since 2018, of 40.3 kg N/ha, compared to the EU 28 average - 77.2 kg N/ha [7].

Table 1. The quantitative and structural evolution of chemical fertilizers used in Romania during the period 1990-2021

Nutrient	MU	1990	1995	2000	2010	2015	2020	2021	Average	St Dev	C(%)	Rhythm(%)
Nitrogen N (total)	thousands to	765	233	239	306	357	469	539	415	191.6	46.1	-5.7
	%	63.1	64.1	78.6	63.6	67.1	63.5	58.4	65	6.3	9.7	-1.3
Phosphate P <sub>2</sub> O <sub>5</sub> (total)	thousands to	313	127	56	123	133	188	266	172	89.7	52.1	-2.7
	%	25.8	34.9	18.4	25.7	24.9	25.4	28.8	26	4.9	18.8	1.8
Potash K <sub>2</sub> O (total)	thousands to	134	3	9	52	43	82	118	63	50.8	80.6	-2.1
	%	11.1	0.9	3.0	10.7	8.0	11.1	12.8	8	4.6	55.4	2.5
Total nutrient	thousands to	1,213	363	304	481	533	738	922	651	327.3	50.3	-4.5
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	X	x	x	x

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE SO (europa.eu) [3].

As can be seen in Table 1, the fertilizers quantities used in Romania have many variations in the period 1990-2021 (CV%=46.1%), in evolution and also in their structure. Thus, if in the year 1990, from fertilizer with N a.s., 765 thousand tons were administered (63.1% of the total), in 1995 the quantity decreased to 233 thousand tons (64.1%), later increasing over the years to 306 thousand tons in 2010 (63.6%) and up to 539 thousand tons in 2021 (58.4%).

The fertilizer P<sub>2</sub> O<sub>5</sub> also records large variations throughout the analyzed period (c% = 52.1%), from 313 thousand tons in 1990 to 56 thousand tons in 2000, gradually reaching 266 thousand tons by the end of the period. In the structure of fertilizers, it occupies about a quarter.

The third active substance studied, K<sub>2</sub>O, varies over the years between 3 thousand tons and 118 thousand tons in 2021, in the structure occupying weights between 0.9% and 12.8%.

The variation in the amount of fertilizers is closely related to the areas of crops, the expenditures involved in their purchase and administration, and the regulations in force.

Table 2. Evolution of agricultural surfaces in agricultural holdings, in Romania, by classes of economic size, for the period 2007-2013

Economic size classes/MU	2007	2009	2011	2013	Average	St Dev	C(%)	Rhythm
	Ha	Ha	Ha	Ha	Ha	Ha	%	%
(1) 2,000 - < 8,000 EURO	4.1	4.3	4.3	3.6	4.1	0.3	8.2	-2.0
(2) 8,000 - < 25,000 EURO	13.0	11.4	13.1	9.5	11.6	1.6	13.8	-5.0
(3) 25,000 - < 50,000 EURO	48.2	47.1	53.9	37.4	46.2	7.3	15.7	-4.1
(4) 50,000 - < 100,000 EURO	122.9	133.4	138.2	95.6	118.3	20.4	17.2	-4.1
(5) 100,000 - < 500,000 EURO	444.6	440.8	443.6	327.0	410.7	58.2	14.2	-5.0
(6) >= 500,000 EURO	1,554.2	1,375.2	1,411.6	1,253.3	1,415.5	143.0	10.1	-3.5

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3]. (SE025) Total Utilized Agricultural Area (ha)

Table 2 shows the evolution of agricultural areas in agricultural holdings in Romania for the period 2007-2013, from where it can be seen that in the first class, the areas vary slightly around 4.1 ha, the second class has an average variation (CV% =13.8%), with a downward trend, from 13 ha to 9.5 ha in 2013. In the third class of economic size, holdings have decreasing surfaces, the biggest decrease is observed between 2011 and 2013,

from 53.9 ha to 37.4 ha. Superior economic size classes, 4,5 and 6, also have important variations, (CV% = middle variation), thus for class 4 the area decreases from 122.9 ha to 95.6 ha, for class 5 the area decreases from 444.6 ha to 327 ha, and in class 6 the area decreases from 1,554.2 ha to 1,253.3 ha. For all classes of economic size, in the period 2007-2013, the surfaces of agricultural holdings had a decreasing tendency.

Table 3. Evolution of agricultural surfaces in agricultural holdings, in Romania, by economic size classes, for the period 2014-2021

Economic size classes/MU	2014	2016	2018	2019	2021	Average	Deviation	St Dev	C%	Rhythm
	Ha	Ha	Ha	Ha	Ha	Ha	Ha	Ha	%	%
(1) 2,000 - < 8,000 EURO	3.5	3.5	4.5	4.6	4.5	4.0	-0.1	0.6	14.1	4.0
(2) 8,000 - < 25,000 EURO	10.6	9.0	11.6	11.7	12.4	10.7	-0.9	1.6	14.5	2.2
(3) 25,000 - < 50,000 EURO	39.9	31.8	33.1	33.4	33.8	33.8	-12.5	2.7	7.9	-2.3
(4) 50,000 - < 100,000 EURO	97.7	88.9	76.9	76.6	77.7	83.5	-34.8	7.8	9.4	-3.2
(5) 100,000 - < 500,000 EUR	328.1	305.2	282.7	283.1	285.3	297.8	-113.0	17.9	6.0	-2.0
(6) >= 500,000 EURO	1,241.2	1,259.3	1,208.9	1,178.8	1,139.5	1,204.2	-211.3	44.6	3.7	-1.2

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

The same evolution was also analyzed in table 3, but taking the data from the period 2014-2021, where, as the data shows, in some classes, the surface areas of holdings increased.

Thus, for class 1, from 2014 until 2021, the area increased from 3.5 ha to 4.5 ha, with an annual rhythm of 4%, for class two the area increased from 10.6 ha to 12.4 ha, with an annual rhythm of 2.2%.

For classes 3, 4, 5 and 6, however, the trend is downward, with annual rhythms between -1.2% and 3.2%.

Thus, at the end of the period for class 3, the area reached 33.8 ha from 39.9 ha, for class 4 to 77.7 ha from 97.7 ha (a decrease by 20 ha), for class 5 the decrease of was even higher, from 328.1 ha to 285.3 ha, and for class 6, the decrease is from 1,241.2 ha to 1,139.5 ha, a decrease of over 100 ha.

We can say that for the small classes of economic size (1 and 2) the areas increased slightly, while for the medium and superior classes of economic size, significant decreases are registered.

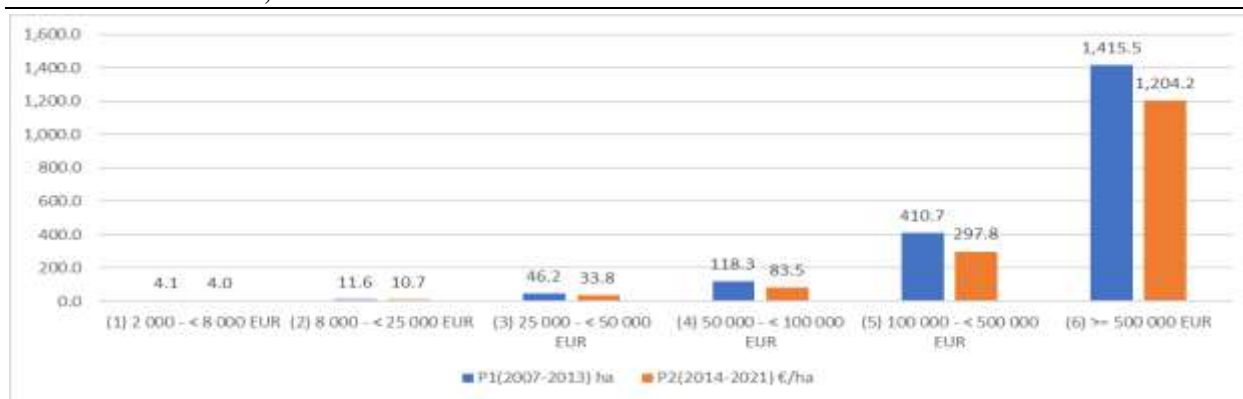


Fig. 1. The agricultural surfaces evolution in agricultural holdings, in Romania, by economic size classes, for the periods 2007-2013 and 2014-2021

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE[3]

Table 4. The deviations significance of the agricultural holdings surfaces, by economic size classes, in Romania, for the periods 2007-2013 and 2014-2021

Economic size classes/MU	P1(2007-2013)	P2(2014-2021)	Deviation (P2 vs P1)		Signif.
	Ha	€/ha	€/ha	%	
(1) 2,000 - < 8,000 EUR	4.1	4.0	-0.1	96.9268	N
(2) 8,000 - < 25,000 EUR	11.6	10.7	-0.9	91.92386	N
(3) 25,000 - < 50,000 EUR	46.2	33.8	-12.5	73.07074	***
(4) 50,000 - < 100,000 EUR	118.3	83.5	-34.8	70.60725	***
(5) 100,000 - < 500,000 EUR	410.7	297.8	-113.0	72.4985	***
(6) >= EUR 500,000	1,415.5	1,204.2	-211.3	85.0702	**

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

Based on the analyzes undertaken in Tables 2 and 3, we calculated in Table 4 the deviations of the agricultural surfaces for the two periods and their significance, from which it can be seen that for the first two classes the deviations are insignificant, while for classes 3, 4 and 5 the deviations are very significant and for class 6, the deviation is distinctly significant. These significances once again underline the major differences between the two analyzed periods, in the medium and large economic size classes.

**Comparative analysis of the main technical and economic indicators of the use of chemical fertilizers in agricultural holdings, by economic size, classes at the**

**level of Romania for the periods 2007-2013 and 2014-2021**

*Analysis of expenditures per hectare of agricultural land with chemical fertilizers*

The following tables show the expenditure with fertilizers per hectare of agricultural land, in evolution, for each economic size class. For the period 2007-2013, the variations are medium for the first 5 classes and large for the 6th class (CV%= 23.3%).

Expenditures per ha are increasing, from 43.52 euros/ha in 2007 to 61.98 euros/ha in 2013, for class 1, from 42.63 euros/ha to 63.69 euros/ha in 2013, for class 2 and from 41.08 euros/ha to 61.96 euros/ha for class 3 of economic size.

Table 5. Evolution of expenditure per hectare of agricultural land with chemical fertilizers, at the level of Romania, by economic size classes, for the period 2007-2013

Economic size classes/MU	2007	2009	2011	2013	Average	St Dev	C%	Rhythm
	€/ha	€/ha	€/ha	€/ha	€/ha	€/ha	%	%
(1) 2,000 - < 8,000 EURO	43.52	47.42	59.16	61.98	53.9	6.6	12.2	6.1
(2) 8,000 - < 25,000 EURO	42.63	49.12	58.35	63.69	55.0	7.4	13.5	6.9
(3) 25,000 - < 50,000 EURO	41.08	50.46	59.77	61.96	54.0	7.4	13.8	7.1
(4) 50,000 - < 100,000 EURO	64.53	46.55	67.55	71.00	61.3	9.1	14.8	1.6
(5) 100,000 - < 500,000 EURO	50.57	62.39	79.12	86.08	69.8	12.9	18.5	9.3
(6) >= 500,000 EURO	49.89	74.70	88.76	109.54	81.4	18.9	23.3	14.0

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

For the higher classes of economic size, the expenditure with fertilizers per 1 ha are higher, in class 4, they start from 64.53 euros/ha in 2007 and reach 71 euros/ha in 2013, this class having the lowest annual growth rhythm, 1.6%, while in the other classes the rhythm is between 6.1% and even

14% for class 6. In class 5, expenditures increase a lot over the years, from 50.57 euros/ha, they reach 86.08 euros/ha in 2013, and for class 6, they even exceed double the value in 2007, from 49.89 euros/ha to 109.54 euros/ha.

Table 6. Evolution of expenditure per hectare of agricultural surface with chemical fertilizers, at the level of Romania, by economic size classes, for the period 2014-2021

Economic size classes/MU	2014	2016	2018	2020	2021	Average	A2-A1	St Dev	C%	Rhythm
	€/ha	€/ha	€/ha	€/ha	€/ha	€/ha	€/ha	€/ha	%	%
(1) 2,000 - < 8,000 EURO	64.74	79.71	79.46	79.25	98.90	78.9	25.0	9.4	11.9	6.2
(2) 8,000 - < 25,000 EURO	64.88	82.87	73.17	72.98	90.53	75.7	20.7	7.7	10.2	4.9
(3) 25,000 - < 50,000 EURO	63.60	83.56	68.32	65.51	82.30	70.2	16.2	8.1	11.5	3.8
(4) 50,000 - < 100,000 EURO	70.61	85.53	70.13	69.54	84.36	75.7	14.3	6.8	9.0	2.6
(5) 100,000 - < 500,000 EURO	83.62	102.25	88.09	83.32	103.41	91.1	21.3	8.2	8.9	3.1
(6) >= 500,000 EURO	100.43	100.54	93.57	90.61	108.01	98.7	17.4	6.8	6.9	1.0

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

In the second analyzed period, 2014-2021, the variations are medium and even small, and the annual growth rhythms of chemical fertilizers are more moderate, compared to the first period. While the highest growth rhythms in the first period were in the upper classes of economic size, in the period 2014-2021, they are in the lower classes of economic size.

Thus, in class (1) 2,000 - < 8,000 euro, the expenditures per ha with chemical fertilizers increased, from 64.74 euros/ha to 98.9 euros/ha, the variation of the years being average (c%=11, 9%) and the growth rhythm of 6.2%. In class (2) 8,000 - < 25,000 euro, expenditures increased from 64.88 euro/ha to 90.53 euro/ha, with an average variation and an annual growth rhythm of 4.9%. In class (3) 25,000 - < 50,000 euro, expenditures increased from 63.6 euros/ha to 82.3 euros/ha,

the variation being an average one (c% 11.5%) and the annual growth rhythm of 3.8%. Starting with class (4) 50,000 - < 100,000 euro, the value of the coefficient of variation is lower and lower, as is the annual growth rhythm. Expenditures per ha increase from 70.61 euro/ha in 2014 to 84.36 euro/ha in 2021 for class (4), from 83.62 euro/ha to 103.41 euro/ha for class (5) 100,000 - < 500,000 euro and from 100.43 euro/ha to 108 euro/ha for class (6) >= 500,000 euro, for the same years. Regarding the significance of the deviations of the expenditures with chemical fertilizers per hectare of agricultural land between the two studied periods, it can be seen from Table 7 that for the first two classes the deviations are very significant, for classes 3, 4 and 5 they are distinctly significant and for the class 6, the deviation is significant.

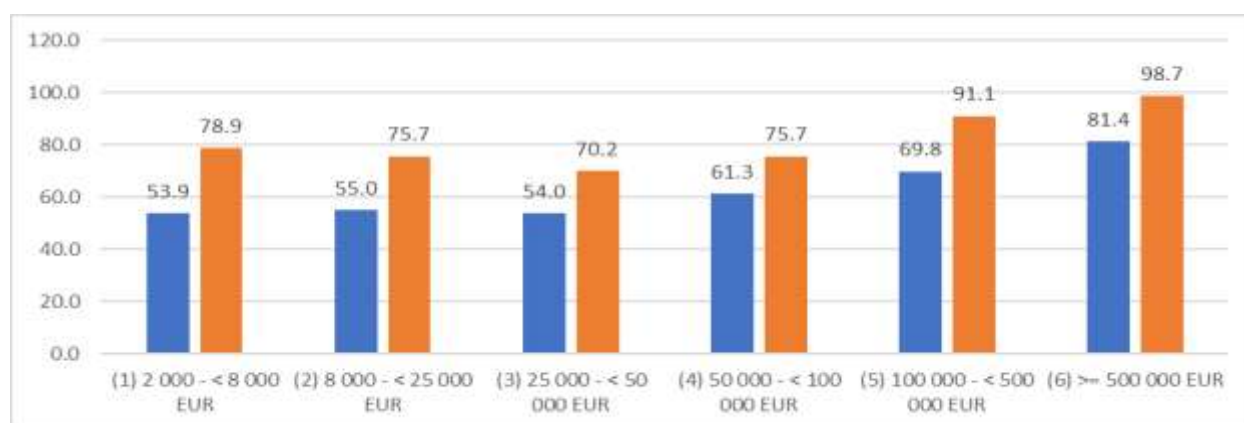


Fig. 2. The evolution of expenditures per hectare of agricultural land with chemical fertilizers, at Romania's level, by economic size classes, for the periods 2007-2013 and 2014-2021

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE [3].

Table 7. The deviations significance of expenditures with chemical fertilizers per hectare of agricultural land, Romania's level, by economic size classes, for the periods 2007-2013 and 2014-2021

Economic size classes/MU	P1 (2007-2013)	P2 (2014-2021)	Deviation (P2 vs P1)		Signif.
	€/ha	€/ha	€/ha	%	
(1) 2,000 - < 8,000 EURO	53.9	78.9	25.0	146.3359	***
(2) 8,000 - < 25,000 EURO	55.0	75.7	20.7	137.5477	***
(3) 25,000 - < 50,000 EURO	54.0	70.2	16.2	130.0517	**
(4) 50,000 - < 100,000 EURO	61.3	75.7	14.3	123.3433	**
(5) 100,000 - < 500,000 EURO	69.8	91.1	21.3	130.5045	**
(6) >= 500,000 EURO	81.4	98.7	17.4	121.3848	*

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

**Analysis of the expenditures with chemical fertilizers to obtain 100 euros of plant production**

The analysis of chemical fertilizer expenditures is completed with the analysis of

the two periods, 2007-2013 and 2014-2021, reporting the expenditures for obtaining 100 euros of vegetable production, by classes of economic size.

Table 8. Theexpendituresevolution with chemical fertilizers to obtain 100 euros of vegetal production, at Romania's level, by economic size classes, for the period 2007-2013

Economic size classes/MU	2007	2009	2011	2013	Average	StDev	C%	Rhythm
	€/€100	€/€100	€/€100	€/€100	€/€100	€/€100	%	%
(1) 2,000 - < 8,000 EURO	6.04	7.26	7.75	7.65	7.3	0.6	8.5	4.0
(2) 8,000 - < 25,000 EURO	5.60	7.30	7.79	7.58	7.1	0.8	11.2	5.2
(3) 25,000 - < 50,000 EURO	7.25	9.38	8.50	9.09	8.5	0.9	10.8	3.8
(4) 50,000 - < 100,000 EURO	14.74	10.45	10.40	10.09	10.8	1.8	16.6	-6.1
(5) 100,000 - < 500,000 EURO	11.07	13.48	11.02	12.18	12.0	0.9	7.6	1.6
(6) >= 500,000 EURO	12.52	15.78	11.04	13.83	12.4	1.9	15.2	1.7

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE (europa.eu) [3].

From the analyse made in Table 8, regarding the period 2007-2013, it can be seen that for class 1, fertilizer expenditures increased from 6 euros to 7.65 euros for obtaining 100 euros of vegetable production, the variation is small, 8.5%, and the annual growth rhythm is 4%.

In class 2, the growth rhythm is slightly higher, 5.2%, and the average variation, 11.2%, from 5.6 euros in 2007 to 7.58 euros in 2013. In class 3, in 2013 it reached 9.09

euros/100 euros of vegetable production, the variation being average, 10.8%. In class 4, a significant decrease in expenditures can be observed, from 14.74 euros to 10 euros/100 euros of plant production, with a variation of 16.6% and a growth rhythm of -6.1%.

In the last classes, 5 and 6, the growth rhythms are low, in class 5 in 2013, 12.18 euros were spent and in class 6, 13.83 euros were spent, still lower values than in 2009.

Table 9. The evolution of expenditures with chemical fertilizers to obtain 100 euros of plant production, at the level of Romania, by economic size classes, for the period 2014-2021

Economic size classes/MU	2014	2016	2018	2020	2021	Average	M2-M1	StDev	C%	Rhythm
	€/€100	€/€100	€/€100	€/€100	€/€100	€/€100	€/€100	€/€100	%	%
(1) 2,000 - < 8,000 EURO	8.31	10.50	9.02	8.37	8.72	9.1	1.8	0.9	10.4	0.7
(2) 8,000 - < 25,000 EURO	8.66	11.18	8.49	8.92	8.98	9.2	2.1	1.0	10.5	0.5
(3) 25,000 - < 50,000 EURO	9.76	12.59	9.07	9.51	9.48	9.9	1.4	1.3	13.0	-0.4
(4) 50,000 - < 100,000 EURO	11.18	12.57	9.93	10.41	9.35	10.8	0.0	1.3	12.1	-2.5
(5) 100,000 - < 500,000 EURO	12.07	13.88	10.88	12.57	10.09	11.9	-0.1	1.4	12.1	-2.5
(6) >= 500,000 EURO	12.58	12.34	11.31	13.67	9.98	12.0	-0.4	1.3	11.0	-3.3

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE SO (europa.eu) [3].

The 2014-2021 period is much more stable, with much smaller differences per year, the

growth rhythms are very low and in classes 3-6 even negative.

The coefficient of variation indicates for all classes of economic size average variations, close to the lower limit of the threshold.

In class 1 in 2021, the amount of expenditures is 8.72 euros/100 euros of plant production, in class 2 of 8.98 euros/100 euros of plant production, in class 3, 9.48 euros and in class 4, 9.35 euros, so for the first classes the values

oscillate around 9 euros spent for 100 euros of vegetable production. For grades 5 and 6, the values in 2021 are 10 euros and 9.98 euros/100 euros respectively, much lower values compared to previous years, when 13.88 euros/100 euros were reached in 2016 for class 5 and 13.67 euro/100 euros in 2020 in class 6.

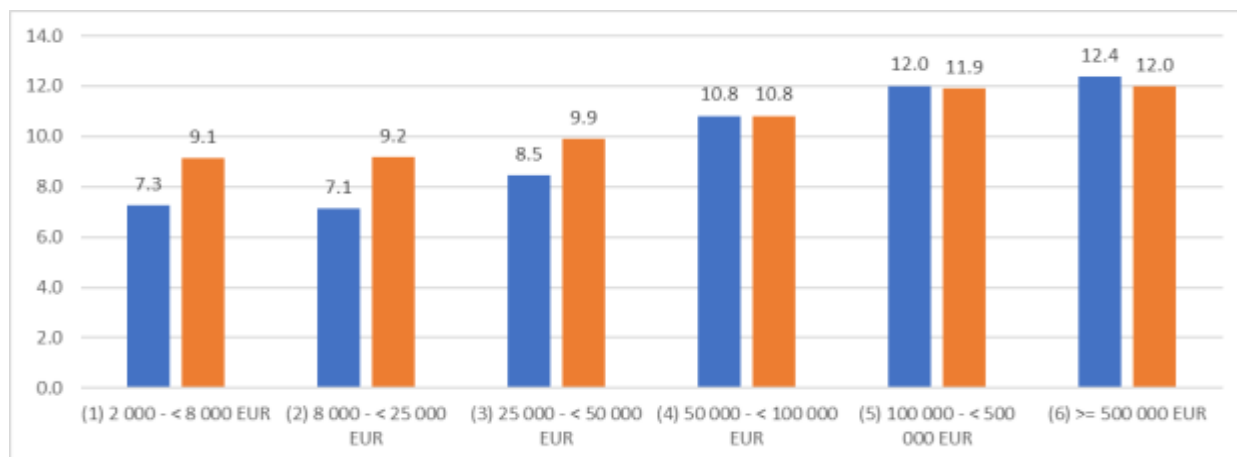


Fig. 3. The evolution of expenditures with chemical fertilizers to obtain 100 euros of plant production, at the level of Romania, by economic size classes, for the periods 2007-2013 and 2014-2021

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE [3].

Table 10. The deviationssignificance of the expenditures with chemical fertilizers to obtain 100 euros of plant production, by economic size classes, in Romania between the period 2007-2013 and 2014-2021

Economic size classes/MU	P1(2007-2013)		P2(2014-2021)		Signif.
	€/€100	€/€100	€/€100	%	
(1) 2,000 - < 8,000 EURO	7.3	9.1	1.8	125.41	***
(2) 8,000 - < 25,000 EURO	7.1	9.2	2.1	128.86	***
(3) 25,000 - < 50,000 EURO	8.5	9.9	1.4	117.06	*
(4) 50,000 - < 100,000 EURO	10.8	10.8	0.0	100.00	N
(5) 100,000 - < 500,000 EURO	12.0	11.9	-0.1	99.01	N
(6) >= 500,000 EURO	12.4	12.0	-0.4	96.87	N

Source: Own calculation on the basis of data from FADN PUBLIC DATABASE SO (europa.eu) [3].

Table 10 shows the significance of the deviations of chemical fertilizer expenditures to obtain 100 euros of plant production, between the period 2007-2013 and 2014-2021. For classes 1 and 2 the deviations are very significant, for class 3 significant and for classes 4,5 and 6 they are insignificant.

## CONCLUSIONS

From this research, the following conclusions were drawn:

-From 2019, according to Regulation 1009, in the European Union the quality of chemical fertilizers obtained from inorganic materials, by extraction or by chemical processes is regulated at the level of each member state.

-In recent decades, many attempts have been made in order to reduce more and more the quantity of chemical fertilizers applied per ha, due to the influence that is very negative for the soil and for the production's quality. However, the necessity to provide for farmers chemical fertilizers is recognized, which plays a very important role in ensuring food security.

-The total amount of fertilizers administered in Romania varies a lot in the period 1990-2021, from 1,213 thousand tons in 1990, to 304 thousand tons in 2000 and to 922 thousand tons in 2021.

-Analyzing the areas of holdings by economic size classes, it is observed that in the period 2007-2013, they had a decreasing trend, and

for the period 2014-2021 in the small economic size classes (1 and 2) they increased, over time what for the medium and superior classes of economic size, the areas suffered important decreases.

-The analysis of surface deviations over the two time periods revealed major differences in the medium and large economic size classes.

-From the analysis of expenditures with chemical fertilizers per hectare of agricultural land, very large increases can be observed in the first period, especially in the superior classes of economic size, while in the period 2014-2021, the largest increases in the expenditures are in the classes 1, 2 and 3. Expenditures per ha in 2021 are between 82.3 euros and 108 euros, depending on the economic size class.

-From the analysis of the expenditures with chemical fertilizers to obtain 100 euros of vegetable production, increases in the expenditures in the first period are observed, climbing on each step of the economic classes, and increases in classes over the years, especially in classes 1, 2 and 3, with the exception of class 4, where expenditures decreased by more than 4.6 euros/100 euros of vegetable production. In the second period, although there are increases in the dynamics of the years, they are much smaller in classes 1 and 2, and even significant decreases in classes 3-6. These smaller variations in expenditure are necessary for a balance between cultivated areas, crops and the output obtained.

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