Retrospective analysis of statistical indicators for vegetable and animal agricultural products obtained in the conventional system and in ecological agriculture

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19 November 2020

RETROSPECTIVE ANALYSIS OF STATISTICAL INDICATORS FOR VEGETABLE AND ANIMAL AGRICULTURAL PRODUCTS OBTAINED IN THE CONVENTIONAL SYSTEM AND IN ECOLOGICAL AGRICULTURE

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Abstract: *The aim pursued in the paper is the analysis of the transformations that took place, in the period 2007-2019, at the level of the two conventional and ecological production systems. The analysis of the statistical data series, INS Tempo-ONLINE and EUROSTAT data for conventional and organic agriculture, was used to reflect the level and trends of economic statistics in agriculture. The need to characterize the evolution and structure of agricultural phenomena also determined the calculation of statistical indicators (average, standard deviation, coefficient of variability, annual growth rate, etc.) from the perspective of cultivated areas, total yields, production yield per hectare and on the head of an animal, etc. This method responds to a well-defined goal: the data series through the calculated indicators highlight the upward / downward trend and help to determine the indicative socio-economic development of the regions taking into account the differentiated growth rates of the systems in each region. The study provides and contributes to information, by knowing the evolution over time of plant and animal agricultural products, obtained conventionally and in organic farming.*

Keywords: *agricultural products, statistical indicators, conventional system, ecological agriculture*

JEL Classification: *D20, O5, Q01, Q13, Q17, Q17.*

INTRODUCTION

"The European Commission's Farm to Fork strategy mentions organic products as a key sector to achieve the food ambitions of the European Green Agreement. The strategy states that "The organic food market is set to grow and organic farming needs to be further promoted". With the help of an organic action plan and common agricultural policy (CAP) measures, the European Commission aims to "achieve the target of at least 25% of the EU's agricultural area in organic farming by 2030 and a significant increase in organic aquaculture" (IFOAM , 2020). Studies show that organic farming is becoming more and more important both in terms of supply and demand. (M. Dobrescu, 2017). Other studies call for consumer information and education on the confusion between "bio" and "natural", the lack of a country strategy on organic farming, Romania's under utilized natural potential, organic farming market (Word Vision Romania Study, June 2019). In Romania, organic agriculture has been officially recognized (by I. Puia and V. Soran, cited by Romulus Gruia, 1998), in studies on agricultural ecosystems. Other studies are aimed at farmers, farmers and other categories of rural entrepreneurs, as well as consumers who love nature and organic agricultural and food products, of very good quality, clean and healthy. *(*I. Toncea, E. Simion, G. Ioniţă, Niţu D. Alexandrescu, V. A. Toncea, 2016).

Given the European Commission's goal of achieving at least 25% organic farming in Europe by 2030, as set out in the EU's "fork to fork" and "biodiversity" strategies, research requires knowledge and studies for specific needs. the agricultural sector, the present study becoming opportune and necessary for the study of the subject on “conventional and organic farming systems” in order to “design more sustainable food systems”.

RESEARCH MATERIAL AND METHOD

This paper aims to find answers to the questions: What are the areas occupied by organic farming in Romania and whether they vary significantly from the environments? What is the yield of organic crops in the yields of conventional crops and what is the coefficient of variation? What

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are the livestock, the total productions obtained and how do they vary? Is there a market for organic products in Romania? The reference data are for the time horizon 2012-2019. The research method consists in the empirical analysis of the available data.

In order to highlight the existing differences in the evolution of the mentioned indicators, the following statistical indicators were determined: minimum, maximum, average, standard deviation, coefficient of variation (CV%) and annual growth rate (%). The coefficient of variation (CV) is a relative measure of data dispersion. CV represents the evaluation of the standard deviation in relation to the arithmetic mean. In order to compare the data, the framing groups of the variability coefficient will be used to assess the homogeneity of a statistical population: CV <10% homogeneous population; 10% <CV <20% relatively homogeneous population; 20% <CV <30% relatively heterogeneous population; 30% <CV heterogeneous population. (8)

RESULTS AND DISCUSSIONS

Data presented by the Research Institute of Organic Agriculture (FiBL) and Agricultural Market Information Company (AM) on organic farming in the EU revealed that at the end of 2018, in the European Union there were ecological areas of 13.8 million hectares (7.7%) managed of over 325 thousand producers, Table no. 1, col 2 and col 12. The countries with the largest organic agricultural areas are Spain (2.2 million hectares), France (2 million hectares), Italy (1.9 million hectares), Germany (1.5 million hectares) . Romania has an ecological agricultural area of over 326 thousand hectares (2.5%) managed by 7908 producers. The ecological areas, for the mentioned countries, are composed of pastures (21% - 60%), arable crops (35% - 74%), permanent crops (1% - 25%). Table no. 1, col 5, 7 and 9.

Table no. 1: Organic agricultural areas in the EU

Nr. crt	Countries	Organic land area in 1000 ha	Percentage of agricultural land which is organic (%)	Organic land use								Producers (no)	Processors (no)
				Grassland (ha)	%	Arable crops (ha)	%	Permanent crops (ha)	%	Other (ha)	%		
0	1	2	3	4	5	6	7	8	9	10	11	12	13
1	EU- 28	13.8	7.7	6039434	44	6132824	44	1457093	11	0	1	327222	71960
2	Austria	638	24.5	385639	60	241101	38	10787	2	278	0	25795	1651
3	Italy	1.958	15.8	540012	28	946691	48	471342	24	0	0	69317	20087
4	Spain	2.246	9.6	1186905	53	487363	22	572207	25	0	0	39505	4627
5	Germany	1.521	9.1	809000	53	596656	39	20655	1	95003	6	31713	15441
6	France	2.035	7.3	728387	36	1166243	57	140394	7	0	0	41632	16651
7	Hungary	209	4.5	116389	56	74086	35	10937	5	7970	4	3929	515
8	Bulgaria	162	3.5	33713	21	65648	40	29478	18	33493	21	6471	181
9	Poland	485	3.4	99663	21	354793	73	30220	6	0	0	19224	533
10	Romania	326	2.5	66890	21	240800	74	18569	6	0	0	7908	161

Source: *Research Institute of Organic Agriculture (FiBL) and Agricultural Market Information Company (AM). Data compiled by Fibl based on Eurostat and national data sources.* https://www.organicseurope.bio/about-us/organic-in-europe/

According to the same sources, the most developed market for organic products is occupied by Germany (5.3%), where retail sales were 10.9 billion euros, followed by France (4.8%) with sales of 9.1 billion Italy, 3.2% with sales of EUR 3.4 billion and Spain (2.8%) with sales of EUR 1.9 billion. Romania in 2018 had retail sales of organic products of 41 million euros. Compared to 76 euros / capita per EU average, the amounts spent on organic products are 205 euros in Austria, 136 euros in Germany, 132 euros in France, 7 euros in Poland, 4 euros in Bulgaria, 3 euros/capita resident in Hungary, etc. Romania spends 2 euros / capita on organic products, on average.

Organic agriculture in Romania

In Romania, 2.5% of the land used is occupied by organic farming. The paper analyzes the statistical indicators related to areas and production yields in 12 arable crops grown in conventional system and in organic farming. Areas are analyzed with the idea that lower production yields require a larger area of land to achieve conventional production yields.

Tabel nr. 2: Utilised agricultural area and arable land 2012-2019 (ha)

Nr. crt	Specification	Minimum ha	Maximum ha	Average 2012-2019 (ha)	Ab std (ha)	CV (%)	Rate annual of growth (%)
0	1	2	3	4	5	6	7
	Utilised agricultural area						
1	Total fully converted and under conversion to organic farming	226309	395228	289575	52635	18.2	4.61
2	Fully converted to organic farming	103093	211487	161127	33567	20.8	10.81
3	Under conversion to organic farming	70353	185168	128448	45779	35.6	-0.11
	Arable land						
4	Total fully converted and under conversion to organic farming	156678	257664	192660	37285	19.4	5.71
5	Fully converted to organic farming	88627	164324	115128	24282	21.1	9.22
6	Under conversion to organic farming	49556	107639	77532	19461	25.1	1.17

Source: own processing according to EUROSTAT data

Coefficient of variability of ecological agricultural areas (18.2%), Table no. 2, col 6 line 1, is more stable compared to the coefficient of variability of the surfaces of ecological arable lands (19.4%), but has an annual growth rate of 5.71% / year compared to 4.61% / year cat it is the growth rate of ecological agricultural areas. Variability is given by fluctuations that may occur in producers' options to choose annual or perennial crops. If for the indicator the total arable area converted, the coefficient of variability is 20.8%, for the indicator arable area under conversion the coefficient of variability is 35.6%, Table 2, column 6 row 2 and row 3. The explanation is due to the trend of producers to opt for organic farming, motivated by the financial support provided for the conversion to organic farming methods, but the 5-year commitment period causes producers to give up this type of farming. Organic producers also face other determinants: volatile markets, changing policies and new societal expectations (6). Similarly, the explanation is justified for the case of arable land, where the coefficient of variability for the total converted areas is 21.1% compared to the arable areas in conversion (25.1%), Table no. 2, column 6 row 5 and row 6.

The annual growth rate of 1.17% in the areas under conversion may be an obstacle to the development of organic farming and may partially explain the stagnation of the number of conversions in recent years in Romania.

Table no. 3: Utilised agricultural area and arable land 2012-2019 - ecological

Nr. crt	Specification	Minimum ha	Maximum ha	Average 2012-2019 (ha)	Ab std (ha)	CV (%)	Rate annual of growth (%)
0	1	2	3	4	5	6	7
1	Arable land	88627	164324	115128	24282	21.1	9.22
2	Wheat and spelt	26170	47820	34091	7888	23.1	7.54
3	Barley	2986	10889	5438	2853	52.5	10.58
4	Grain maize and corn-cob-mix	11188	22937	15583	3967	25.5	5.65
5	Rice	1518	2945	2193	493	22.5	3.07
6	Potatoes (including seed potatoes)	53	303	173	94	54.5	-5.88
7	Sugar beet (excluding seed)	30	360	230	120	52.2	-1.95
8	Rape and turnip rape seeds	4096	11759	9017	2877	31.9	-19.02
9	Sunflower seed	15423	32679	21619	6277	29.0	14.65
10	Soya	6326	16361	10318	3317	32.1	20.93
11	Fibre crops	7	127	62	49	79.2	-29.62
12	Tobacco	0	29	15	0	0.0	0.00
13	Hops	17	31	23	7	32.5	-25.95

Source: own processing according to EUROSTAT data

Ecological arable land: The annual growth rate of organic arable land is 9.22%. The standard deviation (24282 ha) varies within narrow limits compared to the average (115128 ha). The value of the coefficient of variability is 21.1% which means that the dispersion of the data around the average is relatively homogeneous, and the data sample is statistically representative. In order to be able to highlight the ecological arable area indicator, the information resulting from the calculations performed reveals the following aspects:

- Higher annual growth rate of organic areas for barley crops (10.58% / year), sunflower (14.65% / year) and soybeans (20.93% / year) compared to the annual rate of increase in wheat (7.54% / year), maize grain (5.65% / year) and rice (3.07% / year) can be explained by the increased demand (social needs) for these products; Table no. 3 col 7 row 3, 9,10.

- The coefficient of variability, calculated as the ratio between standard and average deviation, defines the threshold for samples of areas cultivated with wheat and spelled (23.1%), maize (25.5%), rice (22.5%) and seed sunflower (29%), the analyzed samples being relatively heterogeneous (20% <CV <30%), the areas cultivated with these crops representing relatively large deviations from the average.

- Coefficient of variability for samples of areas cultivated with barley (52.5%), potatoes (54.4%), sugar beet (52.2%) and hemp for fiber (79.2%) in the 8 years of production , as heterogeneous groups, (CV > 30%).

Table no. 4: Arable land, 2012-2019 - conventional

Nr. crt	Specification	Minimum ha	Maximum ha	Average 2012-2019 (ha)	Ab std (ha)	CV (%)	Rate annual of growth (%)
0	1	2	3	4	5	6	7
1	Arable land	8058329	8737275	8330683	208765	2.5	0.98
2	Wheat	1997633	2168370	2099531	52478	2.5	1.36
3	Barley	206991	303969	268528	30211	11.3	4.76
4	Grain maize	2402082	2730157	2558475	112632	4.4	0.42
5	Rice	7427	12719	10162	1874	18.4	-6.46
6	Potatoes	140310	195055	160107	19506	12.2	-4.93
7	Sugar beet (excluding seed)	22729	31280	26863	2546	9.5	-3.50
8	Rape and turnip rape seeds	105295	632679	399463	169815	42.5	-1.34
9	Sunflower seed	998415	1282697	1060263	94637	8.9	3.23
10	Soya	67672	169422	121939	41382	33.9	10.33
11	Fibre crops	121	1688	876	631	72.1	50.98
12	Tobacco	745	1258	917	153	16.7	-7.55
13	Hops	225	257	241	13	5.6	4.51

Source: own processing according to EUROSTAT data

In order to be able to highlight the conventional arable area indicator for the 12 crops analyzed, the information resulting from the calculations revealed the following aspects:

- The annual growth rate of conventional areas is insignificant for wheat crops (1.36% / year), barley (4.76% / year), corn grains (0.42% / year) sunflower (3.23% / year) and significantly for soybeans (10.33% / year) and fiber hemp (50% / year). In the crops of rice (-6.46% / year), potatoes (-4.93% / year), sugar beet (-3.50% / year), rapeseed (-1.34% / year) a significant reduction in areas with these crops.

- The coefficient of variability, calculated as the ratio between standard and average deviation, (10% <CV <20%) defines the threshold for samples of areas cultivated with wheat, barley, maize, rice, potatoes, sugar beet, sunflower as homogeneous groups, the averages being representative, for the analyzed cases.

- The coefficient of variability for the samples of cultivated areas with soybeans (33.9%), rapeseed (42.5%) and hemp for fibers (72.1%), are characterized as statistically heterogeneous groups. (CV > 30%).

Table no. 5: Yield per hectare 2012-2019 in organic farming

Nr. crt	Specification	Minimum kg/ha	Maximum kg/ha	Average 2012-2019 (kg/ha)	Ab std. (kg/ha)	CV (%)	Rate annual of growth (%)
0	1	2	3	4	5	6	7
1	Wheat and spelt	2,400	4,035	3,447	0,655	19.0	4.16
2	Barley	1,582	3,488	2,672	0,703	26.3	6.37
3	Grain maize and corn-cob-mix	2,587	6,004	4,842	1,297	26.8	10.18
4	Rice	3,199	5,829	4,378	0,960	21.9	4.99
5	Potatoes (including seed potatoes)	4,952	11,640	8,026	2,139	26.7	-5.45
6	Sugar beet (excluding seed)	14,026	40,743	23,091	9,467	41.0	-1.71
7	Rape and turnip rape seeds	2,117	2,548	2,340	0,177	7.6	-1.67
8	Sunflower seed	1,869	2,353	2,196	0,177	8.0	-4.46
9	Soya	1,892	2,713	2,163	0,289	13.4	-6.96
10	Fibre crops	0,079	8,000	2,653	2,726	102.8	1.18
11	Tobacco	0,966	0,966	0,966	0,000	0.0	0.00
12	Hops	1,000	2,000	1,538	0,504	32.8	11.36

Source: own processing according to EUROSTAT data

Average production yield in organic farming (kg/ha): The annual growth rate of the average yield in organic crops varies from 1.18% / year for hemp for fiber to 11.36% / year for hops. Table no. 5, col 7. The coefficient of variability is CV <10% in rapeseed crops (7.6%) and sunflower (8.0%), which means that the dispersion of data around the average is homogeneous in wheat crops (19%) and soybeans (13.4%), the samples are relatively statistically homogeneous (10% <CV <20%), for rice crops (21.9%) and maize grains (26.8%) the samples are relatively heterogeneous (20% <CV <30%), and for hops (32.8%) and hemp for fiber (102.8%) there are very large variations in yield, samples being heterogeneous (CV > 30%). The explanation for statistically unrepresentative samples is given in the fact that production yields fluctuate from year to year due to climatic conditions. Table no. 5, col 6 and col 7.

Table no. 6: Yield per hectare 2012-2019 in conventional system

Nr. crt	Specification	Minimum Kg/ha	Maximum Kg/ha	Average 2012-2019 (Kg/ha)	Ab std. (Kg/ha)	CV (%)	Rate annual of growth (%)
0	1	2	3	4	5	6	7
1	Wheat and spelt	2652	4888	3983	783	19.7	3.30
2	Barley	2613	5090	4058	818	20.1	3.29
3	Grain maize and corn-cob-mix	2180	7644	4896	1749	35.7	4.64
4	Rice	3551	5384	4640	558	12.0	0.56
5	Potatoes	10579	18759	15668	2707	17.3	-1.13
6	Sugar beet	26363	44711	38427	5450	14.2	1.76
7	Rape and turnip rape seeds	1496	2835	2431	422	17.4	2.34
8	Sunflower seed	1310	3041	2244	613	27.3	5.72
9	Soya	1308	2748	2242	456	20.3	3.61
10	Fibre crops	256	5913	3170	2227	70.2	43.17
11	Tobacco	1066	1788	1455	213	14.7	-1.47
12	Hops	546	1103	833	170	20.4	3.43

Source: own processing according to EUROSTAT data

Average yield of production in the conventional system (kg/ha): The annual growth rate of the average yield of crops in the conventional system varies from -1.47% / year (tobacco) to 43.17% / year (hemp for fiber) . Table no. 6, col 7. The coefficient of variability has values between 12% (rice) and 19.7% (wheat), which means relatively homogeneous production yields from one year to another (10% <CV <20%); values between 20.1% (barley) and 27.3% (sunflower) (20% <CV <30%) - production yields being relatively heterogeneous from one year to another; and values between 35.7% (grain corn) and 70.2% (hemp for fiber) - production yields being heterogeneous (CV > 30%). Table no. 6, col 6.

Table no. 7: Comparison of yields obtained in the conventional system and in organic farming, 2012-2019

Nr. crt	Specification	Average yield Conv kg/ha	Average yield Eco kg/ha	% of conventional yield
0	1	2	3	4
1	Wheat and spelt	3983	3447	86.54
2	Barley	4058	2672	65.85
3	Grain maize and corn-cob-mix	4896	4842	98.91
4	Rice	4640	4378	94.35
5	Potatoes (including seed potatoes)	15668	8026	51.22
6	Sugar beet (excluding seed)	38427	23091	60.09
7	Rape and turnip rape seeds	2431	2340	96.25
8	Sunflower seed	2244	2196	97.87
9	Soya	2242	2163	96.46
10	Fibre crops	3170	2653	83.69
11	Tobacco	1455	966	66.40
12	Hops	833	538	64.58

Source: own processing according to EUROSTAT data

The results show that organic yields represent over 51.2% (potatoes) and 98.9% (grain corn) of conventional yields, but the variation is significant at conventional yields. Table. no. 7 col 4.

With regard to the livestock sector, analyzed for species from the conventional system and from organic farming, the changes in the sector are due to variations, both in terms of numbers and production.

Table no. 7: Livestock in the conventional system (number), by species, 2012-2019

Nr. crt	Specification	Minimum (mii capete)	Maximum (mii capete)	Average period 2012-2019 (thousand heads)	Standard deviation (thousand heads)	Coefficient of variation (%)	Rate annual of growth (%)
0	1	3	4	5	6	7	8
1	Cattle	1923	2092	2019	298	14.8	-0.42
2	Cows and buffaloes	1139	1193	1172	153	13.1	-0.34
3	Swine	3834	5234	4657	797	17.1	-4.11
4	Sheep	8834	10359	9711	676	7.0	2.45
5	Goats	1266	1595	1445	251	17.4	3.24
6	Poultry	73289	80136	76501	3657	4.8	-0.72

Source: own processing according to INS TEMPO ONLINE data

Livestock in the conventional system (number): In the period 2012-2019 the annual growth rate is significant for sheep (2.45% / year) and goat species (3.24% / year). The sheep species also has a coefficient of variability of less than 10%, which means that the deviations from the average are not significant, the sample being statistically representative. A significant reduction occurs in the porcine species (-4.11% / year). The explanation is due to the appearance of swine fever which has reduced the number of species.

Table no. 8: Animal production obtained in the conventional system, by species, 2012-2019

Nr. crt	Specificare	Minimum (mii capete)	Maximum (mii capete)	Average period 2012-2019 (thousand heads)	Standard deviation (thousand heads)	Coefficient of variation (%)	Rate annual of growth (%)
0	1	3	4	5	6	7	8
1	Milk (thousand hl)	42113	46615	44222	1436	3.2	-0.68
2	Beef (thousands of tons)	179	206	193	9	22.19	-1.50
3	Pork (thousands of tons)	512	588	554	25	5.27	-0.84
4	Sheep and Goat Meat (thousand to)	104	127	113	7	4.74	2.77
5	Poultry meat (thousand tons)	457	672	549	76	13.35	4.66
6	Eggs (mil.)	5564	6636	6179	391	6.3	- 1.19

Source: own processing according to INS TEMPO ONLINE data

Conventional total livestock production (hl/thousand tons/mil.): The annual growth rate of animal production is significant for sheep species (2.77%/year) and poultry meat (4.66%/year). The coefficient of variability in milk products (3.2%), pork (5.27%), sheepmeat (4.74%) and eggs (6.3%) is less than 10%, which means that deviations from the average are not significant, the sample being statistically representative, except for beef production, where it is found that variations in production compared to the average are large, the CV being 22.19%.

Livestock in organic farming (number): In the period 2012-2019 the annual growth rate is significant for goat species (17.94% /year) and poultry (10.04% /year). The other species analyzed have negative annual growth rates: live cattle (-0.64% /year), dairy cows (-7.67% /year), live pigs (-40.58% /year), sows (-41.01% /year), fattening pigs (-39.63% /year), sheep (-13.09% /year), laying hens (-1.91% /year), coefficient of variability for organic herds ranging from 25.1% (dairy cows) to 141% (fattening pigs) which means that the samples are heterogeneous and not statistically representative. (**Source:** own processing according to EUROSTAT data)

Total organic livestock production (hl/ton/pc): The annual growth rate of organic livestock production is found in the product eggs (1.1% / year), milk (-1.3% /year) and butter (-1% /year). The coefficient of variability is 4.9% for the raw milk product, 24.6% for the butter and 26.8% for the egg product. The organic products analyzed were meat, raw milk, butter, cheese, eggs. (**Source:** own processing according to EUROSTAT data)

Operators in organic agriculture: In Romania, the number of organic agricultural producers is decreasing (9277 producers in 2019), the minimum is met in 2017 (7908 producers), and the maximum in 2012 (15280 producers). The average growth rate is negative (-6.88%/year). Instead, we find increases in the number of processors (8.9%/year), importers (34.6%/year) and exporters (25.8%/year). The coefficient of variability is relatively homogeneous for producers (25.5%) and processors (22.6%), the samples being unrepresentative (CV > 30%), for importers (CV = 94.6%) and exporters (CV = 88, 6%).

CONCLUSIONS

The study highlights the existence of organic farming in Romania, with areas (2.5%) and yields that vary significantly from year to year. The analysis reveals that the difference in ecological / conventional yield varies depending on the crop and can occupy weights of over 90% of the conventional. Lower production yields can be an obstacle to the development of organic farming and partly explain the reduction in conversions in recent years. The reduction in the number of conversions is also due to "difficulties encountered by organic producers in finding customers, but also insufficient revenue to cover certification fees" (4). In the conventional livestock sector, there are increases in sheep and goats, with significant reductions in pigs, and in organic farming there are increases in goats and poultry.

The study also signals the existence of processors, importers and exporters, but also the existence of the market for organic products, especially retail sales. The analysis reveals an increase in the number of importers, which means more imports due to the Romanian consumer's demand for organic food, Romania thus becoming a market for imported organic products, but also a competitor.

Future research should focus on assessing the performance of both types of agriculture, at the economic level, at the management and marketing level in organic farming.

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