DYNAMICS OF ORGANIC AGRICULTURE IN ROMANIA - COMPARATIVE ANALYSIS FOR 2010-2022 PERIOD

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Abstract: *The study analyzed the dynamics of economic operators and the areas cultivated in ecological systems in Romania, in the 2010–2022 period. For the analysis, data from the MADR records were considered. For the analysis, data from the MADR records were considered. The total crops area in the ecological system registered an increasing trend, with some inflections and linear growth in the period 2016-2022. Within the total crops area, the area of grain, pasture and hay crops showed a similar pattern of variation. The leguminous and protein crops showed a fluctuating variation of the surfaces, with a maximum in 2018. Tuberculiferous and root crops recorded the maximum value of the cultivated area in 2012, followed by a decreasing trend. Industrial crops registered an increasing trend throughout the study period. Permanent crops (orchards, vines, fruit trees, nuts) recorded a growth rate in the period 2010-2019, with a stabilization of the surfaces in the period 2019-2022. Different models were obtained to describe the variation of the elements analyzed during the study period.*

Key words*: crops dynamics, ecological farming, economic operators, factors, variation patterns*

INTRODUCTION

Conventional agriculture ensures high crop yields, but associated with it, a series of sustainability and durability effects have been registered [11]. As an alternative to conventional agriculture, the author estimates the perspective of ecological agriculture, with ecological and socio-economic advantages over time.

Ecological farms generate lower yields, compared to conventional farms, but they present a series of advantages in that they provide better food from a nutritional point of view, reduce residues, integrate secondary products (circular economy), and are generally more friendly to the environment [19,17].

The food resources generated by ecological agriculture fall into a market segment that has recently registered an upward trend, in the global agri-food chain [18]. The authors of the study analyzed key parameters of ecological agriculture and identified advantages, but also some barriers to the expansion of these agricultural systems.

As complementary systems of the production of food resources, ecological agriculture systems contribute to the sustainability of the environment, the food system, and society as a whole [15]. Compared to conventional (intensive) agriculture that promotes high yields, ecological agriculture promotes ecological variables (e.g. biodiversity, biotic abundance, soil carbon, etc.) with beneficial effects for environmental sustainability [20]. Ecological agriculture has emerged as an alternative to conventional agriculture, and promotes ecological services, with benefits to the environment and the quality of food resources [4,8]. At the same time, ecological agriculture benefits from the innovative facilities offered by related fields, such as biotechnologies, informatics, artificial neural networks (ANN), artificial intelligence (AI), remote sensing and GIS.

At the level of the European Union, the objective regarding ecological agriculture provides for the increase of surfaces by 25% until the year 2030 [3].

The present study evaluated the dynamics of operators and areas by crop category in the field of organic agriculture in Romania, for the period 2010 - 2022.

MATERIALS AND METHODS

The study analyzed the variation of some parameters specific to organic agriculture during the period 2010 - 2022 in Romania. The annual data recorded by MADR [24] were analyzed for the study.

Parameters related to ecological agriculture were considered, according to the recorded data: operators certified in ecological agriculture (OCEA), total area in ecologic agriculture (TAEA), total grains (TGS), dry and proteinaceous legumes for seeds production (DPLS), tuberculiferous and root plants (TRP), industrial crops (IC), green harvested plants (GHP), other crops on arable land (OCAL), fresh vegetables including melons and strawberries (FVMS), permanent crops orchards, vines, fruit bushes, nuts (PCOV), permanent pasture and hay crops (PPHC), uncultivated land (UL). To facilitate the analyzes and graphical representations in the present study, abbreviations were used for the parameters, presented in parentheses.

The data were analyzed for general statistical characterization, to evaluate the level of variability of the considered parameters over time, during the study period, and to evaluate certain interrelationships between the parameters in the analyzed period.

Appropriate mathematical and statistical tools were used to analyze the data series, in relation to the purpose of the study [9].

RESEARCH RESULTS

The data related to ecological agriculture, which include operators, categories of crops and areas for the considered study period, 2010 - 2022, were analyzed for a descriptive statistical characterization. The obtained results are presented in table 1.

Table 1.

Descriptive statistics for the characterization of ecological agriculture indicators in Romania, period 2010 - 2022

Parameter	OCEA	TAEA	TGS	DPLS	TRP	IC	GHP	OCAL	FVMS	PCOV	PPHC	UL
N	13	13	13	13	13	13	13	13	13	13	13	13
Min	3155.0	182705.8	72297.8	1834.35	269.17	44788.7	4788.49	0.00	734.32	3093.04	31579.10	2333.95
Max	15544.0	644519.7	160154.7	8751.13	1124.92	116506.	78241.7	851.44	1928.36	22219.4	257062.2	10216.8
Sum	143823.	4435366.	1384787	59306.8	8062.73	905864	373719	2918.48	15108.6	175911	1408419	101732
Mean	11063.3	341182.0	106522.1	4562.06	620.21	69681.8	28747.7	224.50	1162.20	13531.6	108339.9	7825.57
Median	10562.00	289251.8	105149	4994.66	626.99	54145.2	14280.5	157.86	1067.67	12019.8	95684.78	8810.73
25 prcntil	9355.50	237934.8	80303.25	2355.89	445.83	49825.2	12133.5	28.82	872.06	8590.82	62251.04	6438.22
75 prcntil	13865.00	432057.6	130506.6	6109.22	723.89	85916	45689.5	310.09	1343.03	21398.4	135329.2	9632.14
Geom. mean	10402.27	318134.3	103284.3	4033.379	569.306	65971.4	20711.8	0	1111.13	11555.2	92828.35	7372.16
Coeff. var	30.244	41.589	26.017	49.445	42.240	36.023	86.809	111.533	32.892	50.962	60.359	29.273

Source: results obtained through the statistical analysis of the data communicated by [24]

Wide variations of the parameters considered, related to ecological agriculture, were found during the study period. To quantify the amplitude of variation, the coefficient of variation (CV) was used.

Based on the values of the coefficient of variation (CV), resulting from the statistical analysis, the variability of the categories of elements specific to organic agriculture in Romania, for the study period, was assessed.

Moderate variability was recorded in the case of total grains (ha), TGS (CV=26.017). The highest level of variability was recorded in the case of other crops in arable land (ha), OCAL (CV=111.533). This can express the high diversity of crop plants

(OCAL category), the attempt of operators in organic agriculture in Romania to cultivate different crop plants, in order to better valorize the products obtained on the market.

The diversity of crops in the ecological system was studied and analyzed in relation to biodiversity, ecosystem functionality, ecological and socioeconomic sustainability of ecological agriculture, but also in relation to other criteria [10,14,21].

In the case of the other parameters, operators certified in ecological agriculture (OCEA), total area in ecological agriculture (TAEA), and crop categories, high variability was recorded, as follows: CV = 30.244 in the case of OCEA; CV = 41.589 in the case of TAEA; CV = 49.445 in the case of DPLS; CV = 42.240 in the case of TRP; CV = 36.023 in the case of IC; CV = 86.809 in the case of GHP; CV = 32.892 in the case of FVMS; CV = 50.962 in the case of PCOV; CV = 60.359 in the case of PPHC; CV = 29.273 in the case of UL.

Variability was an important indicator in the analysis of agricultural systems and technologies [7,16]. Variants of agricultural technologies and practices were analyzed in relation to the sustainability of plant production systems [6,8]. The stability and variability of production was analyzed in relation to organic and conservative agriculture [12]. The yield variability of different crops was evaluated under the specific conditions of organic systems, in relation to the environmental benefits [20]. The variability of crop production in ecological systems compared to conventional systems was analyzed in relation to the crop plant, environmental conditions and soil conditions [5].

Multiparameter analysis (PCA) was used to obtain the distribution diagram by crop categories in the ecological system (biplot parameters) and years during the study period. The crop categories (abbreviation codes in the diagram) were taken into account, with the related areas during the study period. PC1 explained 65.752% of variance, and PC2 explained 12.79% of variance. The PCA diagram is presented in figure 1, and the representation of the components in relation to Eigenvalue (%) is presented in figure 2.

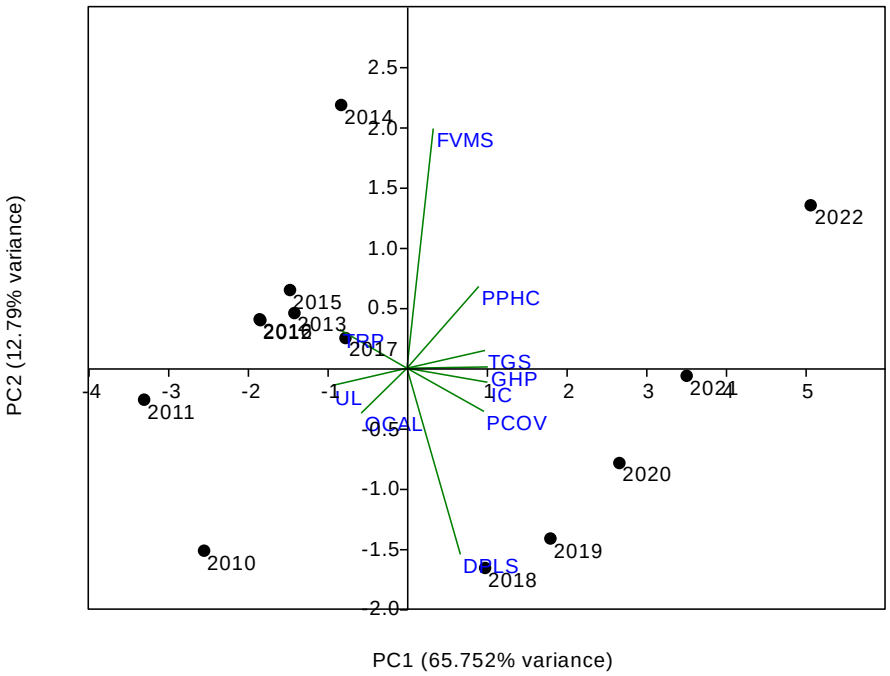


Figure 1. PCA diagram with the representation of crop categories (in code format) in relation to the years during the analysis period

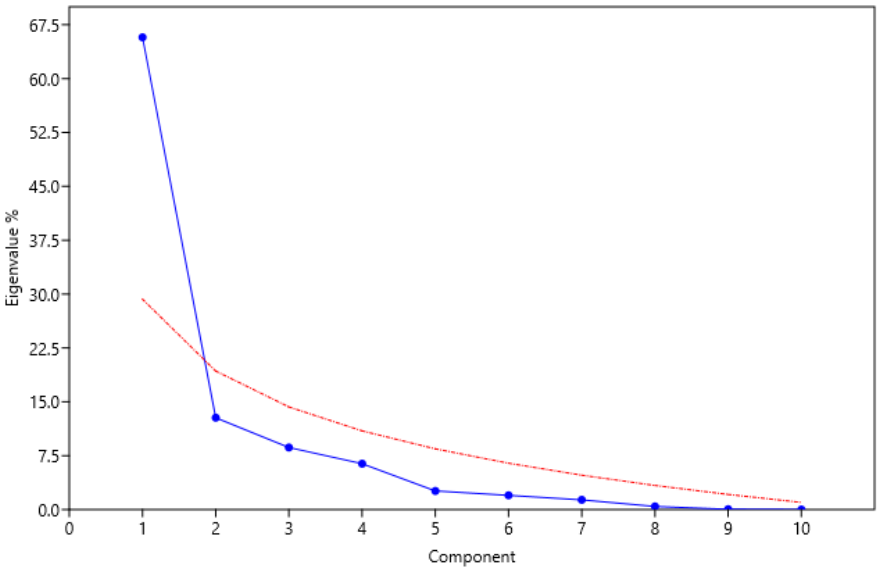


Figure 2. Representation of components in relation to Eigenvalue (%)

A hierarchization, of the ranking scaling type, resulted in the representation of the categories of crops in the ecological system (abbreviated codes) and interevent distance, in relation to the values recorded during the study period. The graphic representation is presented in figure 3.

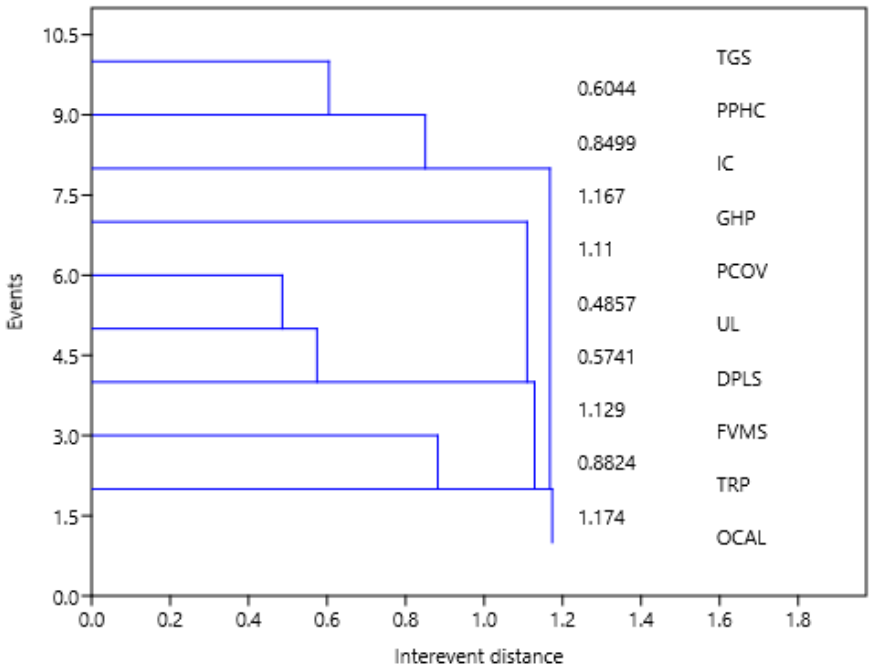


Figure 3. Ranking scaling representation of crop categories in the ecological system, MADR database, Romania, period 2010 – 2022

Principal Components Analysis has been used in various studies to analyze some ecological and socioeconomic factors associated with sustainable agriculture and ecological agriculture [13,23].

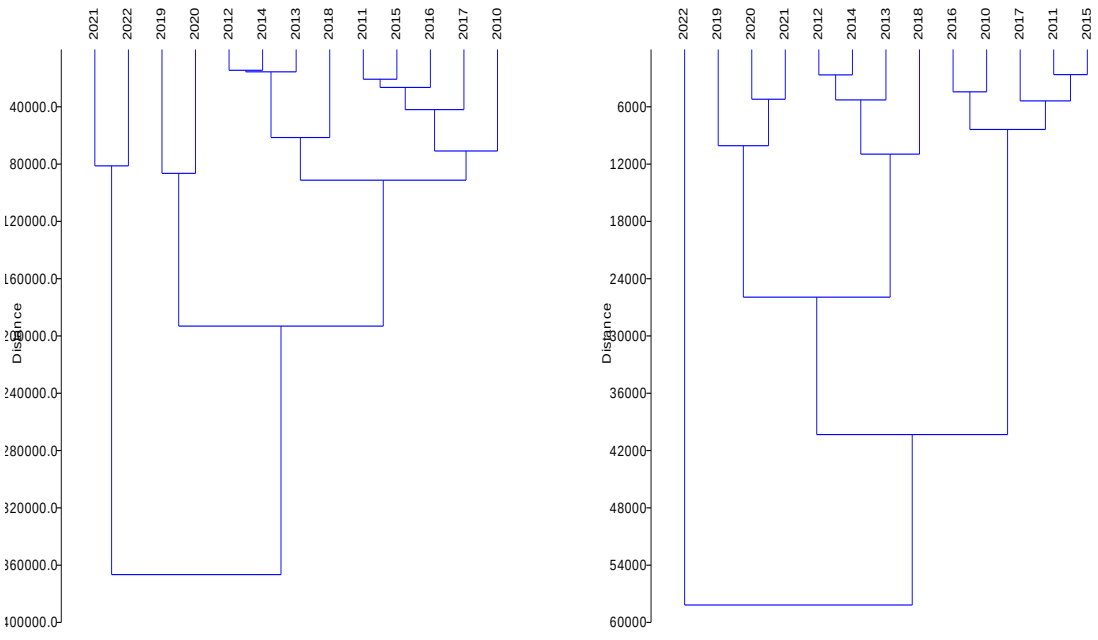
Each category of crops in the ecological system provides certain types of resources with certain quality indices, superior to conventional agricultural systems, products destined for fresh consumption, the food industry, but also for other economic sectors.

A wide variation of the cultures (categories of cultures) was found during the study period, assessment based on the coefficient of variation.

The cultures were analyzed according to certain classification categories, and were evaluated by cluster analysis, in order to capture the degree of similarity in time (years) during the study period.

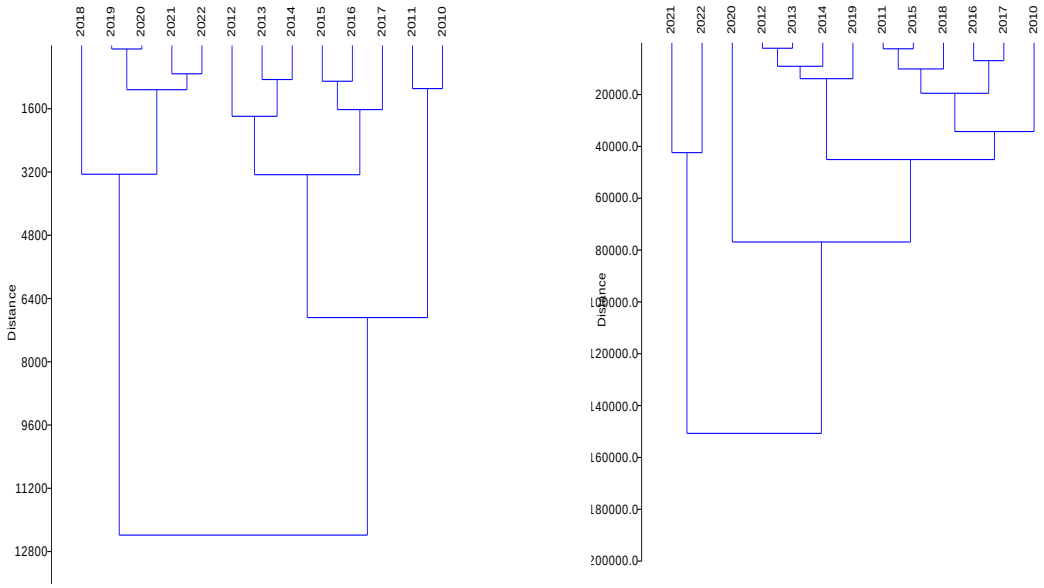
From the general analysis of all parameters (12 parameters, Table 1) associated with organic agriculture in Romania, during the study period, the value of Coph. corr = 0.901. From the analysis of the first two parameters (OCEA, and TAEA), the cluster analysis led to similar values, respectively Coph. corr = 0.902. Based on TGS and DPLS, the cluster analysis led to the Coph value. corr = 0.788 (Coph.corr = 0.791 in the case of TGS; Coph.corr = 841 in the case of DPLS). Based on TRP and IC, CA analysis led to Coph. corr = 0.900 (Coph.corr = 0.878 in the case of TRP, Coph.corr = 0.900 in the case of IC). Based on horticultural crops (FVMS, and PCOV), the CA analysis led to Coph.corr = 0.863, with the value Coph.corr = 0.893 in the case of FVMS, respectively Coph.corr = 0.865 in the case of PCOV. In the case of PPHC, the CA analysis led to the value Coph.corr = 0.904. In the case of the GHP category, CA led to the value Coph.corr = 0.915. In the case of the OCAL category, CA led to the Coph.corr value = 0.888. In the case of the UL category, CA led to the Coph.corr value = 0.889. Among the resulting dendrograms, the general dendrogram (all categories of parameters, figure 4 (a), for TGS and DPLS, figure 4 (b), for FVMS and PCOV, figure 5 (a), and respectively for PPHC figures 5 (b)) are presented as examples.

Cluster analysis was used in studies regarding the classification of farms in conventional and alternative systems of studies of agricultural systems [2], for the study of ecological agriculture models [1], the study of the sustainability of organic farms [22].



(a) all EA indicators (b) TGS, DPLS

Figure 4. Dendrogram representing EA indicators by year (a) of the TGS and DPLS category (b)



(a) FVMS, PCOV (b) PPHC

Figure 4. Dendrogram representing the FVMS and PCOV indicators (a) and the PPHC category (b)

The variation of TAEA in relation to each category of crops in the ecological system was described by different types of equations, under conditions of R^2=0.958, p<0.001 in relation to TGS; R^2=0.315, p<0.151 in relation to DPLS; R^2=0.827, p<0.001 in relation to TRP; R^2=0.915, p<0.001 in relation to CI; R^2=0.950, p<0.001 in relation to GHP; R^2=0.177, p=0.376 in relation to OCAL; R^2=0.112, p=0.552 in relation to FVMS; R^2=0.718, p<0.05 in relation to PCOV; R^2=0.933, p<0.001 in relation to PPHC. From the analysis of the values of the regression coefficient and the safety parameter (R^2, p), it was found the differentiated contribution of the categories of crops in the ecological system to the formation of TAEA during the study period.

The average values regarding the annual growth rates (variation) of cultivated areas in the ecological system were analyzed at the EU level in relation to the target objective of 25% growth until 2030 [3]. The authors of the study communicated encouraging values in this regard, in relation to the proposed objective. In Romania's conditions, the present study identified a decreasing trend in the period 2010-2016 (for most of the analyzed categories) and an accelerating trend, in the period 2017-2022.

CONCLUSIONS

From the analysis of the EA indicators registered in Romania, period 2010 - 2022, a differentiated variation was found in relation to the indicator and the study interval.

For most crop categories, the areas recorded a decrease in the period 2010-2016, and an increasing trend in the period 2017-2022.

Adequate statistical indicators described the behavior of the analyzed AE indicators, with different levels of variability. Mathematical models described the variation of TAEA in relation to each category of crops, under conditions of statistical safety.

The growth rate of the areas in the AE system in Romania, for the analyzed crop categories, falls within the trend at the EU level, and in relation to the EU program to increase the AE areas by 25% until the year 2030.

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