ASSESSMENT OF THE CORELATIONS BETWEEN THE AGROECOSYSTEM COMPONENTS AND FOOD SECURITY DOMAINS. CASE STUDY – REPUBLIC OF MOLDOVA

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Abstract. The productivity of the agroecosystem is a function directly dependent on the interaction between: *the environment – social factors – agricultural systems*. In the framework of this research, the interaction principles of the structure and functionality components of the field crops agroecosystems in the agri-food system in the production conditions of the agricultural households in the Central Zone of the Republic of Moldova and the impact on the dimensions of food security were studied. The assessment for a period of 41 years of the central properties of structure and functionality of the agroecosystems of winter wheat, sunflower and grain corn crops*: (i) productivity; (ii) stability; (iii) sustainability; (iv) fairness; (v) autonomy,* denotes *the variable character of productivity*, highlighting aspects of agroecosystem instability. A factor that influences the productivity of the agroecosystems of the researched crops is the difference in the harvest indices, which in percentage values are approx. 40% for winter wheat crop, 35% for sunflower and 45% for grain corn crop. The variable character of productivity deregulates the functional criterion such as agroecosystem efficiency. The factor generating agroecosystem instability for the researched crops is the inefficient use of agricultural potential at the national level, especially of soil resources. Agroecosystem dysfunctions affect the dimensions of food security such as: 1) the physical availability of food; 2) economic and physical access to food; 3) the use of food; and 4) the stability of the three dimensions over time, which consequently causes food insecurity in the Republic of Moldova.

Keywords: agroecosystem, agrochemical degradation, winter wheat, sunflower, corn, food security.

INTRODUCTION

Plant production, useful as a food source, "is the result of the joint action of the essential resources of the biosphere: climate, soil, water and cultivated varieties. The interference of these resources, which contribute to obtaining the fraction of biomass that can be used directly in human and domestic animal food or for well-defined economic purposes (fibbers, energy, etc.) takes place inside the agroecosystem.

The main processes in the agroecosystem are regulated by human factors through various management systems, interfering in biological processes, the biotic subsystem (soil-plant-animal), physical-climatic and socio-economic processes (Coste and Borza, 2003).

From the perspective of the contemporary development of agroecology, (Conway, 1986) describes the agroecosystem based on five central properties of structure and functionality: (i) productivity – that represents the amount of products such as agrifood, fuel or fibber that an agroecosystem produces for human use; (ii) stability – refers to the consistency of production in the agroecosystem, valued as the main agricultural product; (iii) sustainability – is tangential to maintaining a specified/planned production level over a determined period of time; (iv) equity – refers to the distribution of agricultural production in an equitable manner; (v) autonomy –the individual self-sufficiency capacity of an agroecosystem".

According to the researcher (Gerald, 1988), "the productivity of the agroecosystem is a function directly dependent on the interaction between: the environment - the social factor - the agricultural systems". From the perspective of productivity evaluation, agroecological researchers recommend "drawing special attention to the relationship between agroecosystems and agricultural technological systems, based on the appreciation of the agroecosystem as a functional unit of the biosphere created and maintained by human factors in order to obtain biomass intended for self-consumption.

An agricultural technological system represents the total spectrum of technologies used by the farmer or an agricultural community to shape a natural ecosystem from a well-defined geographic perimeter into an agroecosystem" (Gerald, 1988; Miguel and Clara, 2005).

Currently, in the process of greening the entire food system, agroecology pays special attention to strengthening the levels of food security and nutrition.

The increasing demand in agri-food products at the international level caused by population growth, the modification of the food diet richer in proteins, taste aspects and the diversification of product demands and the tendency of economies to replace fossil oil with bio-oil, creates a state of pressure on the agri-food system, generating multiple vulnerabilities and risks for the food security environment.

Another factor that generates pressure on agricultural production resources is "population growth in certain regions of the Earth, as well as the orientation of the human population towards a diet richer in animal products, against the background of the decrease in vegetable and cereal production in particular, as a consequence of the reduction of arable surfaces per inhabitant, as well as result of soil degradation or reaching genetic and technological limits for crop diversification, are serious consequences for the food security of the population and future generations" (Axinte et al., 2004).

Ensuring the food security of a state's population is primarily the government's obligation and the responsibility of public and private entities involved in the management of the agro-industrial sector for the production and processing of agrifood products. A state must efficiently and rationally manage its resources and provide the population with the necessary products according to food security criteria, during the entire period from the identification of problems, to finding solutions and recording the positive effects.

Therefore, the food security of the country, which according to the FAO criteria [10], "exists when all people, at any time, have physical and economic access to food that is sufficient in quantity and quality, healthy and diversified to ensure the nutritional elements that meet their needs of food for a healthy and active lifestyle, depends to a large extent on the state and level of productivity of the agroecosystems that are the basis of the country's agro-industrial system".

On the other hand, the inefficient use of agricultural potential represents a threat to the security and food independence of the country and this problem must become a concern of scientists to regulate the efficacy of using of natural resources, energy products introduced into the agri-food system and socio-economic relations at all levels of structure and functioning of an agroecosystem.

The contemporary conceptual framework (8; 9) proposed by the FAO of food security "is based on two groups of determining factors, as follows: physical factors and temporal factors. From the category of physical factors according to FAO we can list: *availability, accessibility and use*. In the category of physical factors are included the elements that refer to ensuring stability".

From the perspective of food security and nutrition (Rainer et al., 2000), "availability consists in the physical existence of agri-food products, ensured by production from domestic resources or from imports from the international market. At the national level, food availability is a combination of production from national resources, imports from other food markets, food aid and food storage within urban households".

In terms of defining food security (Axinte et. al., 2004; Rainer et. al., 2000), "accessibility represents the state when all individuals within the national territory have sufficient resources to produce food according to the nutritional diet. This factor is dependent on household resources – capital, labour force, knowledge – and costs. It should be noted that adequate accessibility can be ensured without the involvement of the agro-industrial production sector. In such a case, the ability of the households to produce sufficient income, which cumulatively with domestic production could ensure the required level of agrifood products, becomes relevant.

„Food use (Boincean and Dent, 2020; Racoviţa, 2014) refers to the socio-economic aspects of food security, the composition of the consumed food, aspects related to the social function through which food can have community cohesion through the consumption offer, food traditions and rituals. All these socio-economic aspects are determined by knowledge and habits. The focus on the individual level of food security must be taken into account and refers to the ability of the human body to receive food and convert it into energy, which is used either to carry out daily activities, either to be stored".

Stability or sustainability refers to the temporal dimension of food security and involves access to adequate food for the population in any period of time, ensuring an adequate food supply process corresponding to consumption. In some literature sources, there is a distinction between: (i) chronic food insecurity, which involves the inability to meet food needs on an ongoing basis, and (ii) transit food insecurity, when the inability to meet food needs is of a temporary nature.

Transitory food insecurity is sometimes divided into two subcategories: (a) cyclical, when there is a regular factor of food insecurity, such as the period of insufficiency food in the period leading up to the harvest of agricultural crops, and (b) temporary, which it is the result of short-term, exogenous shocks such as droughts or floods (19; Young et al., (2001). The above listed characteristics ensuring food security, such as: availability, accessibility, utilization and stability, are similar to the characteristics of the structural properties of the agroecosystem, which include - productivity, stability, sustainability and equity.

Thus, we observe an interdependent conceptual correlation, as the principles of functionality and structure of the agroecosystem by definition have the objective of satisfying the criteria and indicators of food security and safety.

Such a trend is highlighted in the basic directives of the agroecological development strategy of agrifood systems proposed by agroecology. Thus, the researchers from the agroecological area propose "based on the data on the agricultural production of the agroecosystem of the main crops, from the national agricultural system, by transforming them into energy and protein units and based on the data on their need in the national agrifood system, to determine the optimal share of different agroecosystems, to ensure these needs on the smallest possible surfaces and with the lowest possible energy and material consumption" (Conway, 1986).

The assessment of the structure and functionality criteria of the agroecosystems of field crops in the agricultural production system at the national level, as well as diagnosing systemic dysfunctions, allows us to identify models for ensuring food security at the level of the country, region or local community, in accordance with the bioproductive potential of natural resources and domestic consumption needs.

MATERIALS AND METHODS

Scientific researches on the agroecosystem productivity of crops - winter wheat, sunflower and corn, in real production conditions, was carried out for the years 2012, 2013 and 2014, within the agricultural households: SRL "Trofion", Chiştelniţa village and SRL "Tîrşiţei Agro", Tîrşiţei village, both from Teleneşti district, from the Republic of Moldova which correspond to the pedoclimatic zone of location of ecopedologic polygons 11, 12 and 14 of IPAPS "N. Dimo" (Cerbari, 2010). The determination of productivity indicators was carried out according to the metric method for winter wheat and the linear method for sunflower and corn. Based on the methodology in the field of pedology, the ratings of the biotope for the cultivation of agricultural crops were determined within the households selected for research, in order to determine the potential productivity values depending on the soil fertility (Andrieş et al., 2010; Andrieş and Leah, 1999). Applying the methodology recommended by IPAPS "N. Dimo" the values of the indicators of the potential harvest were calculated depending on the amount of atmospheric precipitation during the research years. The evaluation of the quantitative, economic and energy parameters within the agroecosystems of the studied crops were determined and assessed according to the Technological Sheet applied by the mentioned agricultural households, using the methodology recommended by Afanasiev, V., 1989 and Pimentel, D., 2008 (Pimentel and Pimentel, 2008; Afanasiev, 1989). The determination of the structural and functionality components of the agroecosystems of the researched crops have been studied for the years 1989-2021, based on the data provided by the National Bureau of Statistics of the Republic of Moldova. The data and the results have been assessed and processed using Excel 2010 software.

RESULTS AND DISCUSSIONS

The particularities of the organization and operation of the agroecosystems of field crops, which are components of the agricultural productive system, are of strategic importance for ensuring the environment of food security for the individual, community and national level.

The food security is one of the pillars of national security, which exists only when "the state has sufficient availability of agricultural and food products, which are able to cover the food needs of all the inhabitants within its borders and ensure, at the same time, the necessary stocks of fodder for animals, but also water in situations of natural calamities, war, social and economic crises at the level of regions or the whole country" (10). The strategic visions and priorities on ensuring the country's food security are described in the National Security Strategy approved by Parliament Decision no. 153 as of 15.07.2011, which in point 4.11 defines food security as one of the ways to ensure national security (28).

The concept of food security of the Republic of Moldova was developed and adapted according to the security environment in the reference period in the context of elaborating the Food Security Strategy (FSS) of the Republic of Moldova for the years 2023-2030, approved by the Governmental Decision no. 775 as of 09.11.2022, providing the definition of food security adopted at the World Food Summit in 1996 (24).

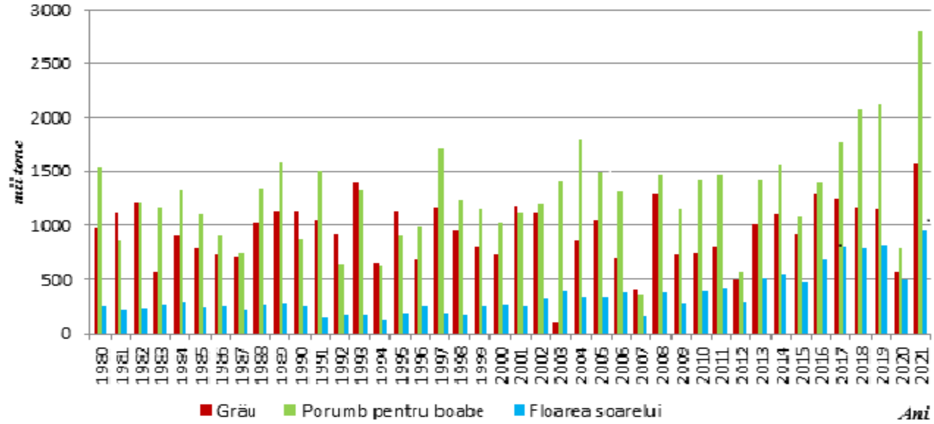
It is worth mentioning the fact that SSA is approached through the prism of the four dimensions of food security and resides in: 1) the physical availability of food; 2) economic and physical access to food; 3) the use of food; and 4) the stability of the three dimensions over time.

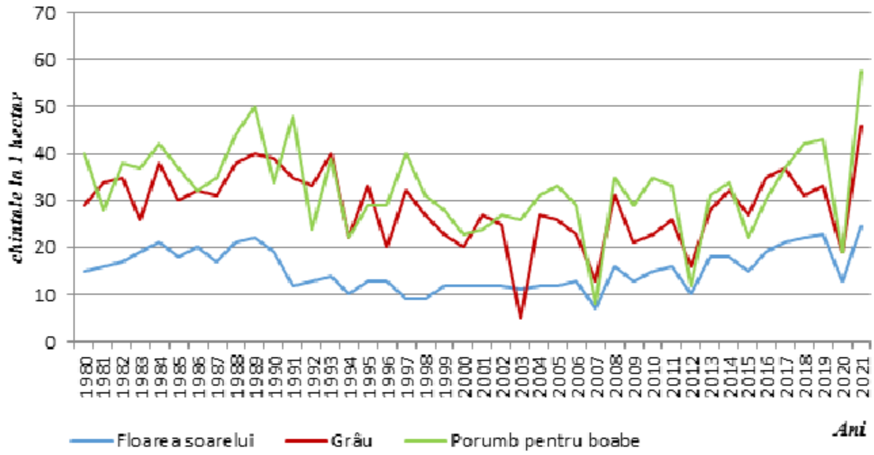
Researches on the correlation between the components of the agroecosystems of the studied crops demonstrate that productivity exerts an influence on the food security component such as availability - which signifies the physical existence of agri-food products from national resources, from imports, food aid and food stores within urban households.

Analysis of the functionality principles of the agroecosystems of the crops - winter wheat, sunflower and corn, for a period of approx. 41 years, based on the values of the global harvest and the average harvest per hectare, denotes the variable nature of productivity for each crop, evaluated according to the Conway model (Conway, 1986) and shown in figure 1.

In accordance with this research, it has been established that a factor influencing the productivity of the agroecosystems of the researched crops is the difference in the harvest indices, which in percentage values are approx. 40% for the winter wheat, 35% for the sunflower and 45% for the corn under the conditions of the studied agricultural years.

The difference between the indicators of the average harvest in the field and the values of the statistical average harvest, which were the basis for evaluating the effective productivity of the researched agroecosystems, deregulates the functional criteria - *the agroecosystem efficiency*, which according to S. Axinte 2004, expresses the system's ability not to record losses and is an economic expression, resulting in an input/output ratio, measured in a common unit - the farmer's profit, and influences food security dimensions such as *stability* and *sustainability*, which refers to the population's access to adequate food in any period of time and ensuring a process adequate food supply.





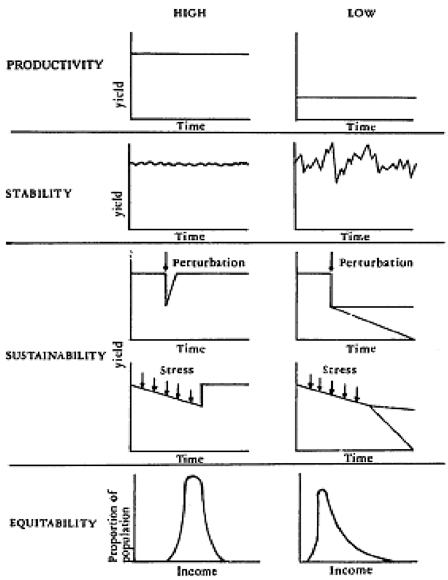


Figure 1. Comparative assessment of the structure and functionality criteria of the researched crop agroecosystems according to the G. Conway model (Conway, 1986)

The difference in harvest certified in the research reveals the insufficient appreciation of the bioclimatic potential of the agrifood production resources of the Republic of Moldova. The lack of an adequate appreciation of the production potential generates economic, social and ecological impact on the entire agri-food system. Moreover, the difference in productivity indices, which also contains a share of harvest losses, causes an additional load for each energy unit throughout the food chain.

Thus, the agroecosystems of the researched crops under current production conditions show indicators of reduced *functional efficiency*, which affects the good functioning of the entire agri-food system at the national level.

A threat to food security, as mentioned by A. Rusnac 2005, is also *"the lack of an objective system for presenting data in statistical reports in the agro-industrial complex"*, a phenomenon that was highlighted in the present research.

The difference in harvest highlighted in the research and the analysis of the average harvest indicators in the field and the statistical one, influences other criteria of agroecosystem structure such as *soil resources* and *their fertility*, amplifying dehumification (humic degradation) and agrochemical degradation of soils, qualified by I. Krupenicov (Andrieş, 2007), with number 1 and 2 in the list of the main forms of chernozem degradation (11 forms in total).

Considering the difference in harvest indicators highlighted in the research, the process of evaluating the export of nutritional elements and assessing the depletion of soil fertility is incomplete, because the values of the difference between the average harvest in the field and the statistical harvest or harvest losses is not included in any records to appreciate the total export of nutritional elements from agrocenoses.

The assessment of the export of nutrients from the soil, which is carried out through the main and secondary agricultural products of crops, is an important criterion for the oppression of nutrient regimes, the determination of the balance of biophilic elements in agriculture, the development of norms and the calculation of fertilizer norms (Miguel and Clara, 2005).

Research in the agrochemical field (Andrieş, 2007), reveals the legitimacy according to which the consumption and export of NPK from the soil is directly dependent on the harvest values. In the case of low harvests, the export of NPK is lower. Once crop values increase, NPK consumption by crop plants also increases and varies depending on crop quality.

It is worth paying attention to the fact that the differences in the harvest indicators do not include the part of humus mineralized in the soil by the researched crop plants. The comparative evaluation of the values of mineralized humus according to the values of the average harvest in the field and the values of the statistical harvest presented in table 1, we observe a difference of approx. 963 kg/ha, amount of humus that is not included in the evaluations of the dehumification processes of soils used in agriculture. In the case of sunflower, a value of 772 kg/ha is certified, and in the case of corn, 790 kg/ha.

The decrease in data on the productivity of agroecosystems is reflected in the inadequate assessment of soil degradation processes and does not allow the development of policies to improve soil fertility corresponding to the generating factors and the real physico-chemical and biological properties of the damaged soil.

The variable nature of productivity influences another functional criterion such as agroecosystem stability. The evaluation of the agroecosystems of the researched crops according to the model proposed by Gerald G. Marten [11] and the results presented in figure 2, allows us to appreciate the agroecosystems - winter wheat, sunflower and corn in the real production conditions of the Republic of Moldova, as *agroecosystems unstable but sustainable*.

Table 1

Values of the export of biophilic elements and the share of mineralized humus from the soil by year and the researched crops

Years of research	**Harvest indicators, SH/FH,** ***kg/ha***	**Export of biophilic elements,** ***kg/ha***			**C ratio from the C:N report,** ***kg/ha***	**Mineralized humus,** ***kg/ha***
		N	***P_2O_5***	***K_2O***		
Winter wheat						
2012	1200,0	42,6	12,8	40,3	426,0	710,0
	2708,0	78,0	29,4	62,4	624,0	1040,0
2013	2810,0	80,9	30,5	64,7	809,0	1348,3
	5529,0	154,6	55,6	135,3	1546,0	2576,7
2014	3300,0	93,1	34,3	76,2	931,0	1551,7
	6495,0	172,9	63,1	131,3	1729,0	2881,7
San flower						
2012	1030,0	74,0	20,6	116,4	740,0	1233,3
	1392,0	100,8	28,0	158,2	1008,0	1680,0
2013	2050,0	113,4	39,9	212,0	1134,0	1890,0
	3481,0	161,0	49,0	294,0	1610,0	2683,3
2014	1840,0	91,8	30,6	183,6	918,0	1530,0
	3373,0	156,4	47,6	285,6	1564,0	2606,7
Corn						
2012	1040,0	32,5	13,1	32,5	325,0	541,7
	-	-	-	-	-	-
2013	4330,0	92,9	38,7	96,3	929,0	1548,3
	7936,0	133,5	63,2	120,9	1335,0	2225,0
2014	4260,0	92,9	38,7	96,3	929,0	1548,3
	8746,0	147,0	69,7	133,1	1470,0	2450,0

*SH – statistical harvest

**FH – field harvest

The analysis of the obtained data shows that, a factor generating *agroecosystem instability* for the researched crops, is the inefficient use of the agricultural potential at the national level and especially of the soil resources, which according to the researcher in the field of agroecology S. Axinte 2004, is a agroecosystem structural criterion and refers to the volume of required resources.

Thus, the structure criteria: *resources*, *availability of resources*, *diversity*, generate impact on the dimension of food security such as accessibility, which requires that all individuals have sufficient resources, produce and procure food according to the diet.

The research results show that the agroecosystems of the studied crops occupy 1219 thousand ha of the total arable surface of 1600 thousand ha, in case of the Republic of Moldova. Researched crops have a different area from year to year, with an average over a period of 10 years (2012-2022) of the areas occupied by approx.: 346 thousand hectares for the winter wheat or - 23% of the total; 373

thousand hectares for sunflower or – 25% of the total; 500 thousand hectares or – 33% of the total in the case of corn.

Another 28 field crops, out of the total of 33 included in the statistical records, for the year 2021 occupied an area of approx. 86356 ha of the total arable area [23]. The NBS data research has highlighted that, although cultivated in the national agricultural system, certain quantities of the main agricultural product of the 8 mentioned crops are imported to ensure domestic consumption (26; 27; 28).

The results of the comparative evaluation of the data in table 2 show that, annually, approx.: 22367.3 t - fresh potatoes are imported; 89.7 t - soya; 3782.3 t - onion; 2717.0 t - cucumbers; 113.4 t - buckwheat; 16057.6 t - carrots, beetroot and other edible roots; 7301.3 t - tomato; 4377.8 t - cabbage, cauliflower and other similar products.

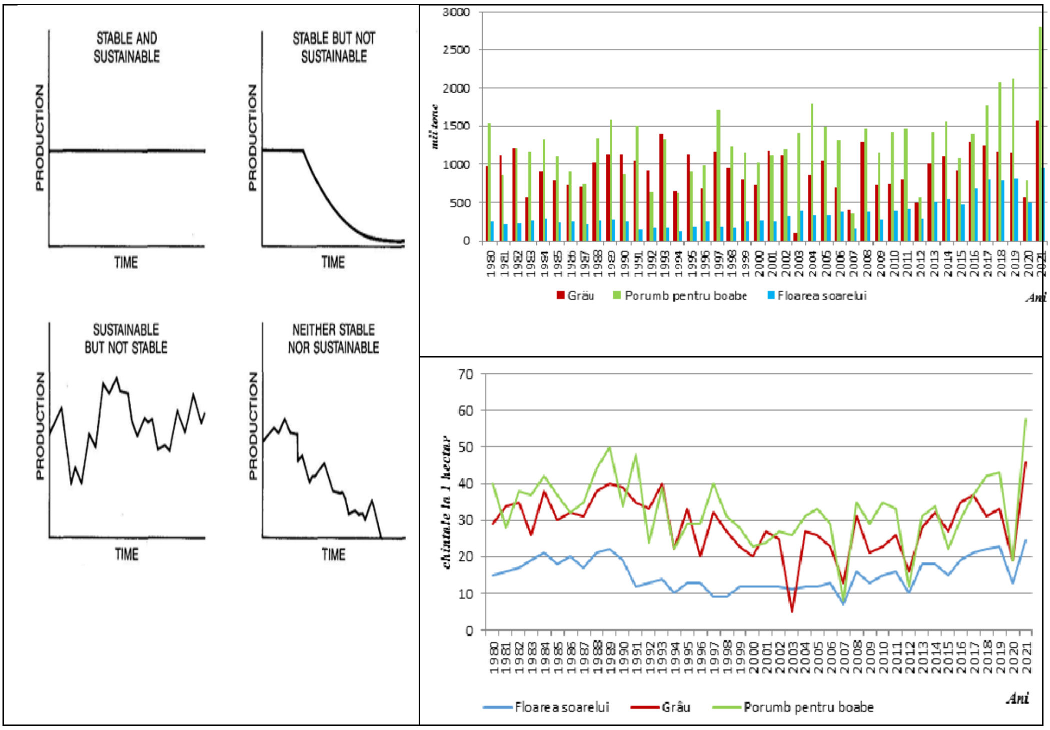


Figure 2. Comparative evaluation of the criteria of structure and functionality of the researched crop agroecosystems according to the Gerald G. Marten model (Gerald, 1988)

Integration of global yield data of 15 field crops (28; 29), including the crops studied in the article, presented in table 2 and their analysis through the lens of the import/export values of the main agricultural product of these crops, allows us to establish the optimal need for these products at the domestic level.

Following the integrated evaluation of the data, it was established that the global winter wheat harvest for the 2021-2022 agricultural year was 1565 thousand tons, of which approx. 1038 thousand tons of winter wheat were exported to the foreign grain market.

The data reveal that the internal needs are approx. 530 thousand tons, distributed for food consumption, fodder and as seed material. Through the ratio of the sown areas and the recommended quota for one hectare, approx. 70 thousand tons of seeds are needed as seed material. Respectively, for food consumption and as fodder, a share of approx. 457 thousand tons of winter wheat.

Based on the data obtained in the present research, within the winter wheat agroecosystems, in the dry years such as: 2003; 2007; 2012; 2020; the internal requirement of winter wheat was not ensured. At the same time, in agricultural years favourable to the cultivation of winter wheat, we observe that a double surplus product is obtained compared to domestic needs.

Comparative analysis of the data on the global productivity of sunflower agroecosystems and the values of seed export, allows to estimate the internal need, which is approx. 300 thousand tons, being intended for processing and production of oil, direct consumption as seeds or products derived from seeds, for fodder and seed material.

According to the sown area, about 7 thousand tons of sunflower seeds would be needed for seed material. Correspondingly, 293 thousand tons of the global sunflower harvest, which varies from year to year, depending on the agrometeorological conditions, it could be annually used by local consumers, and the difference, which in some years is approx. 500-600 thousand tons, is exported to the European or international markets.

The evaluations of the productivity of the agroecosystems of corn reveal that the internal requirement of corn is about 950 thousand tons, which is mostly intended for fodder and a smaller amount for food consumption and as seed material.

Based on the data presented in the research, we estimate that, in the unfavourable years for the corn, such as the years: 2007; 2012; 2020, the domestic corn requirement is not ensured, with quantities of approx. 400-500 thousand tons, which represents half of domestic consumption. In favourable years for corn, the global harvest is in the limit of 1500-1800 thousand tons, and in 2021, when a harvest of approx. 2793 thousand tons, we note a triple surplus compared to the domestic requirement.

Evaluations of the distribution process of arable land for perennial crops, such as fruit, apple and nuts, grown on an area of approx. 50675 ha (51148 ha (2020), 50538 ha (2021) 50340 ha (2022) and vineyard in the environment on an area of approx. 25316 ha (25000 ha (2020), 25412 ha (2021) 25535 ha (2022), a total of 75991 ha, we note that a share of approximately 180 thousand ha are not included in the statistical data (28).

The conducted research shows that the inefficient use of agricultural potential is a threat to the food security sector at the national level and this problem must be studied within a research in order to regulate the efficiency of the used natural resources, energy products introduced into the agri-food system and socioeconomic relations at all levels of structure and functioning of agroecosystems of field crops.

The evaluations highlight that the excessive exports of the main agricultural product of some crops from the agricultural production system of the Republic of Moldova, which also implies the excessive use of agricultural land for their cultivation, is a risk to food security, which can become a national security threat in the conditions of natural, anthropogenic or economic-financial destabilizing factors.

This phenomenon can be described as – using one's own soil, economic, social and financial resources for the purpose of ensuring the food security of other states, respectively, and in consequence undermining the food security system, the stability of other dimensions of the economy and national security.

The food security risk, generated by the excessive export of three dominant crops such as: winter wheat, sunflower and corn, directly affects soil fertility through the excessive extraction of fertility elements from the soil by crop plants as a result of humus mineralization and their irreversible export during the harvest.

In the 2021-2022 agricultural year, exports of the main agricultural product for the winter wheat crop according to the NBS data constituted approx. 1038 thousand tons, which represents the extraction and export from the soil of approx. 26026.0 t of N; 10068.6 t of P2O5 and 20760.0 t of K2O.

In the case of the sunflower culture, the export constituted approx. 500 thousand tons, 25000.0 t of N being extracted and exported from the soil; 7500.0 t of P2O5 and 48500.0 t of K2O. Export amount of corn was approx. 1457 thousand tons, which constitutes a share of the biophilic elements extracted and exported from the soil of approx. 31908.3 t of N; 12980.0 t of P2O5 and 30451.3 t of K2O.

The annual export of biophilic elements extracted from the soil with the main agricultural product of the researched crops is approx.: 82934.3 t of N; 30548.6 t of P2O5 and approx. 99711.3 t of K2O, which leads to disequilibrium in the balance of nutrients in the soil, as well as energy flows inside and outside of the agroecosystems, which affects the agrifood production system.

One of the main sources of restitution and compensation of nitrogen, phosphorus and potassium reserves in the soil are the organic and mineral fertilizers (Cerbari, 2010). In the conditions of the Republic of Moldova, the source of mineral fertilizers is imports from other states, and for organic fertilizers, it is the national animal husbandry sector.

In the 2021-2022 agricultural year, imports of mineral fertilizers, according to NBS data, constituted approx. 39628.1 t of nitrogen fertilizers, 13.6 t of phosphate fertilizers and 415.2 t of potash fertilizers. At the same time, mineral or chemical fertilizers containing two or three of the fertilizing elements: nitrogen, phosphorus and potassium were imported in the amount of 106264.6 tons (Andrieş, 2007).

The evaluation results of the nutrients export denote a value 3 times higher compared to the amount of the fertilizers imports in physical quantity. Consequently, we note that the restitution and compensation of NPK reserves through the quantities of fertilizers imported and incorporated into the soils of the Republic of Moldova used in the agricultural circuit is not ensured. Given the NPK required for development, and knowing that the cultivated plants extract it from the soil through the mineralization of organic matter and especially humus, the organic matter balance cannot be ensured, which will contribute to the acceleration of agrochemical degradation and semi-dehumification of soils in the Republic of Moldova.

The energy invested per flow of inputs, including the share of energy extracted through the mineralization of soil organic matter, which is not found in the main agricultural product, expressed by the low or negative energy conversion yield, represents a proof of the low energy efficiency of the agro-ecosystems of the researched crops.

As it was highlighted in the research, the reduction of energy efficiency is caused by the differences in the harvest indicators revealed in the evaluation of the potential and actual productivity of the researched crops. Detailing the energy balances per unit of product and unit of area, demonstrates that differences in yield at primary technological stages increase costs per unit of the main agricultural product and lead to energy loading throughout the food chain.

The research results show that in the current production conditions, economic interests prevail, while some food security priorities are ignored, because 80% of the arable land is intended for three crops with increased economic effect: winter wheat, sunflower and corn.

Based on the calculated data regarding the cultivation areas of field crops of social, food and fodder importance, as well as the required main agricultural product of 33 field crops described in the statistical records of the Republic of Moldova, the land redistribution is presented in table 2.

To ensure the efficient use of agricultural land from the Republic of Moldova, the areas devoted to the researched crops must be reduced as follows: 240 thousand hectares for the winter wheat crop, 260 thousand hectares for the sunflower and 390 thousand hectares for the grain corn crop. Depending on the needs of domestic consumption, table 2 recommends the quotas for agricultural land and for other crops of food importance.

The structure of the lands in table 2 was defined according to the conditions of ensuring the necessary agri-food products from internal resources and the reduction of the import quota, which would lead to the consolidation of the autonomy and food independence of the Republic of Moldova.

Table 2

Recommended cultivation areas according to the internal need for agro-food products for a group of 33 field crops

No.	Culture	Internal consumption needs, t	Current cultivation area, ha	Recommended cultivation area, ha
1.	**Winter wheat**	530000,0	346000,0	**240000,0**
2.	**Sun flower**	300000,0	373000,0	**260000,0**
3.	**Corn**	950000,0	500000,0	**390000,0**
4.	**Potatoes**	52145,0	790,0	**20000,0**
5.	**Soya**	36879,8	14200,0	**50000,0**
6.	**Buckwheat**	131,6	5,0	**2000,0**
7.	**Onion**	16772,4	487,0	**5000,0**
8.	**Garlic**	95,6	41,0	**82,0**
9.	**Cucumbers**	5258,8	48,0	**100,0**
10.	**Tomato**	16382,0	348,0	**1000,0**
11.	**Carrot**	11623,2	234,0	**395,0**
12.	**Cabbage**	8934,7	152,0	**251,0**
13.	**Peas**	21088,8	8441,0	**16882,0**
14.	**Green peas**	4298,5	1312,0	**2624,0**
15.	**Field vegetables**	5899,0	4095,0	**8190,0**
16.	**Beans**	649,1	158,0	**300,0**
17.	**Pumpkin**	204,4	76,0	**150,0**
18.	**Green pumpkin**	408,3	23,0	**50,0**

19.	**Eggplants**	820,3	54,0	**100,0**
20.	**Sweet pepper**	2056,5	182,0	**360,0**
21.	**Fibber**	58,3	10,0	**20,0**
22.	**Vegetables**	150,4	53,0	**100,0**
23.	**Beet**	2387,8	67,0	**100,0**
24.	**Pumpkin crops**	5183,2	621,0	**1200,0**
25.	**Sugar beet**	737129,1	10700,0	**21500,0**
26.	**Tabacco**	497,8	364,0	**364,0**
27.	**Rape**	92355,4	33858,0	**33858,0**
28.	**Barely**	23549,6	56915,0	**50000,0**
29.	**Oat**	133,0	584,0	**1000,0**
30.	**Maize for silage**	13154,3	4922,0	**50000,0**
31.	**Root crops for fodder**	399,1	115,0	**5000,0**
32.	**Lucerne**	**-**	**-**	**100000,0**
33.	**Autumn pea**	**-**	**-**	**100000,0**

When evaluating the degree of food independence for products such as potatoes or tomatoes, the coefficient of food dependence is 0.4 units and 0.6 units, respectively, denotes a dangerous level 3 dependence and an increased degree of risk for food security.

The research results obtained in the framework of the agroecosystems from the Republic of Moldova, reveal the problem of irrational use of energy resources invested in production, as well as soil resources, with a negative impact on the state and functioning for the future, which caused a food insecurity state that will grow in the next period, given the need for increased energy investments, rising costs, environmental pollution and degradation of soil fertility.

The functional and structural disturbances of the agroecosystems of field crops undermine the *systemic autonomy*. The risk-generating factor is the imbalance between the crop production system and the processing of products in the national agrifood system, including the breeding of animals and birds for domestic food needs. According to the diagram presented in figure 3, we highlight a dramatic reduction of livestock at the national level, during the research years. As we can see, in 1980 the number of pigs at the country level was approximately 2 million heads, and in 2021 approximately 400 thousand heads are recorded.

We witness a similar evolution in the case of cattle and sheep, which in 1980 recorded a figure of approximately 1300 thousand heads and in 2021 approx. 500 thousand sheep and only 100 thousand cattle are recorded. At the same time, in the 3 table we observe that the significant reductions in animal husbandry are particularly evident during the years right after the drought. The accessibility of resources, associated with the benefit, another agroecosystem structural criterion - *intergeneralized benefit* and - *extrageneralized benefit*, creates an impact on the food security as the use of food which refers to the distribution of agrifood products within the community, according to an adequate diet, in a healthy physical environment with safe water sources and adequate sanitation facilities.

The instability of agricultural production reduces the consumption of agri-food products at the individual level, which is much lower than in the neighbouring countries or other countries in the region (24).

The instability of the agroecosystems productivity also influences the incomes at the level of agricultural producers, as well as at the level of population. For instance, the effects of the 2007 drought on agrifood production units from the Republic of Moldova, which according to the estimations in the mentioned period (Spivacenco, 2005), caused a damage to the national economy for over $1 billion. In 2012, extreme weather events led to losses in the amount of 1.0-1.5 billion lei.

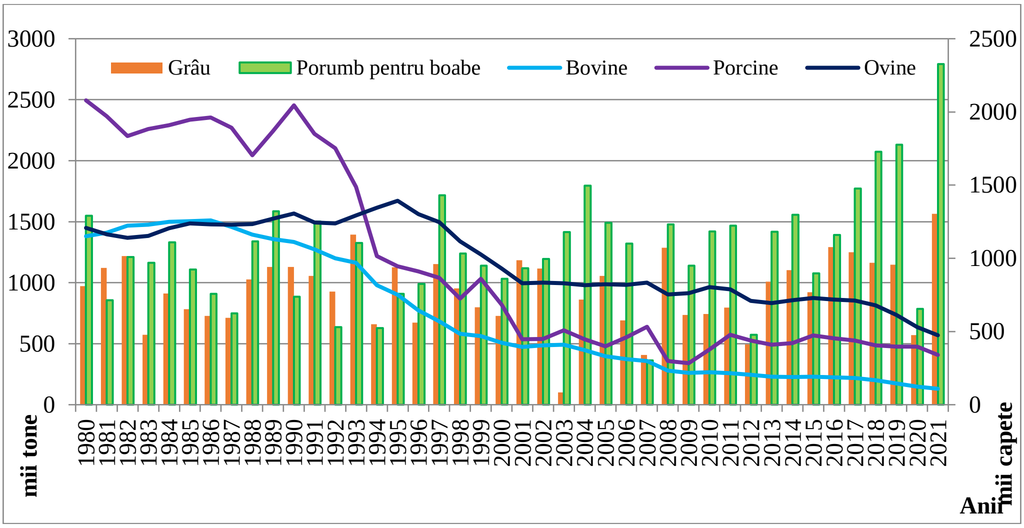


Figure 3. Correlation between the global harvest of wheat and corn with the livestock

The research results reconfirm the need to evaluate the agroecosystem productivity, in terms of quantitative and energetic parameters. The complex evaluation of productivity based on economic, quantitative and energetic parameters offers a three-dimensional assessment, which includes the relational aspects between the structural and functional components of agroecosystems and highlights systemic dysfunctions and mistakes.

CONCLUSIONS

1. Analysing the functionality principles of the agroecosystems of crops - winter wheat, sunflower and corn for grains, in the period of approx. 41 years and based on the values of the global harvest and the average harvest per hectare, we can see the variable nature of productivity for each individual crop, being qualified as unstable but sustainable agroecosystems.

2. The evaluation of agroecosystems based on quantitative, energetic and economic parameters, highlighted the dysfunctional aspects of productivity, efficiency and agroecosystem effectiveness criteria. The results of the research also indicate dysfunctions of the agroecosystem structure criteria such as: resources, resource availability and diversity, related to the inefficient use of agricultural potential, especially soil resources.

3. The decreased productive potential, combined with the harvest losses, represents a vulnerability for food security and undermines the general security environment, because it constantly leads, year after year, to the increase of

technological costs per unit of processed agricultural surface. At the same time, crop losses increase the cost of each calorie of food processed from raw agricultural material.

4. Redistribution quotas of the agricultural land have to be modified including sided crops in crop rotations that contribute to improving the fertility of soils used in agriculture. The share of winter wheat, sunflower and grain corn agroecosystems, which occupy 80% of the land used in agricultural field of the Republic of Moldova to be reduced to 56%.

5. The agroecosystem imbalance highlighted in the agricultural production sector (vegetable and zootechnical) from the Republic of Moldova can be corrected by ensuring a cyclical correlation of the agroecosystems of field crops and zootechnical ones at the local, regional and national level.

6. The agroecosystem is the interference platform between the physical effects of the changing agroecosystem structure, functionality components and the dimensions of food security. Optimizing the structural and functional criteria of the agroecosystem is the only way to ensure food security.

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