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THE AGRO-ECOSYSTEM AS NATURAL ECONOMIC PRODUCTION UNIT IN ROMANIA

ABSTRACT

The natural environment, by the diversity of its ecologic systems, ensures the existence of all living beings, of the human species implicitly. The agricultural ecosystem is a functional biosphere unit, with a structure generated by the criterion of anthropic utility of supplied biomass, energetically dependent on the natural sources and fixation and transfer mechanisms.

The agro-ecosystem economic value is given by the extent and modality in which it contributes, by the intermediation of the activity of the other beings, of humans in particular, to ensuring the existence, in general, and food, in particular; its economic character is mainly supported by the value and volume of the primary and secondary biological production of the eco-system, by the use of sources and resources of the ecosystem, by putting into value the energies of trophic chains from the ecosystem.

In the agricultural ecosystem, the adopted structural models have largely varied in time, yet the energy dependence, anchored in the rhythm imposed by nature, has greatly limited the productive performance, by comparison to other activities. These conditionings will remain objectives as long as energy concentration into accessible forms to the human body is mainly related to biological mechanisms rather than to technologies developed by people; this is related to the use of the practically infinite reservoir of solar energy, without taking into consideration the quality, the specific organic substances respectively, which are essential for human physiology.

Key words: sustainable development, natural resources, agricultural ecological systems.

JEL Classification: Q01, Q57.

1. INTRODUCTION

Agriculture is an economic activity in strong interdependency with the environment, being affected and affecting in its turn the environment quality in which it is developed. The agricultural practices have the purpose to deviate the natural flow from the ecosystem, to the benefit of certain species, in order to maximize their productivity. In order to reach such objectives, the natural plant and animal forms are replaced by certain varieties that have been adapted to the human needs throughout the selection processes.

That is why the agricultural ecosystems or the agro-ecosystems, established as a result of humans' intervention upon the natural ecosystems that have been fully of partially transformed, are the most important in the biosphere.

The agro-ecosystem as economic production unit cannot be dissociated from its character of ecological and implicitly natural unit. A great part of the agro-ecosystem biotic and abiotic components directly or indirectly participate to the existence of the other ecosystems, to obtaining biological production and to life existence in the ecosystem, while the polluting or depolluting agricultural practices (positively or negatively) affect the ecological stability of the landscape.

The growth and development of crops, their biological productivity and finally the obtained harvest are the result of the exchange of substances and of the energy transformations within the agricultural ecosystems. These dynamic and very complex processes take place under different forms for each cultivated plant species and ecosystem type and are conditioned, on one hand, by the plant biological needs, which are different by species, and on the other hand, by the action of natural environment factors: relief unit, weather (through light, heat, air currents), water and soil characteristics. Synthetically, these factors that are indispensable for the biological activity of plants, can be expressed both by the term "pedoclimatic factors and by the term "vegetation factors", *i.e.* factors that express the weather and soil influence upon plants.

2. STATE OF KNOWLEDGE

The living environment is represented by all lifeless (abiotic) factors and the living (biotic) factors. The abiotic part of the environment forms the **biotope**, which comprises the substratum (mineral and organic elements) and the climate factors (light, temperature, humidity, wind), while the biotic part forms the **biocenosis**, which consists of the populations of plants and animals from different species, which are living in a biotope.

The biotope substratum can be of three kinds, according to its nature: *solid* (soil), *liquid* (water) and *gas* (atmosphere); hence the *biotope* is also of three types: *terrestrial* (for example the park, having soil as substratum), *aquatic* (for example the pond, having as substratum the water mass and the solid substratum at the bottom of the pond) and *aerial* (having the atmosphere as substratum). The terrestrial and aquatic biocenoses have a vertical structure and a horizontal structure. There is a close relation and mutual influences between the biotope and biocenosis, they can exist only together. A biocenosis physiognomy is recognized on the basis of biotic forms. In its turn, the biotope acts as a selection factor in the construction of the biocenosis. The biotope characteristics favour the development of a certain species and prevent the penetration of others in the territory. Whenever a certain biotope is recurrent in the field, the corresponding biocenosis is also recurrent through its biotic forms.

The relations that are established between the individuals from different species are called *interspecific relations*. The relations established between the individuals from the same species are called *intraspecific relations*. There are different communication and cooperation forms between the individuals from a certain group, necessary to provide unity and security to the group. The solidarity of intraspecific collectivities, the good relations between the individuals, are established through the sonorous, chemical, chromatic, luminous, electrical and behavioural language.

Together, biotope and biocenosis make up the **ecosystem**, and the science that studies it is the **ecology** that has a double profile, both theoretical and applicative.

The first definition of ecology (as a science of the interaction between organisms, of the interaction of living matter with the earth's surface, of the biological productivity and of the relations between man and nature) was given by the German professor Efenst Hakel, one of the great evolutionists of the last century, who developed the concept of Ch. Darwin' evolution of species from the work "Origin of Species" that appeared in 1859. A wide range of definitions eventually appeared. Some of them focus on the organism, the others focus on the supraindividual biological systems.

The agroecology or agricultural ecology was founded as a scientific discipline by the Italian Girolamo Azzi, in the year 1920. He used to define it as ***a branch of ecology correlated with the agricultural science, which has as main field of study the influence of environmental (biotic and abiotic) factors on the growth and productivity of crops.*** He considered that "instead of trying to fight against the unfavourable weather conditions, the agroecology recommends the adaptation of crops to different weather conditions". His vision represents the theoretical foundation of the works on the ecological zoning of crops.

The *ecosystem* term was introduced by the British ecologist Sir Arthur George Tansley in 1935 who described the natural systems as a continuous interaction between their living and lifeless components.

The ecosystems are very different as regards their size and complexity. The populations from the biocenosis componency are able not only to support the rigours of the surrounding environment (biotope) but also to transform it, which determines new interactions between species (indirect interactions), as well as defining a complex system of interactions between species and between species and environment.

The ecosystem is organized by five main (trophic) subsystems:

1. substances of anorganic nature (chemical elements or mineral substances);

2. primary producers (all plants and certain photosynthesizing microorganisms);

3. animal consumers (primary and secondary consumers of different orders);

4. vegetable and animal detritus (lifeless organic matter);

5. decomposing microorganisms (organisms reducing the organic matter to mineral components).

In a more simple way, and reducing the ecosystem components to the most important ones, we can state that the ***structure of ecosystems is determined by a variety of factors*** that are inter-related, among which the most important components are the ***soil, air, sunlight, water*** – all these characterizing the biotope and the living organisms that occupy this biotope, representing the biocenosis or the community of plants and animals specific to a certain biotope.

The type of ecosystem, its operation modality and hence the relations between the component organisms and the surrounding environment are determined and finally controlled by the amount of available energy. ***The most important energy source is obviously the solar radiated energy***. Once it is fixed by the plants, the energy incorporated in the organic mass circulates within the ecosystem or it can also pass from one ecosystem to another by a series of processes that include: migration of animals, hunting, plant harvesting, erosion phenomena, etc.

An ecosystem always has a functional structure. The most important functions of an ecosystem are the following: *energy function*, *matter circulation function* (the biotic cycle of water, organic substances, carbon, nitrogen, phosphorous, etc.) and the *self-regulatory function.*

The essence of ecosystem functioning is the use of solar energy and nutrients in the biological circuit, in the case of natural ecosystems, and in the biological-technological or technical-economic circuit in the anthropized ecosystems, where these are transformed into organic substances, biomass, in bioproducts and in products specific to artificial ecosystems respectively.

Ecosystem functioning depends on its anthropization level, in principle resulting from the relations between the species composing it and the interactions with the abiotic factors and with the economic-social factors respectively, which are increasingly obvious as we go on the way from “natural” to “artificial” (Table 1).

Table 1
Classification of the different categories of biosphere ecosystems

<table>
<tr><th>Crt. no.</th><th>Ecosystem type</th><th>Ecosystem category</th><th>Ecosystem characterization</th></tr>
<tr><td>1</td><td>Natural ecosystem</td><td rowspan="2">– Epigeous (on the ground).
– Hipogeous (under ground).
– Marine/oceanic divided into three main biomes: continental plateau, abyssal zone, hadal zone (over 6000 m);
– Continental waters (limnologic biomes
– Running waters with coastal and subcoastal zones and lake zones;
– Terrestrial: tundra, mountain, forests (steppes, savannas, desert).</td><td>– The human impact effect is not felt (equatorial forests, bottom of the seas and oceans, polar zones).
The effect of pollutants and human activities is less felt.</td></tr>
<tr><td>2</td><td>Modified ecosystems (with low anthropization level)</td><td>– The indirect effect of pollutants and human activities is felt to a certain extent (indirect anthropomorphic effect).</td></tr>
<tr><td>3</td><td>Ecosystems equipped with facilities (high anthropization level)</td><td>– Agroecosystems (eco-farms and tourism farms included) are:
– agrarian ecosystems (of crops necessary to humans) and
– zooproductive ecosystems (of animals producing useful biomass for humans, consisting of zootechnical ecosystems – of the animal farms; aquatic ecosystems – fisheries, nurseries, mixed production farms [*] and agro-forestry ecosystems – mixed ecosystems for forest fauna exploitation [**])
– Sylvicultural (forestry) ecosystems from the following zones: arctic glacial, temperate[***], subtropical, tropical, austral subtropical, Antarctic.
– Urban ecosystems of the residence, recreational, industrial, civic areas.</td><td>– The ecosystems of human interest for obtaining food and raw vegetable and animal products.
– Ecosystems directly influenced by human activities by the selection of biocenosis componency and by a permanent intervention for biocenosis population regulation.</td></tr>
</table>

Source: Altieri, 1991, quoted in Arsene, G.G. (2002).
[*] Macrophitic algae, shrimp, oyster farms, etc.
[**] Game animals, cynegetical reservations, hunting parks, forestry-cynegetical units.
[***] Ecosystems from the following zones: steppe, sylvosteppe, oak, beech, coniferous, azoned forests and plantations, mixed zones (forest – tundra; forest – peatery; forest – grassland; forest – steppe).

3. MATERIAL AND METHOD

Starting from the premise that the economic development takes place within ecological systems, at present the eco-development concept is increasingly used.

This concept is defined as a complex relation established between the economic development and the natural environment, with a special focus on the adequate and rational use of natural resources, of technology and management style.

The paper intends to investigate the agro-ecosystem as relevant territorial unit of the interconditionality relations of the environmental factors – water, air, soil. The conjugated action of these strengthens the idea that the agroecosystem as economic production unit also has a strong character of ecological and implicitly natural unit.

The informative material on which the paper was based consists of scientific reference works from the world and national literature. The methodological tools that have been used are the analysis and synthesis of relevant information for the approached subject.

4. RESULTS AND DISCUSSIONS

4.1. INTERCONDITIONALITY OF ENVIRONMENTAL FACTORS AND THE ECOLOGICAL OPTIMUM OF AGRICULTURAL SYSTEMS

Modifying the biocenosis structure, man had also to intervene upon the biotope, transforming it in such a way so as to become favourable for the cultivated species, which resulted in structural and functional differentiations (Table 2).

Table 2

Structural and functional differences between agricultural ecosystems and natural ecosystems

Crt. no.	Characteristic	Natural ecosystems	Agricultural ecosystems
1	Net productivity	Average	High
2	Trophic chains	Complex	Simple
3	Species diversity	High	Low
4	Genetic diversity	High	Low
5	Cycles of matter	Closed	Open
6	Stability	High	Low
7	Entropy	Low	High
8	Anthropic control	Not necessary	Obligatory
9	Permanence in time	Long-lasting	Limited
10	Habitat	Complex	Homogeneous
11	Stage in ecological succession	Natural ecosystem	Mature in initial stage
12	Phenology	Differentiated	Synchronized

Source: Altieri, 1991, quoted in Arsene, G.G. (2002), p. 138.

These transformations were achieved on about 30% of the land area, which produced a strong ecological impact upon the natural ecosystems.

The agro-ecosystem, as functional unit of biosphere created by man to obtain agricultural products, has the following component parts:

– a*grobiocenosis* (biotic, living component), imposed by man through the cultivation of certain plant species or maintenance of certain domestic animal species;

– a*grobiotope* (abiotic, lifeless component) is developed by man within the natural biotope by transformations of the physical environment for creating best conditions for crops.

The natural ecosystems generally have a more stable relative *equilibrium* than the agro-ecosystems, with lower diversity.

The important characteristic of the agricultural ecosystems consists in the inseparable *symbiosis* with the *human activity*; the cultivated plants and the whole agricultural ecosystem in general cannot compete against the wild plants and natural ecosystems when humans no longer take care of them.

As anthropized ecosystem, the agro-ecosystem is differentiated from the natural ecosystem in the first place by increased *energy consumption* and by the use of other energy sources than solar energy; secondly by a substance flow that does not follow the natural *biogeochemical cycles.* The aim is to obtain highly productive harvests.

The **field** (plot) is considered the element at the basis of agro-ecosystem. The field has an accurately delimited area according to the biotope uniformity principle and to the administrative decision principle; the same crop management techniques will be applied on its area; tillage works, application of fertilizers and pesticides, administered irrigation water.

The biocenosis set up on this biotope is rather uniform in space, the same crop is cultivated on the entire area, associated with the same weeds, the same phyto-patogens (with their hyperparasites) and the same pests with their specific predators. The soil microflora and microfauna are also homogenous, although less specific to the crop. In time, on the respective field certain crops are successively grown, which maintain the uniform properties.

The higher next level to the field is the ***crop rotation*** in which it is included. The area on which the crop rotation is organized is very well delimited. Throughout the ecosystem, the biocenosis is the same, and its distribution in space as well as the alternance in time, on different fields, are specific to this ecological level. The crop rotation is organized at farm or agricultural unit level.

Depending on the cultural energy input (energy introduced by man in order to obtain higher yields) we have **three types of agro-ecosystems**: extensive, intensive and industrial.

a) *The extensive agro-ecosystems* are characterized by a high ratio of energy output under the form of product to energy input. Thus, one calorie input produces about ten calories under the form of useful harvest. The traditional agriculture systems, the orchards and family gardens are included in the category of extensive agro-ecosystems. The applied technology is rudimentary, the cultivated varieties have low productivity, and the pest control is poor or even non-existent. The obtained harvest is low. The extensive agricultural ecosystems enable the re-circulation of all terrestrial natural resources and their regeneration.

b) *The intensive agro-ecosystems* are characterized by an output-input energy ratio approximately equal to one. The additional energy from the use of fossil fuels (mechanization plus application of chemical substances) leads to a higher productivity of intensive agro-ecosystems that is 3-6 times as high compared to that of traditional agro-ecosystems. This adds to the use of new varieties, land reclamation works, irrigations, etc.

As long as the technological energy resources are acceptable, it is recommended to produce foodstuffs through intensive agro-ecosystems.

In these systems, the natural recycling of mineral and organic substances must be compensated by fertilizers and other substances, which increase energy consumption. In the absence of natural recycling, the soil content in easily soluble substances decreases, leading to a decrease of soil natural fertility.

In this category of agricultural ecosystems are included the farms that use fully mechanized and chemified technologies, the fruit-tree plantations and intensive vineyards.

c) *The industrial agroecosystems* by an output-input energy ratio less than one. In order to obtain one calorie of food product, about 2–20 cultural energy calories are needed, mainly technological energy. Compared to the traditional agricultural ecosystems, man introduces dozens of times more energy in these ecosystems.

The structure and productivity of industrialized agricultural ecosystems are fully dependent on the energy resources available for mankind. Although their productivity is high and the action of external factors is well-controlled, these agricultural ecosystems are unstable due to their sensitivity to the supply flow of mineral, organic and energy resources. The following units are included in this group: poultry, swine, cattle raising complexes, the piscicultural production complexes and the greenhouses.

The territorial distribution of crops can be correctly achieved only when there is an overall assessment of the ecologic zonality of these crops. The design of *ecosystem modules* presupposes the establishment of certain *zonal agricultural systems*, which include crop structures, technologies differentiated in space and time, in relation with the ecologic conditions. Hence, the zonal agricultural systems represent functional units of the natural environment used in obtaining useful vegetable biomass, controlled by farmer.

In the approach to the relations between the natural environment and the agricultural production, agriculture geography gets connected to the agricultural ecology. The link between the two disciplines requires to clarify and systematize certain ecologic concepts and issues, some of them being debated for a longer time, *i.e.* those referring to the *limited action of the vegetation factors,* others more recent, such as those regarding the **ecological optimum in agriculture** or, some of them being expressed on this very occasion, such as those referring to the *delimitation of agricultural ecosystems,* in order to determine the place of the crops and animals grown by man within these ecosystems.

The biological needs of crops feature high variability not only by species but also from one stage to another throughout the vegetation period. Under the considered ecosystems, they are confronted with the *action of vegetation factors, variable in space and time,* factors that lie at the basis of the formulation of the following laws:

– *Shelford's tolerance law,* according to which "the development of the living matter is possible only between certain limits of the physical factors concentration; these range from ecological optimum to ecological pessimum, which can be the minimum or maximum concentration of the factor; between the optimum and the two pessimum points (minimum and maximum) there is a tolerance zone of the living matter";

– *Mitscherlich's law of the cumulative action of factors,* according to which "the living matter is the result of the action of all factors". At present, the law is reformulated, in the sense that one or other limiting factors for the biological development becomes in certain situations a prevalent factor in the conditions of the permanent interaction of all factors;

– *Liebig's law of the minimum,* according to which "the development of the living matter requires a minimum amount of essential material (biogenic chemical elements and energy)". According to more recent visions, this law is much debatable, as it is considered that the minimum necessary chemical material is not a sufficient factor in the living matter development;

– *Odum' law* provides a general formulation, in the sense that "organisms are controlled in nature by the amount and variability of materials, for which any small demand exist and by the critical physical factors, as well as by the tolerance limits of organisms to the physical factors and to other environmental factors".

The action of vegetation factors on plant growth and development, in relation to their biological requirements, determines a highly significant reference level, namely the ecological optimum.

The definition of the ***ecological optimum of crops*** imposes: the specification of this concept content, the determination of conditions that characterize it, and the establishment of the geographical zones featuring these conditions. Furthermore, starting from the so-defined ecological optimum, the limiting action of the natural environmental factors creates situations and delimits areas that are increasingly less favourable, up to the unfavourable ones, where plants hardly have their biological needs satisfied, or which become improper to their growth and development.

The ecological optimum concept was mentioned for the first time by A.F.W.Schimper, who based this concept on physiological criteria, having in view three successive steps, namely:

– *absolute optimum*, which corresponds to the highest possible activity level of each function in part; beyond this point, the respective activity decreases by the slowing down function performed by the other functions of the plant, related to the considered function;

– *the harmonic optimum*, which corresponds to the most favourable intensity of any function in relation to the other functions of the plant;

– *the theoretical ecological optimum,* which represents the summing up of the different harmonic optimums of the plant functions.

This modality to express the ecological optimum, interesting from the theoretical point of view, is difficult to put into practice, as it implies the direct measurement of the optimum activity level of each function in correlation with the other functions of the plant.

In the very favourable areas, the natural conditions correspond to the biological requirements of crops from the practical point of view, thus characterizing the ecological optimum situation. The differentiation of the other zones: favourable, little favourable, very little favourable and improper, was made to the extent in which negative factors intervene in the componency of the living environment of plants, with increasingly larger values compared to the ecological optimum zone; for a more analytical characterization, both the very favourable and the favourable zones were subdivided into two or three subzones.

4.2. THE AGRO-ECOSYSTEM – NATURAL-ECONOMIC PRODUCTION UNIT

In Romania, the comparative analysis in the territory of the agricultural systems has in view the diversity and specificity of the pedological and climate systems (equally mountaineous, hilly and plain), the general and regional particularities of the social history and of the economic conjuncture that generated a land structure where the agricultural land areas prevail (62%). The highest *share of agricultural land*, over 80%, is found in the Romanian Plain, the Western Plain and in the Central and Southern Dobrogea Plateau – defined as agricultural regions of first importance, which include 11 counties. Its share decreases to 40–65% in the hilly area and to less than 20% in the mountain area.

The structure of the agricultural land use is characterized by the complementarity of the two basic categories, *i.e.* arable land and natural pastures and hayfields, whose differentiation in the territory is prioritarily given by their altitude. Thus, the *agricultural land share* decreases from over 80% in the low altitude areas (plain, certain plateaux), to 40–60% in the hilly areas and to less than 20% in the mountain areas; the share of natural pastures and hayfields increases from less than 10% in the plain to over 60% in the mountains.

This context highlights the great importance of land resources diversity, our country being considered a “pedological mosaic”, with all the soil classes, types and subtypes from the latitude of the temperate zone, but also with soils of alpine tundra type. As regards soil quality, we must specify that not all soils have favourable properties, *i.e.* a high fertility potential.

The quality of soil and ecological factors is expressed by soil rating scores. Soil rating represents the component of ecological sciences that is able to represent, both quantitatively and mainly qualitatively, the potential of an agricultural land area at a given moment and in perspective.

In the studies and research works on agricultural land rating in Romania, performed by the team coordinated by Dumitru Teaci, the ecological favourability is investigated by crops and agricultural uses, resulting 23 agroecosystems. These are characterized according to the common relief unit, the fragmentation level, the energy and density of relief fragmentation, main use, specific character.

At the same time, according to a scheme determined by the weather conditions (temperature, rainfall) and soil (texture, humus reserve and ph) each agroecosystem receives a rating score ranging from 0 to 100. The rating scores that express the favourability level as against the ecological optimum, presented in this paper, are taken over (from the above quoted work) for the arable land areas in non-irrigated conditions and for the natural pastures.

In order to achieve an efficient use of the weather, orographic and soil resources, which should lead to a maximum conversion of solar energy and soil substances into chemical and potential energy, included in the agricultural products, the specialists established the share of crops for the arable area of each agroecosystem (Table 3).

Any deviation from the ecological optimum, i.e. from that ratio of crop needs to environmental factors, means additional costs, higher energy consumption, low profitability rate. For example, the potatoe is recommended for cultivation in Suceava Plateau, in the Subcarpathians depressions from Transylvania, in the Meridional Carpathians and in the intra-mountaineous depressions, where the best conditions for this crop are found.

Table 3

Share of crops recommended for the arable area, by groups of agro-ecosystems, in Romania

Agro-ecosystem group	**Arable area Thou ha**	**Crop**								
		Wheat	**Barley**	**Maize**	**Soybean**	**Sugar beet**	**Sunflower**	**Potatoes**	**Fodder crops**	**Other crops**
1,2,11	3469.4	11	7	34	8	4	6	0	15	15
3,4,10	923.7	14	12	26	8	3	7	0	16	14
5	922.3	13	7	32	6	3	7	2	15	15
6,7,8	1054.1	20	13	21	5	6	1	1	17	16
12	48.0	20	8	21	4	0	5	7	18	17
13,14	684.7	22	12	23	3	0	0	3	22	15
15	60.6	22	14	23	0	1	4	4	19	13
16,17,18,20	1869.9	25	15	16	1	0	3	5	20	15
9,19,21,22	654.8	27	19	3	0	1	0	9	29	12
23	927.2	19	14	0	0	0	0	8	49	10
TOTAL	9984.7	17	11	24	5	2	5	2	19	15

Source: D. Teaci şi colab., Agricultura şi silvicultura românească 2020, Integrarea în structurile europene şi mondiale, Editura Omniapres, Bucureşti, 1999.

In the agricultural ecosystems, an important role in the harvest size is played by the agricultural technique. This can improve the ecological relations, the action of vegetation factors and finally the productivity in agriculture can increase and the crops can be cultivated across larger areas. Hence the agricultural technique represents a specific dynamic element for the agricultural ecosystems and from this point of view the ecological optimum also acquires the significance of a dynamic concept. On the basis of a differentiated analysis of the natural and agrotechnical factors, the action of each factor or group of factors upon yields can be determined, in the complex influence of all the other factors, also having in view the criterion of reaching the maximum yield. The application of this analysis system is based upon an extremely complex scientific documentation, specially designed for different geographic areas.

4.3. AGRO-ECOSYSTEM MANAGEMENT

The ecosystems represent the basic unit of order in the surrounding environment. That is why the management of these systems is extremely important. At present, there are many cases when the management of a subsystem can be harmful for the overall system.

In order to apply the managerial principles to the ecological systems it is important to consider the ecosystem in its entirety, as well as the relations between its components and the overall system; in this perspective, it is not the species that define the ecosystem, but rather its abiotic components, materials and energy, as well as the overall relations that constitute an entity that should be recognized as such (as real or constructed). One should start from a terrestrial, forestry, mountaineous, river, lake, marine, etc. ecosystem so as to know its organization, hierarchies, laws and principles, production, vitality and continuity. All these in the perspective of subsequent knowledge of its reactions to the human activity and its role in the economy.

Any natural ecosystem, but mainly the agricultural ecosystem, artificialized by its essence, must be monitored and then managed according to well-defined rules, so as its bioproductivity remains constant or increases. That is why the agro-ecosystem management should have in view and reach the following objectives:

– evaluation of non-conventional energy resources;

– rational exploitation of biotope and biocenosis from the farm area;

– establishment of experimental ecosystems, differently modeled according to the economic-productive interest, in which to investigate specific ecologico-economic programs;

– piloting by specific means, adapted to the given production structure, in order to best manage the respective systems, so as to make the connection between the environment and the economy.

This adds to the ecological management responsibilities and technological change management, cultural hygiene, users' health, crop protection and biotope protection.

The agro-ecosystem has all these attributes, yet it operates only on medium and large-sized areas, on economically viable farms, with a wide range of tools, such as: ecological impact assessment, environmental audit, analysis of product life cycle, ecolabelling of products and environmental protection programs.

The audit is necessary in order to monitor the environment protection measures through ecological and economic performances. In fact it is a quality control management in its entirety, and also along the biological and technological chains. An independent monitoring and investigation can give us information whether, for example, the fertilizers were incorporated into soil according to the scientific results, in the right amount according to the ecological point of view. Any agricultural product obtained according to strict ecological and biological norms must be labeled as such, so as to differentiate it from the product obtained by conventional practices.

At present, there is an increased focus on the *rehabilitation, protection, rationalization, transformation and control of the natural environment,* using the

ecosystem engineering and the **experimental ecology**. These are meant to invest-tigate the plants and animals at different integration and organization levels, in mutual interdependency with the environment, using, as main instruments of action upon the ecosystems, the forecastable ecological complexes and the programmable ambient systems.

The **ecological-economic systems** concept is of great importance, making it possible to solve up the management problems in a unitary and complex way. The perimeters of these complex systems must be investigated, taking into consideration the demographic and socio-economic development of the regions included in the ecosystems. Another aspect is integrated into this concept: the optimum zoning and the territorial distribution of the homogeneous and heterogeneous ecological-economic systems, which include a wide range of administrative units. Thus, the administrative boundaries disappear and the ecological-economic boundaries emerge through a territorial hierarchy scheme of the ecological-economic systems, as follows: the republic (national territory); province (groups of counties); county (groups of economic-industrial, agricultural, forestry); economic unit (industrial, agricultural, forestry, tourism commercial company); economic subunit (industrial section, agricultural farm); homogeneous biocenosis complex; (agricultural, forestry) biocenosis or biogeohydrocenosis (piscicultural) biocenosis.

Each system must have a functioning and development program, designed by ecologists, technologists and demographers for several years. The ideal situation would be to organize a network of representative models of such ecosystems, in order to be investigated from all points of view. The results obtained in these economic

4.4. AGRO-ECOSYSTEM CONSERVATION AND PROTECTION

The agricultural environment protection is obviously an organic component of the sustainable development of agriculture according to ecological criteria, contributing to the unaltered preservation of the biological heritage, to the plant and soil health, to increasing soil production capacity. The agricultural ecosystem protection has in view to reach an equilibrium between biocenosis and biotope, between the vegetable and animal worlds on the agricultural land areas.

In the anthropized cultivated biosystem, the ecological equilibrium must be maintained between biocenosis and biotope, within the biocenosis, as well as between the natural processes and the farmer's activity.

In essence, the ***agricultural environment protection strategy has in view the rational use of natural and material resources, in agreement with the development of less polluting technologies.*** The development of scientific research and the ecosystem monitoring, in the industrialized areas in particular, is of extreme importance. The great ecological complexity of the agricultural territory, diversified through anthropic interventions, imposes the correct approach to solutions, as the land areas feature distinct particularities, resulting in the need to approach them on a differentiated basis.

The agricultural ecosystems protection includes objectives and actions adopted in almost all countries, and briefly refers to the following management objectives:

– active cooperation between the agricultural and industrial biosphere, with the application of less polluting technologies within the accepted limits for each polluting agent;

maintenance and improvement of the surface and ground water quality in the case of irrigation water, in order to avoid certain negative effects upon soil and crops;

air resource management, in the sense of diminishing the polluting emissions, so as to reach the lowest pollution level possible, which should not exceed the atmosphere regeneration capacity;

ecological protection of crops, by integrated control measures and actions, mainly in the case of pests and diseases, resulting in a good phyto-sanitary condition and diminution of applied pesticides;

improvement of the national monitoring and information system for the ecosystem control, monitoring and investigation by land, by air and by remote sensing.

In Romania, the agricultural environment pollution and deterioration process was aggravated as a result of the anthropic activities and of certain natural phenomena such as flooding, prolonged drought and landslides. A significant contribution to agro-ecosystem degradation is brought by clearing the fruit-tree and vine plantations and the demolishment of certain units of industrial type. The polluted irrigation water contaminates the soil, which results in low yields on the polluted and degraded land. That is why the reconstruction and rehabilitation of degraded agricultural land becomes imperative, before some other agro-ecosystem components, so that this land may be re-introduced into the economic circuit.

In the recent period, the *restoration ecology* concept gains ground, taken over from Western researchers, who, in part, gave up the ecological reconstruction concept, replacing it by the rehabilitation, restoration concept, with concrete objectives and actions, such as: *natural and artificial regeneration, crop rotation, bioremediation, ecological constructions.*

At the same time, the reconstruction of degraded land areas by industry represents a particular problem for Romania, large land areas being taken out of the agricultural circuit in the carboniferous basins, in the areas of electrical and thermal power stations, of the non-ferrous metal mines and of certain chemical plants, of petrol pipelines and wells.

5. CONCLUSIONS

The living environment is represented by all lifeless (abiotic) factors and the living (biotic) factors. The abiotic part of the environment forms the **biotope**, which comprises the substratum (mineral and organic elements) and the climate factors (light, temperature, humidity, wind), while the biotic part forms the **biocenosis**, which consists of the populations of plants and animals from different species, which are living in a given biotope.

Together, biotope and biocenosis make up the **ecosystem**. The ecosystems represent the basic unit of order in the surrounding environment. The ecosystem functionality depends on the following:

– its anthropization level, in principle resulting from the relations between the species composing it and the interactions with the abiotic factors and with the economic-social factors respectively, which are increasingly obvious as we go on the way from "natural" to "artificial".

– the use of solar energy and nutrients in the biological circuit, in the case of natural ecosystems, and in the biological-technological or technical-economic circuit in the anthropized ecosystems, where these are transformed into organic substances, biomass, in bioproducts and in products specific to artificial ecosystems respectively.

The agro-ecosystem is "a functional biosphere unit created by man in order to obtain agricultural products". The important characteristic of agricultural ecosystems is represented by the inseparable *symbiosis with the human activity,* as the crops and in general the entire agricultural ecosystem cannot compete against the wild plants and the natural ecosystems when humans no longer take care of them.

The components of agroecosystems are the *agrobiocenosis* (biotic, living component), imposed by man by the cultivation of certain crop species or maintenance of certain domestic animal species and the *agrobiotope* (abiotic, lifeless component) developed by man within the natural biotope by transformations of the physical environment for creating best conditions for crops.

As anthropized ecosystem, the agroecosystem is differentiated from the natural ecosystem in the first place by increased *energy consumption* and by the use of other energy sources than solar energy; secondly by a substance flow that does not follow the natural *biogeochemical cycles.* The aim is to obtain highly productive harvests.

The **field** (plot) is considered the element at the basis of agroecosystem. The field has an accurately delimited area according to the biotope uniformity principle and to the administrative decision principle; the same crop management techniques will be applied on its area (tillage works, application of fertilizers and pesticides, amount of administered irrigation water) that guide or model the environmental factors.

The higher next level to the field is the ***crop rotation*** in which it is included, with a well-dedined area, organized at farm or agricultural unit level.

Depending on the type of cultural energy (energy introduced by man in order to obtain higher yields), three types of agro-ecosystems can be distinguished*: extensive, intensive and industrial*.

The action, variable in space and time, of the vegetation factors, upon the growth and development of plants, in relation with their biological needs, enabled the formulation of the “Shelford’s Tolerance Law”, “Mitscherlich’s law of the cumulative action of factors”, “Liebig’s law of the minimum”, “Odum’s Law” and determined the ***ecological optimum of the agricultural systems***, with three successive integration steps: *absolute optimum*, *harmonic optimum* and *theoretical ecological optimum.*

This expression of the ecological optimum, interesting from the theoretical point of view, is difficult to put into practice, as it implies the direct measurement of the optimum activity level of each function in correlation with the other functions of the plant.

Romania is located in an area benefiting from an overall good ecological supply and with a medium photosynthesis capacity, firstly determined by the natural environmental factors and secondly by the anthropic intervention. Thus, 98% of the country’s terrestrial and aquatic territory is productive, and only about 2% is non-productive.

The quality of soil and ecological factors is expressed by **soil rating scores**. Soil rating represents the component of ecological sciences that is able to represent, both quantitatively and mainly qualitatively, the potential of an agricultural land area at a given moment and in perspective.

On Romania’s territory, the ecological favourability by crops and agricultural uses results in 23 agroecosystems. These are characterized according to the common relief unit, the fragmentation level, the energy and density of relief fragmentation, main use, specific character, weather conditions (temperature, rainfall) and soil (texture, humus reserve and ph); each agro-ecosystem receives a rating score ranging from 0 to 100.

Any deviation from the ecological optimum, *i.e.* from that ratio of crop needs to environmental factors, means additional costs, higher energy consumption, lower profitability rate.

The natural ecosystems, and mainly the agricultural ecosystems, which are artificialized by their essence, must be carefully monitored and then managed according to well-defined rules, so that their productivity remains constant or increase.

At present, there is an increased focus on the restoration, protection, rationalization, transformation and control of natural environment, using the ecosystem engineering and experimental ecology, to reach an equilibrium between the vegetable and animal worlds on the agricultural land area perimeter and outside it.

REFERENCES

1. Arsene, G.G. (2002), *Elemente de ecologie generală*, Editura Orizonturi Universitare, Timişoara.
2. Berca, M. (2003), *Pledoarie pentru dezvoltarea durabilă: Biodiversitatea – indicator al supraviețuirii biosferei şi al continuității vieții economice şi sociale*, Economistul nr. 1337 (2363), Bucureşti.
3. Bordânc, Floarea, Sima, Elena (2006), *Diferențieri regionale ale favorabilității/restrictivității condițiilor de mediu natural în spațiul rural*, în volumul „Diversificarea activităților economice din mediul rural şi creşterea competitivității agriculturii", Editura ASE, Bucureşti.
4. Richițeanu, A. (2007), *Agroecosisteme*, Note de curs, Universitatea din Piteşti.
5. Teaci, D. şi colab. (1999), *Agricultura şi silvicultura românească 2020, Integrarea în structurile europene şi mondiale,* Editura Omniapres, Bucureşti.
6. Tomescu, C. (2008), *Economia managementului ecologic*, Note de curs, Universitatea din Piteşti.
7. http://www.fermierul.ro.
8. http://www.greenmedia.info.
9. http://www.mapam.ro.