The basic provisions of the concept of ecologically oriented agroecosystem management

L Z Khalishkhova*, I R Guchapsheva, A Kh Temrokova, M A Marzhokhova and O I Bagova
Kabardino-Balkarian State Agricultural University named after V.M. Kokov, Nalchik, Russian Federation

* E-mail: L_a_u_r_a@inbox.ru

Abstract. The study discusses the problems of forming the concept of a balanced, environmentally oriented management of the agroecosystem. A set of parameters for managing the agroecosystem is formulated, determinants-constraints of the management process are identified, the possibilities of using an adaptive approach in agriculture are considered, the contribution of the mechanisms of self-organization and self-support of the agroecosystem to the optimization of its functioning is assessed, the most significant blocks of the structure of self-organization of the agroecosystem are identified.

1. Introduction
Agroecosystems are autotrophic agricultural ecosystems controlled by humans. The history of agriculture is about ten thousand years old, but despite such an extensive experience, the concept of agroecosystem management has not yet been developed, in which all structural elements would come together into a single whole.

The agroecosystem is managed through biological intermediaries. Intermediaries play the role of biological enhancers in the agroecosystem and reduce the cost of anthropogenic energy. Intermediaries include crops, farm animals, soil biota, and all other organisms that inhabit the agroecosystem.

Among the properties of the agroecosystem, its management deserves special attention. Agroecosystems are managed primarily from the external environment. This is the main difference between agroecosystems and natural systems, in which self-regulation plays the most important role.

Management from within is much more efficient than reactions and feedbacks that form under the influence of external regulators.

The put forward thesis updates the research devoted to the formation of conceptual approaches to the management of the agroecosystem, the identification of the significance of the self-regulating forces of the agroecosystem, the establishment of functional relationships of the structural components of agroecosystems with the substantiation of the optimal parameters of their management. In this regard, it seems to us advisable to form agroecosystems in such a way that their internal regulation mechanisms, similar to those that take place in natural systems, contribute to their stabilization and increase in efficiency. Theoretically, it is quite obvious that the contribution of the mechanisms of self-organization and self-support of the agroecosystem will optimize the total costs of energy and funds for artificial systems of external regulation.
The solution of the tasks set will provide the requested level of ecological and economic balance of the agroecosystem, allow to create conditions for their functional stability, as well as develop approaches to the management of the agroecosystem as an integral self-organizing structure.

2. Materials and methods
The activation of the biological potential of the agroecosystem and its components at various levels from a plant or animal to the system as a whole, focused on replacing a significant amount of anthropogenic energy with internal energy of biological processes occurring in the agroecosystem, constitutes the main target setting for managing the agroecosystem. The scientifically based concept of agroecosystem management provides for the rationalization of the natural and economic infrastructure, the adaptation of the economic use of the territory to the specifics of the local landscape. The processes of agroecosystem management should be as close as possible to the contours of self-governing natural systems by optimizing the agricultural landscape introduced into the economic circulation.

From the point of view of ecology, a significant simplification of the natural environment of a person in agricultural systems carries significant dangers. The main essence of the concept of agroecosystem management with the achievement of parameters of high productivity and sustainability is to preserve and increase its diversity. Maintaining high productivity of fields must be combined with the preservation of diverse protected areas, conservation of areas of various sizes that are not exposed to anthropogenic impact. The rich species diversity of natural areas is a source of communities recovering in succession rows. The exploitation of natural systems valuable to humans should not exceed their ability to heal themselves.

The productivity of the agroecosystem is ensured by the intensity and direction of the processes of metabolism and energy transfer between the cultivated crop and the natural environment under human control. The ecosystem level of biological organization of agroecosystems largely depends on the quality of approaches and conceptual foundations of management, the level of its conformity to nature.

Structurally, the concept includes five elements:
1. Management strategy, that is, the level of intensification of processes in the agroecosystem, reflecting the amount of anthropogenic energy costs.
2. Management tactics, which is the process of adapting the strategy to the natural conditions of management and market conditions.
3. The main features of the agroecosystem, the quantitative values of which are regulated by man and represent the key parameters of management.
4. Limitations of control actions, that is, determinants of agroecosystem management.
5. Controlled elements of the agroecosystem. The basis of the agroecosystem is the activity of living organisms, which can act as intermediaries for the management function.

Each of the highlighted elements requires detailed consideration.

3. Results and discussion
To manage the agroecosystem, anthropogenic energy is spent, used for soil cultivation, irrigation, application of fertilizers and plant protection chemicals, for heating livestock buildings in winter, and so on. The amount of anthropogenic energy that is spent on the functioning of the agroecosystem depends on the chosen management strategy.

The control strategy can be intensive, with high energy inputs, extensive, low energy inputs, or compromise when energy inputs are moderate.

These agroecosystem management strategies correspond to the accepted ecological worldview.

An intensive management strategy envisages the use of plant varieties and animal breeds with high productivity potential, and an increase in the input of anthropogenic energy. The most striking example of the application of this strategy was the third agricultural revolution, dating back to 1940-1970. 20th century. In the process of this revolution, also called the "green revolution", there was an active breeding of more productive varieties of plants and their introduction into production, the
expansion of irrigation, the use of fertilizers, pesticides, and modern technology. During the Green Revolution, third world countries experienced an increase in grain yields, which led to significant social and political changes. The increase in food production led not only to an improvement in the nutrition of the population of developing countries, but also to the enrichment of farming, the development of commodity-money relations in rural areas. Another consequence of the «green revolution» is to change the attitude towards the genetic fund of the planet. Before its onset, the genetic fund of the Earth was considered a common heritage, and following the results of the first works on genetic modification of plants within the framework of the "green revolution", this approach was revised. In modern conditions, the genetic wealth of various countries has all come to be regarded as a commodity with potential commercial value. The development of intellectual property law and the emergence of «genetic banks» have further strengthened this attitude towards genetic diversity.

At the same time, this revolution has dealt a significant blow to the environment and accelerated demographic growth. In the period 1970s - 80s. of the last century, the negative consequences that manifested themselves in the environment became obvious. The runoff of mineral elements from terrestrial agrocenoses into water bodies has significantly increased. The water sources were polluted. Excess nitrogen and phosphorus led to "explosive" reproduction of phytoplankton, changes in the quality of drinking water, death of fish and other animals. Huge areas of land have undergone soil erosion, salinization and, accordingly, a sharp decline in fertility. A significant number of wild and domestic plant and animal species have disappeared forever [1].

In environmentally oriented management, this agroecosystem management strategy is unacceptable.

An extensive agroecosystem management strategy involves a significant reduction in the cost of anthropogenic energy, the abandonment of pesticides and other mineral fertilizers, and the use of a biodynamic, that is, organic approach in agriculture. An intensive strategy leads to a decrease in the productivity of the agroecosystem, which, under the current demographic circumstances, will not meet the needs for food. Low-cost agroecosystems are possible only on marginal lands, where significant costs of anthropogenic energy are unreasonable, since they give a low return. For the majority of agricultural systems, this strategy is also unpromising.

A compromise strategy for managing the agroecosystem is focused on its sustainable development. This option for managing the agroecosystem assumes a moderate investment of anthropogenic energy, the use of low-hazard pesticides of a new generation, mainly herbicides.

A compromise strategy is most expedient, since it allows you to combine a sufficiently high yield of agricultural products with the preservation of environmental conditions and energy savings. The high level of energy consumption for agroecosystem management is not ecologically justified. In addition, energy as such is in short supply, since energy resources are limited, and the production and transportation of energy is accompanied by environmental pollution. In this regard, an environmentally oriented approach to agroecosystem management, which assumes moderate consumption of anthropogenic energy, provides a sufficiently large amount of high quality agricultural products and does not reduce the sustainability of the agroecosystem, allowing it to conserve its agricultural resources. Conducting agricultural production in an agroecosystem according to this approach requires compliance with a number of requirements:

- it is necessary to limit a part of arable land under profitable crops that destroy the soil, preserving part of the agroecosystem under perennial forage lands or forest plantations;
- it is necessary to limit interference with the soil during its processing, as well as the amount of applied mineral fertilizers and chemical plant protection products;
- it is necessary to limit the number of livestock in the agroecosystem.

In an ecologically oriented agroecosystem, formed according to the principles of sustainable development, it is required to cultivate cultivated plants and raise farm animals, which require relatively low costs of anthropogenic energy; use environmentally friendly crop rotations with perennial grasses and green manures to maintain soil fertility; to cultivate mixtures of cultivated plants that use agricultural crops in an integrated manner and do not require large expenditures for plant
protection; to distribute farm animals throughout the agroecosystem to facilitate the application of organic fertilizers.

The agroecosystem formed in this way is self-sustaining and has the utmost similarity to natural ecosystems. Currently, the share of sustainable agroecosystems is negligible in Russia and in the world as a whole.

Key parameters of agroecosystem management include trophic structure, spatial structure, primary and secondary biological products, and agricultural resource management.

The trophic structure characterizes the relationship between producers, consumers and decomposers of an agroecosystem, expressed by the number of individuals of living organisms, their biomass, or the energy contained in them per unit area per unit of time. Trophic structure also describes the migration and dissipation of energy in the agroecosystem, reflecting its transition from free to bound form.

Energy entering the agroecosystem is transmitted through food chains. The trophic structure of an agroecosystem is much simpler than the structure of natural ecosystems, since it has only two food chains: plants - humans and plants - farm animals - humans.

As a result of the introduction of spontaneous organisms of parasitic insects and weeds, additional food chains may appear that will absorb energy. Thus, the control of the trophic structure of the agroecosystem involves, in addition to controlling the flow of energy flowing through the main food chains, the suppression of additional food chains, along which the outflow of energy from the main chains occurs.

The solution to the problem of energy conservation in food chains is solved through the specialization of the subject of production activities, determined by natural and economic factors. At first glance, the production of crop products seems to be more profitable, since in this case there is no dissipation of energy in the link "plants - farm animals". At the same time, not all types of crop production are profitable and not in all climatic conditions. Thus, in certain agroecosystems, it is more profitable to process energy into livestock products, that is, to direct the flow of matter and energy through the food chain “plants - farm animals - people”. The spatial structure of an ecosystem is the vertical and horizontal distribution of organisms of various species in space. The spatial structure is formed primarily by the plant part of the biocenosis. This principle should, if possible, be reproduced in the agroecosystem. Recently, the principles of adaptive landscape agriculture have been developed, according to which the territories of different landscape facies should be used in different ways. [2].

Recognition of the key role of natural landscape patterns in any nature of its use should be fundamental. Thus, it is necessary to direct efforts to identify an adequate socio-economic purpose of the landscape and to establish, on this basis, the types of activities that correspond to its natural properties to the maximum extent. That is, agricultural activities deployed in the agroecosystem should make the most of the useful properties of the natural landscape and, to a minimum, affect the change in its natural properties. [3].

So, for example, slope lands require the use of special soil conservation programs and the use of crop rotation with the exclusion of row crops and an increase in the proportion of grasses. Optimization of the size of fields is also considered as one of the management methods, since the probability of the spread of insect pests largely depends on the area of crops.

An important parameter of an ecologically balanced agroecosystem is the even distribution of farm animals over its area. The first to write about this in his works was A.T. Bolotov. This approach allows you to optimize energy consumption for the supply of feed and manure removal. Large livestock complexes are anti-ecological as such.

We believe that the main principle of agroecosystem optimization is the principle of natural-anthropogenic compatibility, which presupposes ecological optimization of the agricultural landscape through a balanced ratio between the exploitation and transformation of the agroecosystem and its protection.

Thus, a cultural agroecosystem can be formed that meets the high environmental requirements of rational nature management. The most important features of a "cultural agroecosystem" are: high
parameters of productivity and economic efficiency; optimal ecological environment for people to live.

The most important element in the food chain of the agro-system is primary biological products. In this case, methods are used to improve the conditions for plant growth, as well as the efficiency of the use of resources by plants and their communities.

In the case of optimizing the conditions for the growth and development of plants, management is aimed at reducing the influence of extreme environmental factors, including technogenic impacts, soil salinization, lack of moisture and mineral nutrition elements. In the case of an increase in the efficiency of resource use, the agroecosystem is managed through the use of cultivated plants that are more resistant to adverse conditions, along with the use of plant cultivation methods that increase the efficiency of the use of agroecosystem resources. Managing the complex of anthropogenic stressors of the agroecosystem allows one to control the range of tolerance of the agroecosystem.

Primary biological products act as an energy reserve for secondary biological products. As it is processed in food chains, it goes to replenish the mass of heterotrophic organisms, that is, agricultural animals of the agroecosystem. The amount of secondary biological products depends on the amount of primary biological products in the agroecosystem. Fluctuations in the volume of primary biological production inevitably create fluctuations in the volume of secondary. Agroecosystem management entities are interested in preserving the livestock of farm animals, since recovery after forced losses requires a long time, effort and significant costs. This unfavorable factor from an economic point of view has favorable environmental consequences. The decline in the number of animals leads to the restoration of the biodiversity of pastures and the replenishment of the volume of primary biological products. At the same time, based on economic considerations, a person seeks to reduce fluctuations in the level of secondary biological production. It is possible to stabilize the livestock of farm animals through measures such as safety stocks of feed, export of feed. But the determining factor will be the economic feasibility of these measures.

The most adequate management method in this case will be the formation of a livestock of farm animals with the inclusion of fractions of high and medium stability, as well as the labile and superlabile type.

Within the framework of agroecosystem resource management, management should extend to some resource elements that determine the amount of primary biological products in the future, which can contribute to the formation of a sustainable agroecosystem.

The most important element of the soil resources of the agroecosystem is humus and nitrogen, which are renewable. Elements such as phosphorus, potassium and others are non-renewable. With an increase in the level of exploitation of the agroecosystem, the outflow of these substances increases and they need to be compensated by applying mineral fertilizers.

The most important non-renewable resource is the biodiversity of the agro-ecosystem, which must be maintained at a high level. It is the maintenance of biological diversity in the agroecosystem that ultimately acts as a key condition for the implementation of differential rent I and II in agriculture, in view of the fact that with the adaptive selection and placement of cultivated species and varieties, their optimal ratio and constant selection improvement, more profit can be obtained from every piece of land [4].

It is obvious that the management of polydominant agroecosystems using technogenic factors is a rather complicated process. Phenotypic diversity, creating unpredictability of responses of a large number of biotic components, predetermines the decisive role of biodiversity in the sustainable growth of the quality and quantity of crops produced in the agroecosystem. Due to the limited possibilities of using technogenic factors of agroecosystem stability, the selection of safety crops, varieties of mutual insurance, maintenance of mechanisms and structures of biocenotic self-regulation, as well as the phenological heterogeneity of agroecosystems, confirming the expediency of an evolutionary analogous approach to their design, have a decisive influence.

In natural ecosystems, heterogeneity is continuously increasing in the course of evolution. Unlike natural ecosystems, agroecoses, agroecosystems and agrolandscapes are fixed in time and space by a
community of cultivated plant species, which leads them over time to genetic homogeneity. As a result, the structure of trophic links is significantly simplified and the total energy losses increase significantly. Moreover, in some periods of the growing season under conditions of agrophytocenoses, there is an acute shortage of certain life factors, and in others, many of them remain underutilized. The specificity of the agroecosystem is also largely determined by the weakened regime of competitive relations, the leveling of ecological conditions, and the cosmopolitan nature of most weed species. These and many other factors that determine a decrease in the ability of agroecosystems to maintain ecological balance due to the mechanisms and structures of biocenotic self-regulation, require increasing investments of irreplaceable energy, which inevitably leads to an exponential increase in material costs for each additional unit of production, increases the risk of destruction and environmental pollution [5].

A very important and specific role in ensuring high productivity and environmental sustainability of the constructed agroecosystems is played by the nature of the relationship (direct and indirect) between cultivated plants and their other biological components (competitive, symbiotic, parasitic, neutral), which ultimately determine not only effective the use of natural resources, including solar energy, but also the possibility of maintaining ecological balance through mechanisms and structures of self-regulation.

The agroecosystem management process can be limited by limiting determinants. A person in the process of management cannot get out of the framework of these restrictions. Such constraints may include biological, resource, environmental and economic constraints.

The functioning of the agroecosystem is based on the vital activity of the organisms inhabiting it, which is its biological limitation. Among the biological constraints of the agroecosystem are the amount of solar energy assimilated by cultivated crops for photosynthesis, the amount of nitrogen fixed by microorganisms, indicators of reproduction and productivity of farm animals. Overcoming these limits by human forces is impossible. It is the impossibility of overcoming the biological limits of agroecosystems that becomes the reason for the cessation of the growth of their productivity.

The second type of constraints is resource constraints, which are the most important factors that determine the productivity of an agroecosystem: climate, relief, genetic type of soil, its composition, availability of water resources for irrigation, amount of precipitation, and duration of the warm period. The composition of species and varieties of cultivated plants, species and breeds of farm animals depends on these conditions.

The set of ecological constraints of the agroecosystem is an ecological imperative that includes a set of standards for all areas of management in the agroecosystem that violate its ecological balance, including a decrease in soil fertility, depletion of water reserves, pollution of the environment and foodstuffs produced.

The economic constraints of the agroecosystem require the achievement of certain profit parameters. It is impossible to cultivate crops and raise farm animals if these activities within a particular agroecosystem are not profitable and do not provide competitive products. Thus, expensive terracing of slopes can be justified when growing grapes and tea, but unprofitable when growing potatoes. At the same time, the assessment of the efficiency of production activities in the agroecosystem should be based not only on taking into account production costs, but also on the cost of destructible resources. Environmental friendliness as such becomes a criterion for the competitiveness of an agroecosystem, since economic activity that allows the destruction of resources inevitably becomes ineffective. Maintaining ecological balance and biodiversity makes the agroecosystem sustainable. A sustainable agroecosystem acquires the property of sestaining, which makes it possible to produce agricultural products for a long period while preserving all agricultural resources. A key parameter for the sustainability of an agroecosystem is strengthening the elements of its self-regulation, including partial recycling of mineral elements by applying organic fertilizers to fields and cultivating green manure, reducing the level of erosion and leaching of mineral elements, bringing the livestock of farm animals in line with the capacity of pastures, and increasing the area of forest plantations.
The use of the adaptive approach in agriculture focuses on the cultivation of such crops and the breeding of farm animals that allow the most efficient use of the bioclimate. Within the framework of this approach, the entire agricultural production system is focused on ensuring the maximum return on each unit of anthropogenic energy introduced into the agroecosystem.

The selection of varieties for agrozones should be based on the characteristics and main structural elements of the agroecosystem, such as relief features, hydrological regime, etc.), drought-resistant plants (dry beetles) predominate in the southern steppe regions.

Violation of the requirements of the adaptive approach leads to a significant increase in the cost of agricultural products, which can form «zero effects» of activity when crops and animals introduced into new areas do not take root [6].

Achieving the goals of agroecosystem management is possible through the so-called intermediaries, that is, individual blocks endowed with signs of self-organization, as it happens in natural ecosystems. Agroecosystem is an autotrophic ecosystem and at the same time a manufacturing enterprise. In this object of management, the interests of economics and ecology can coincide and be opposed. Management of the state of the agroecosystem makes it necessary to take into account not only the parameters of productivity and profitability, the level of costs for obtaining products, but also to comply with the conditions for protecting the resources of the agroecosystem, preserving biodiversity, and controlling environmental pollution.

Among the most significant blocks of the structure of self-organization of the agroecosystem, we single out the blocks «field biocenosis», «soil - plant / farm animals», «cattle-meadow-arable land», «forest-field».

The block "field biocenosis" reflects the connections of a cultivated plant, phytophages, entomophages, weeds.

The block «soil - plant / farm animals» is a set of conditions for optimal growth and development of plants, realizing the productivity potential of farm animals.

The block «cattle-meadow-arable land» determines the ratio of the area of arable land, meadows and livestock of farm animals.

The block "forest-field" is focused on maintaining agricultural resources by organizing a forest-agricultural agroecosystem.

The use of an adaptive approach to organizing the functioning of an agroecosystem can activate beneficial symbiotic relationships and ensure an optimal level of soil fertility. The control of the level of phytotoxicity of the soil and the content of residual amounts of herbicides by instrumental, that is, physicochemical and biological methods of the blocks «field biocenosis» and «soil - plant / farm animals» makes it possible to identify a set of environmental measures to manage the state of the agroecosystem.

Thus, instrumental and biological control makes it possible to develop a set of environmental recommendations for agroecosystem management [7].

So, depending on the results of the state according to the instrumental and biological control of the agroecosystem, a complex of agrotechnical measures is developed, as well as recommendations for adjusting crop rotation (Figure 1).

An integrated approach to ensuring environmental control over the state of the agroecosystem, mainly physicochemical (instrumental) and biological, is quite effective for solving scientific and practical problems of agroecosystem management.

Within the framework of the “cattle-meadow-arable land” block, it is possible to search for the optimal structure of the agricultural ecosystem by forming the ratios of the area of arable land, meadows and the livestock of farm animals, in which there would be enough fodder on pastures to feed them, and organic waste from livestock to maintain soil fertility. In modern conditions, it is possible to organize a rather complex agroecosystem, in which the ration of farm animals will consist of grasses from arable land and a certain proportion of juicy and concentrated feed (grain). At the same time, the waste of livestock of farm animals is necessary to compensate the arable soil for the
loss of organic matter and nutrients, as well as to replenish the reserves of mineral substances through the introduction of green manure and mineral fertilizers. At the same time, the excessive concentration of farm animals in large farms and livestock complexes adopted in modern farming systems reduces the profitability of transporting organic matter to fields if they are more than 5 km away. Thus, a return to small farms with no more than 50 head of cattle is a way to optimize and ecological balance of the agroecosystem [8].

**Figure 1.** An integrated approach to monitoring the state of the agroecosystem.

The «forest-field» block assumes the maintenance of agricultural resources through the formation of a forest-agricultural agroecosystem. The alternation of forest and arable land reduces erosion, improves the microclimate, and helps to normalize the hydrological and hydrochemical regimes. The forest forms a complex of beneficial symbiotic bonds.

In a temperate climate, forest reclamation is a win-win method for increasing crop yields. The statistics reflect an increase in yield by 5-15% in the forest-agricultural ecosystem compared to a purely agricultural one. The costs of tree planting are fully offset by higher yields. In addition, irrigation and drainage risks of soil destruction are leveled.

Thus, the formation of a sustainable agroecosystem requires a set of appropriate calculations. The concept of agroecosystems will differ depending on the initial natural conditions, such as soil, climate, as well as economic specifics, including market conditions, demand for manufactured products, and
energy supply. In any case, the structure of an agroecosystem should be based on an ecological imperative (Figure 2).

Of course, it is impossible to completely liken an agroecosystem to a natural one. For the removal of nutrients from the agroecosystem, it must receive compensation, for the discrepancy between its structure and the natural ecosystem, it must also be paid with energy [9].

Any impact on agricultural resources capable of destroying the soil, natural forage lands, and polluting the aboveground and underground waters of the agricultural landscape must be subject to regulation and restrictions. It is not the action itself that should be normalized, as, for example, the created load per unit area of arable soil, farm animals per unit of pasture area, but the results, such as the parameters of the chemical and physical properties of the soil, the projective cover of the grass stand, etc.

The rationing of the share of arable land, which is the most important parameter of the agroecosystem, is influenced by climate and relief. In mountainous areas, the area of arable land will be extremely limited, on the plain of the forest zone it should be no more than 40%, and in the steppe zone no more than 70%. Thus, the area of arable land in the agroecosystem must fit into the environmental standard.

The size of the field is also an important parameter that has an indirect effect on the «biocenosis of the field». The share of grain and row crops, perennial and annual grasses, weediness thresholds, and pasture capacity must also be subject to environmental regulation.

Thus, when considering agroecosystems using an adaptive approach as an intermediate link between natural ecosystems that develop on the basis of solar energy and industrial systems provided by fuel energy, ways of solving modern problems of sustainable development and ecological balance can be outlined. Increased industrialization in agricultural production has led, on the one hand, to an increase in the consumption of energy and chemicals, on the other, to chemical pollution of the environment and soil erosion. The separation of management processes from the agroecosystems themselves and landowners under the influence of market development, exports leads to the priority of the production of goods characterized by a quick payback over agriculture, based on stable productivity while maintaining soil fertility and other resources of the agroecosystem [10].

Overcoming the stratified negative tendencies requires new forms of conservation tillage and the approach of agroecosystem management to the agroecosystems themselves. The results of our studies allow us to hope that a decrease in the load on soil resources, a decrease in soil treatment and its pollution with chemical toxicants will allow the formation of symbiotic subsystems that will be able to provide a long-term increase in soil fertility and the stability of agroecosystems.
The use of an adaptive approach to organizing the functioning of the agroecosystem while ensuring regular environmental control, rationing and limiting impacts on agricultural resources, within the framework of a long-term scientifically grounded concept of agroecosystem management, will make it possible to bring agroecosystem management as close as possible to the contours of self-governing natural systems by optimizing the agricultural landscape introduced into the economic circulation and ensure comprehensive rationalization natural and economic system.

Adaptability implies the potential of the system to preserve its structure under the influence of changes in external conditions due to the ability of self-regulation and moderate investments of anthropogenic energy, as well as the ability of the agroecosystem to transform naturally while simultaneously implementing the main functions, responding to external and internal changes. Control of changes in the environment and agricultural production should be accompanied by corrective actions, which can be carried out repeatedly if the previous ones are unsuccessful.

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