

## ECOLOGICAL ISSUES OF ENSURING SUSTAINABLE DEVELOPMENT OF AGRICULTURE IN AZERBAIJAN

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### Abstract

*The sustainable development of the agricultural sector is determined by three closely interrelated components: economic, social and environmental. In the paper, we have tried to identify environmental problems in the sustainable development of the agricultural sector, focusing on the environmental component of sustainable development. At the same time, the system of factors determining the sustainable development of agricultural production was substantiated during the study. The purpose of the study to systematize and justify the environmental factors that contributes to the sustainable development of agricultural production. Relevance of the study ensuring food security in the context of Azerbaijan's integration into the world market urgently requires sustainable development of the agricultural sector. The high level of environmental tensions in the development of agriculture requires a radical renewal of the strategy and tactics of agricultural development, strengthening the role of the agricultural sector.*

*Key words:* sustainable development, agriculture, environmental factors, food security

### INTRODUCTION

The concepts of "sustainable development" and "sustainable economic growth" are closely linked. And sustainable development means sustainable economic growth. The main task of sustainable development is expressed in the continuous (sustainable) satisfaction of the needs and desires of society. Sustainable economic development is the gradual improvement of one state by another as a result of dynamic growth and the balanced interaction of the components of the economic system in the long run. The instability of the economic system is its inability to continue to move on a positive growth trajectory due to its negative components [27].

The principles of sustainable development by researchers include the following:

- 1) Stability, i.e. the mandatory existence of three interrelated components of compliance with the triple concept, which combines economic, social and environmental aspects;
- 2) Sustainability, i.e. development in any sector of the economy should show a certain dynamics of change (even negative), because

it is impossible to talk about sustainable development only in the conditions of complete cessation of this process;

- 3) Positivity, i.e. changes in all three components must be positive. In other words, such development of a sector or economy is unsustainable if production or economic indicators that aggravate environmental or social parameters are achieved.

Currently, the most accepted concept in the world is the concept of "Sustainable Development". The concept was adopted at the UN Conference in Rio de Janeiro-92 and is used in the development of national strategies for sustainable development. Since 2003, the Azerbaijani state has adopted a National Program for Environmentally Sustainable Socio-Economic Development. The Republic of Azerbaijan signed the Paris Agreement on April 22, 2016, added to the UN Framework Convention on Climate Change, and ratified it in October of that year. According to this agreement, Azerbaijan aims to maintain a 35% reduction in thermal gas emissions by 2030 compared to 1990, as a contribution to global climate change mitigation initiatives. In addition, it has joined

the Sustainable Development Goals (SDGs) approved by the UN Summit for Sustainable Development for 2016-2030 [14].

There are problems in life, the solution of which depends not only on humanity, but also on all countries and their populations. Such problems include the protection of the environment, the ecological balance of the biosphere.

Taking into account the current ecological situation and socio-economic situation, the following three main directions of the environmental policy of our republic can be identified:

- Application of advanced methods based on the principles of sustainable development in order to minimize environmental pollution and regulate its protection, based on ensuring environmental safety;
- Efficient use of natural resources to meet the needs of present and future generations, use of inexhaustible energy sources through alternative, non-traditional methods and achieving energy efficiency;
- Assessing needs at the national level on global environmental problems, identifying solutions, expanding relations with international organizations, as well as ensuring their implementation using national potential.

Currently, due to economic, political, technological and other reasons, more than 50% of the world's population lives in cities, and this figure is expected to increase to 70% by 2050. For this reason, the leading countries of the world, with the support of international organizations, are trying to apply sustainable development models that balance economic development and the environment to prevent environmental, demographic and other problems caused by increasing urbanization.

As in many countries, environmental problems in Azerbaijan are more typical for industrial and agricultural regions (Baku, Sumgayit, Shirvan, Ganja, Mingachevir, Nakhchivan).

Pollution of the environment, soil and water is one of the main reasons hindering the sustainable development of agriculture. However, agriculture also plays an important

role in polluting the environment, soil and water. Agriculture causes significant and sometimes irreparable damage to the natural environment.

Recently, many publications have seen the achievement of sustainable agriculture in the transition from a man-made farming system to an environmentally sustainable system of “ecologically balanced agriculture”.

In this context the purpose of the paper is to identify environmental problems in the sustainable development of the agricultural sector.

## MATERIALS AND METHODS

In this paper used a systematic approach to determine the system of factors contributing to the sustainable development of agricultural production and statistical comparative analysis methods to assess the environmental situation in the agricultural sector. The paper uses data from the Ministry of Ecology and Natural Resources and the Azerbaijan Statistics Committee. In the process of working on the paper were used the relevant laws and national programs of the state, such as Law of the Republic of Azerbaijan “On ecologically clean agriculture”, “State Program on forest protection and sustainable development in the Republic of Azerbaijan for 2022-2030”, “National Strategy for Improving Solid Waste Management in the Republic of Azerbaijan for 2018-2022”, “State Program of Socio-economic Development of the Regions of the Republic of Azerbaijan in 2019-2023” and etc.

## RESULTS AND DISCUSSIONS

Agriculture is a complex and multi-level system. In this regard, in our opinion, it is important to identify internal and external factors affecting the sustainable development of agriculture (Figure 1). External factors play a crucial role in sustainable development. From this point of view, the existence and development of these factors is clearly related to the macroeconomic environment. Internal factors cover the level of development and condition of the economy and the enterprise.

Sustainable development is expanded reproduction, where investment, use of material, financial and labor resources, as well as strategic and institutional transformations are interrelated and aimed at meeting the growing needs of society.

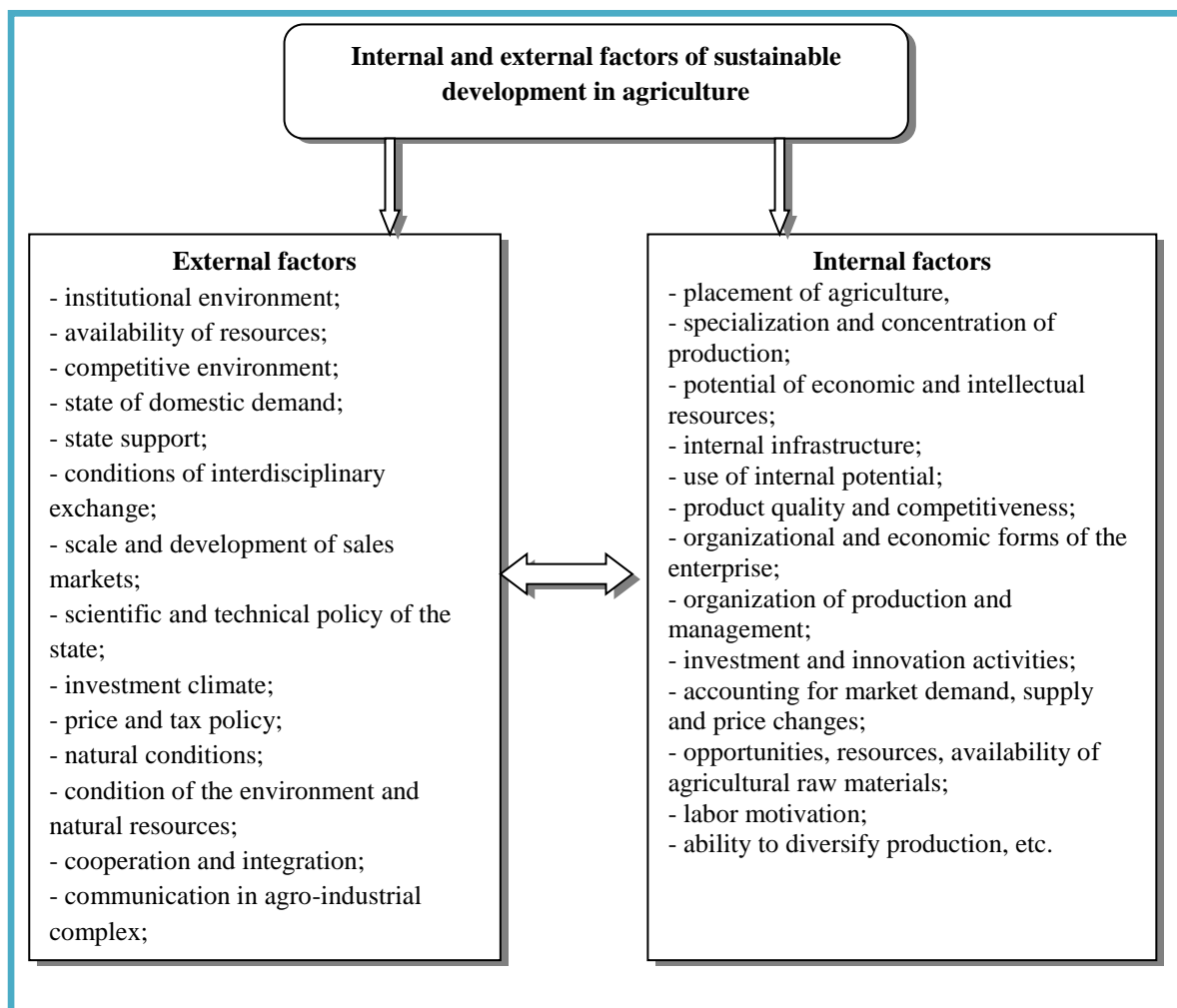


Fig. 1. Classification of internal and external factors affecting sustainable development in agriculture  
 Source: Compiled by the authors based on the collected information.

When efforts at sustainable economic development are combined at all levels - regional, state, family and individual - in a more compact way, a fertile ground is created for high results [10]. The dependence of agriculture, a key component of sustainable agricultural development, on natural resources and climatic conditions makes it less sustainable than other sectors of the economy and does not allow it to adapt to a market economy. As a result, agriculture cannot develop without state support [11].

In our opinion, state support for agriculture is important. This is because agriculture is the basis of ensuring the country's food security and supplying industry with raw materials.

And this support cannot negatively affect sustainable development; on the contrary, it promotes sustainable development.

In contrast to the crises that regularly occur in the world economy during economic development, "sustainable development" involves maintaining a balance between the interrelated elements of the system - the economy, the social sphere and the environment [2]. The concept of sustainable agricultural development is inextricably linked with the growth of food production, efficient use of economic and intellectual resources, improving the welfare and quality of life of the rural population, stable and balanced management of nature. Only a balance of economic, social and environmental components can ensure the

sustainable development of this industry for a components of sustainable agriculture long time. The relationship between the development is shown in Figure 2.

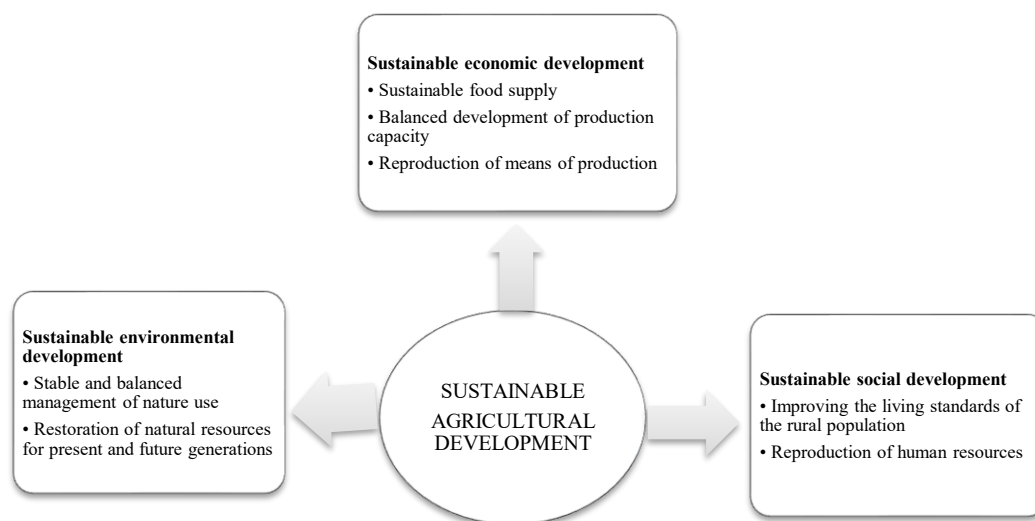


Fig. 2. Interrelation of components of sustainable development of agriculture  
Source: <https://cyberleninka.ru/article/n/metodologicheskie-osnovy-ustoychivogo-razvitiya-regionalnyh-sotsio-ekologo-ekonomicheskikh-sistem> [5].

The use of stable, balanced nature is associated with ensuring the current and long-term sustainability of agricultural systems, improving the quality of the environment and protecting natural resources.

Climate change should also be emphasized in terms of agricultural sustainability. Climate change's negative impacts are already being felt, in the form of increasing temperatures, weather variability, shifting agroecosystem boundaries, invasive crops and pests, and more frequent extreme weather events. On farms, climate change is reducing crop yields, the nutritional quality of major cereals, and lowering livestock productivity [25].

#### **Assessment of the impact of the ecological situation in the Republic of Azerbaijan on the sustainable development of agriculture**

Agriculture is a field of social production, closely related to the biological laws of the development of the living world. No other field of economic activity is as prominent as in agriculture.

Ensuring the stable and sustainable development of agricultural production, which is the basis of the agrarian sector, depends, above all, on the efficient use of water and land resources, soil productivity enhancement

and ensuring its reproduction. It should be noted that after the independence of our country, radical reforms have been carried out in the agricultural sector [15]. The measures taken by the state to improve land use are one of the leading directions of the independent agrarian policy in the country (amelioration, salinization, environmental pollution, etc.). In order to improve the quality of the environment, efficient use and restoration of natural resources, strengthening the legislation in the field of environmental protection, the interaction of nature with society is regulated by the Law of the Republic of Azerbaijan on Environmental Protection adopted on June 8, 1999.

Maintaining the necessary balance between the economy, society and the environment in the context of the global environmental crisis can only be achieved through the formation of a new environmentally safe and economically optimal model of development - sustainable development. In this context, the main priority now is to coordinate global, regional and national tools to achieve the goals of sustainable development [14].

Improving ecological conditions, environmental protection, forestry,

hydrometeorology, etc. Great work has been done in the last few years as a result of the principled position of the country's leadership, national and state programs aimed at their comprehensive solution have been approved, legislative acts in the field of ecology and environmental protection have been approved. and government decisions have been made or improved [1, 13, 16, 18, 19, 20, 21].

The liberation of our territories from Armenian occupation in 2020 has set new tasks in the fields of socio-economic and innovative development. In accordance with the "Azerbaijan 2030: National Priorities for Socio-Economic Development", the "Strategy for Socio-Economic Development in 2021-2025" sets the task of implementing reforms, projects and measures in 5 important areas on the basis of national priorities:

- 1) sustainable, growing and competitive economy;
- 2) a dynamic, inclusive and socially just society;
- 3) competitive human capital and space for modern innovations;
- 4) a great return to the liberated territories;
- 5) clean environment and "green growth" country.

The analysis shows that the main environmental problems of the country are:

- pollution of water resources with wastewater, including exposure to transboundary pollution;
- low level of quality water supply of settlements, loss of fresh water before delivery to consumers, lack of sewerage lines;
- air pollution by industrial enterprises and vehicles;
- degradation of fertile soils (erosion, salinization, etc.);
- inadequate management of solid industrial and domestic wastes, including hazardous wastes;
- biodiversity thinning;
- reduction of forest resources, fauna, including fish stocks.

Maintaining the necessary balance between the economy, society and the environment in the context of the global environmental crisis can only be achieved through the formation of

a new environmentally safe and economically optimal model of development - sustainable development. The main priority here is to coordinate global, regional and national tools for achieving the goals of sustainable development.

To assess the state of the natural elements of the research object, let's consider the climatic features of the country. Most of the territory of the Republic of Azerbaijan is located in the subtropical climate zone, only in the north-eastern temperate zone of the Greater Caucasus Mountains. Of the 7 climate zones in the world, only 2 are in Azerbaijan, of which 65% are subtropical and 35% are temperate. The uniqueness of natural and geographical conditions has created conditions for the diversity of species of flora and fauna. 9 out of 11 climate types on Earth are found in Azerbaijan. This factor plays an important role in the formation of rich biodiversity in the country [14].

The main risks for agricultural production are: uneven distribution of precipitation throughout the year; dry winds that contribute to moisture loss and soil drying.

The main element of the resource potential of agricultural production is land, or more precisely, land cover. However, not enough attention is paid to the problems of biologicalization of agriculture. It takes nature 200-300 years to restore one centimeter of black soil [12]. However, buildings, flooded lands, inefficient agriculture, especially intensive pastures, improper irrigation and plowing have led to the withdrawal of agricultural land in our country.

The implementation of a number of economic and organizational measures to ensure the timely, targeted and high level of capital investment in nature protection measures has become sustainable in the country. Analysis of expenditures on environmental protection shows that expenditures in 2010 increased by about 1.6 times from 260,673.8 thousand manat in 2012 to 419,317.9 thousand manat. Expenditures in 2012-2015 decreased by 3.1 times. The main reason for the decline is the devaluation process that took place in the country in 2015-2017. We see an increasing

dynamics of spending between 2016-2019. Expenditures incurred in 2019 compared to 2015 increased by 2.8 times from 136,208.3 thousand manat and amounted to 387,680.4 thousand manat. The decline in 2020 can be seen as a reduction in environmental spending

in the structure of global storm and pandemic costs. Thus, compared to 2019, expenditures on environmental protection in 2020 decreased by about 1.6 times and amounted to 239,764.5 thousand manat (Figure 3).

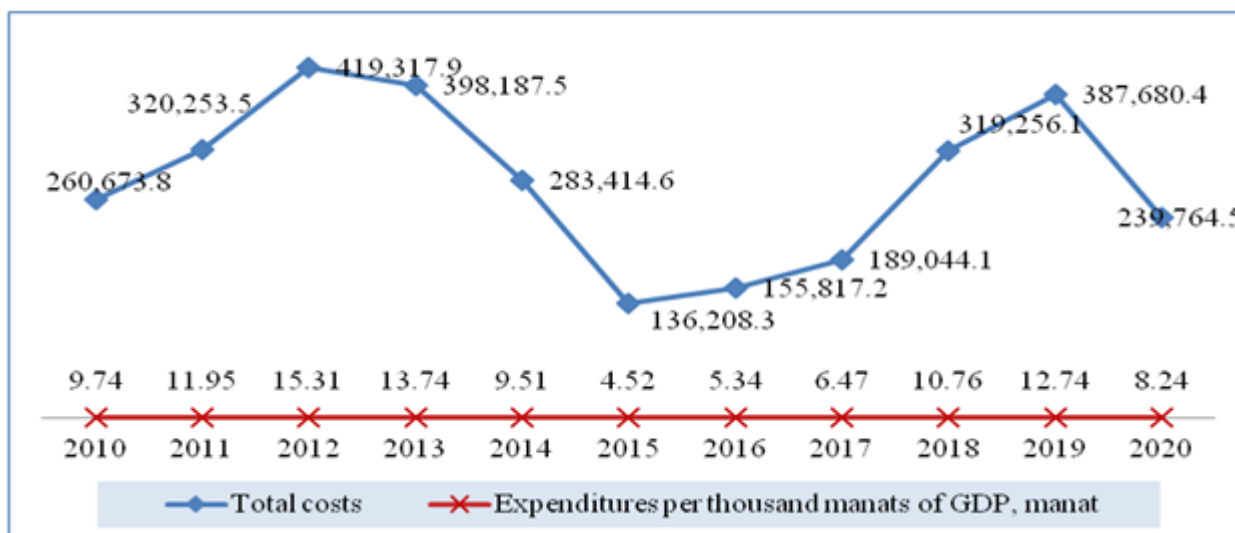


Fig. 3. Expenditures on environmental protection in 2010-2020 (thousand manats)

Source: Compiled by the authors based on the State Statistical Committee of the Republic of Azerbaijan [22].

In the structure of expenditures, current expenditures on environmental protection measures - 15%, overhaul of fixed assets for environmental protection - about 0.3%, maintenance of reserves and national parks, protection and reproduction of wild animals, fish - 1.8%, forestry operations - 2.8% %, funds directed to fixed assets for environmental protection and efficient use of natural resources - 80%. Expenditures per thousand manat of GDP in 2020 amounted to 8.24 manat.

The amount of funds directed to fixed capital for environmental protection and efficient use of natural resources in the Republic of Azerbaijan is given in Table 1. The analysis shows that the volume of major investments in environmental protection and efficient use of natural resources in the country decreased by about 10.4% between 2010 and 2020, from 190,007.2 thousand manat to 170,208.7 thousand manat. It should be noted that the decline in oil revenues has not passed without an impact on investments in fixed assets in the country. Compared to 2010, there was a 1.7-fold decrease in 2016. In 2016, 99.5% of the

total investment in this area was directed to the protection and efficient use of water resources.

In the context of population growth and deterioration of the environment, as well as the observed global climate change and declining fertile land resources and drinking water resources, it is necessary to improve the provision of the population with quality food, increase and intensify agricultural production. For these reasons, substantiation and solution of complex scientific views for the development of irrigation and land reclamation complex with modern engineering, economic and environmental safety and more effective protection of the environment, advanced management methods, information technologies in irrigation and land reclamation It is necessary for its application and rapid future development on a completely new level, taking into account the trends in the field [17].

Water is a prerequisite for life, support for sustainable development and is one of the biggest global risks and deserves special attention. This is because water scarcity and

mismanagement, especially in transboundary watersheds, can even increase the potential for conflict. At the same time, problems with water resources can exacerbate social, environmental, economic and financial stresses.

It should be noted that the main reason for the increase in the amount of water in large rivers is small rivers. However, recently these small rivers are also in danger of drying up. Rivers also regulate soil, air humidity and microclimate. In this regard, the protection of such areas should always be kept in mind.

Modern agriculture is not only the largest consumer of water resources, but also one of the most polluting areas. It is primarily about the pollution of rivers with organic matter, water bodies with eutrophic nutrients, water sources with pesticides and mineral fertilizers, ground and surface water with oils and waste generated during the cleaning of agricultural machinery.

Our republic has limited water resources. However, research shows that the country's potential water resources can meet the water needs of industry, agriculture and households. Approximately 67-70% of water resources (19.0 - 20.5 cubic km) are formed in transboundary rivers and 9.5-10 cubic km mainly in inland rivers. In dry years, water reserves fall to 27.0-22.6 cubic km. Accordingly, 17.1 - 14.3 cubic km of these waters belong to transboundary rivers. The total surface water resources in Azerbaijan vary between 9.0 and 11.0 cubic km. [23].

The World Economic Forum has listed the water crisis as one of the top three important global risks. This problem is included in the UN 2030 Sustainable Development Goals, the Sendai Framework Program for Disaster Risk Reduction and international agreements such as the Paris Agreement. For this purpose, cross-border diagnostic tests are carried out in our country in order to prevent water pollution and at the same time transboundary pollution. Our country participates in various projects at the national, regional and global levels [24, 26].

In general, no investments were made in air protection in 2010, 2015 and 2016. It is

important to pay attention to the protection of the atmosphere in order to improve the ecological situation in our country and ensure environmental security. Research shows that the air situation in the country remains tense.

Agriculture is a major part of the climate problem. It currently generates 19–29% of total greenhouse gas (GHG) emissions. Without action, that percentage could rise substantially as other sectors reduce their emissions. Additionally, 1/3 of food produced globally is either lost or wasted. Addressing food loss and waste is critical to helping meet climate goals and reduce stress on the environment [25]. According to empirical studies, there is a long-term relationship between agricultural production and carbon dioxide (CO<sub>2</sub>) emissions in Azerbaijan. Agricultural production and the square of GDP have a negative impact on air pollution [9].

In order to protect the atmosphere, many developed countries have already switched to European standards. In order to prevent air pollution and efficient use of natural resources, the use of technologies to improve energy efficiency, as well as alternative energy sources such as sustainable energy sources (wind, solar, biogas, biomass, geothermal, hydroelectric) has become widespread. In Azerbaijan, this work is very slow.

Land resources are valued as one of the key elements of its existence and potential for the development of all countries. Land, with its natural historical landscape and land cover, is one of the most important natural resources for the life of society. Unlike other natural resources, it is spatially limited and irreplaceable. Being the basis for the development and deployment of the productive forces of society, all sectors of the economy, land resources in agriculture and forestry act as the main means of production, the object of production relations. The economic and environmental well-being of the state depends to a large extent on their condition, how and to what extent they are used. Like any natural resource with which society interacts throughout its life, land

resources are subject to structural and qualitative changes in the process of use. Human activity must be strictly in accordance with the laws of nature, and ignoring or underestimating them can lead to unintended consequences. It is the duty of society as a whole to protect the natural fertility of the soil and to use all types of land resources efficiently.

When assessing the efficiency of land use by changing and improving land relations, the level of protection of soil fertility, the degree of ecological balance, the volume of land improvement work, etc. should be taken into

account. is also of great methodological importance [3].

In 2010, 2015, 2016, 29%, 0.5% and 0.5% of total investments were directed to the protection and efficient use of lands, respectively. The volume of investments in land protection increased by 8.6 times in 2019 compared to 2016 and amounted to 4,734.9 thousand manat from 550,000 manat. In 2020, the total investment amounted to 170,208.7 thousand manat, all of which was aimed at the protection of water resources and their efficient use. According to other indicators, no investments were made in 2020.

Table 1. Funds directed to fixed capital for environmental protection and efficient use of natural resources (thousand manats)

	2010	2015	2016	2017	2018	2019	2020
Overall	190,007.2	84,864.4	109,546.0	133,387.0	247,912.2	309,855.6	170,208.7
protection of water resources their efficient use	134,936.9	84,474.4	108,996.0	117,387.0	233,348.1	294,922.5	170,208.7
to protect the atmosphere	-	-	-	16,000.0	13,498.5	10,198.2	-
protection of lands and t efficient use	55,070.3	390.0	550.0	-	1,065.6	4,734.9	-

Source: The State Statistical Committee of the Republic of Azerbaijan [22].

The exogenous environment plays a crucial role in the sustainable development of the national economy. Separately, both the present and the future of each country can be characterized as a function of the complex of relations formed between the national → regional → global levels [4].

At the global level, agriculture is currently in a period of transition from the Green Revolution to the Second Green Revolution or the Biotechnological Revolution. Thus, against the background of limited land and water resources, although intensive production methods have provided a significant increase in global food supply, there have also been serious negative impacts on the environment and ecosystems. This factor has necessitated the expansion of the use of new technologies in modern times that allow for sustainable agricultural production. That is why biotechnology in modern times acts as a means to radically strengthen global food security and reduce the negative impact on the environment. Thanks to biotechnology,

plant species resistant to drought, heat, cold, soil salinization, pests, toxic herbicides, as well as animal species resistant to diseases and climate change are created. Such species help to ensure farm efficiency in marginal areas and rehabilitate degraded soils, as well as significantly reduce the need for pesticides and mineral fertilizers. However, the creation of effective national regulatory systems in each country based on international standards is one of the important global challenges to identify and control the negative impacts of the application of biotechnology on the environment and food security.

It is time to introduce completely new and effective methods and approaches to the storage and distribution of food resources in accordance with the requirements of food availability. The responsibility for the treatment of ecosystems, the importance of environmental safety must be made clear to everyone, the scope of awareness-raising in these areas must be significantly expanded, and the views of farmers on the protection of



nature and biodiversity must be fully understood in the context of climate change. It should be clear that food producers need to fully understand the important points in this regard [10].

The development of Climate-Smart Agriculture (CSA) is of particular importance in terms of solving environmental problems in the agricultural sector and combating climate change. Climate-Smart Agriculture will help achieve the following goals: increased productivity, enhance resilience and reduced emissions. According to a study based on an extensive review of scientific evidence relating in particular to climate-smart agriculture (CSA), focusing on the role of the CSA, a set of priority actions for greening systems has been compiled. The results of the analysis provide insight into a new model of system dynamics capable of representing complex causal relationships and non-linear feedback loops between key dimensions and sustainable development actors [6].

The liberation of our territories from Armenian occupation in 2020 has set new tasks in the socio-economic sphere as well as in the environmental sphere. Armenia has committed unimaginable environmental terror in the occupied territories of Azerbaijan for almost 30 years, and it continues to do so. The scale of the environmental catastrophe (environmental terrorism) caused by the Armenian terrorist forces in the region is unimaginable. Unprecedented damage has been inflicted on the flora and fauna of Karabakh and its forests, the agricultural system has been completely destroyed, and our lands have been mined.

The above-mentioned violations of international conventions on ecology and the environment, to which Armenia is a party, including the UN Convention on the Prohibition of the Use of Military or Any Other Hostile Methods of Environmental Change.

According to the land balance, more than 200,000 hectares of land in the liberated areas will be used for agriculture after the restoration of agriculture, of which about 9,000 hectares are backyards.

There is also an accurate assessment of the potential for the establishment of irrigation systems in these areas, and irrigation opportunities in general. After the assessment of land and water resources and the establishment of an accounting system, the main task is undoubtedly to carry out land reform in the liberated areas.

According to estimates, due to the restoration of agricultural production in the region, the total volume of agricultural production in the country is expected to increase by more than 8% [8].

## CONCLUSIONS

As a result, it should be noted that all processes between agriculture and the environment are closely linked. The negative manifestation of one does not pass unnoticed to the other. Currently, the depletion of natural resources reduces the base for agricultural production, which can create great economic difficulties in the future. Based on our analysis, let us note that these difficulties are already manifesting themselves. Inefficient use of lands, application of large amounts of fertilizers, improper installation of irrigation systems, etc. causes pollution of soil, water and atmosphere with harmful components, chemicals, exhaust gases.

Given that natural resources are the national wealth of the country, then the issue of solving the environmental problem in the context of economic security should always be in the center of attention during their privatization.

Given the importance of sustainable development investments, the use of material, financial and labor resources, as well as strategic and institutional changes and expanded reproduction to meet the growing needs of society, we must emphasize the importance of the state's role in ensuring sustainable agricultural development in Azerbaijan. Optimization of technological processes aimed at the development and improvement of agriculture is not possible without the financial support of the state. This is very important to prevent environmental

pollution and provide the population with healthy and environmentally friendly food. Also increase investments in agricultural R&D, extension and advisory services, as well as capacity development to improve national agricultural innovation systems [7] and the coordination of investments/measures in agriculture and a higher level of knowledge of farmers [6].

In addition, it is important to regularly monitor the current state of environmental factors using qualitative and quantitative indicators to assess threats and limit further unsustainable expansion of economic activity, and to achieve a balanced use of factors of production. Otherwise, in the future, our country may face serious problems related to sustainable development.

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