RESOURCE-SAVING IN AGRICULTURE – INTERSECTIONS CENTER OF ECONOMICS, ENVIRONMENTAL PRODUCTION AND ECOLOGICAL EDUCATION OF SPECIALISTS

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Introduction

Resource-saving is an urgent problem of any production. It is also relevant for the agricultural sector. In agriculture, from an economic point of view, it makes it possible to reduce the cost of production and make it more profitable, and from the ecological point of view resource-saving minimizes the negative impact of agrarian technologies on the natural environment, and from the point of view of the ecological education system, resource-saving is the result of knowledge and beliefs that had been formed in the process of training of the future agricultural specialists. Resource-saving solutions are ultimately the result of a three-pronged complex: the requirements of the economics, the direction of economy at the ecologization of technology and professional ecological knowledge of the agricultural specialists. In fact, there are a lot of differences in this complex, starting with the basic conceptual apparatus and ending with practical guidelines.

The complexity of the resource-saving problem lies in the fact that it affects various sectors of not only economics, but also sociology, biology, nature management, ecology and other sciences, and none of them acting alone can offer the only effective way of its holistic solution.

The aim of the article is to develop the ways to achieve consensus in the field of economic science, requirements of ecology for preserving the natural environment in the agrosphere and the system of environmental training for the future agricultural specialists.

The starting point in solving the problems of resource-saving in agriculture is the content of the concept of ‘resources’.

In economics the concept of ‘resources’ (from the French *ressource* – an auxiliary tool) includes ‘money, values, reserves, opportunities, sources of funds, income’. Some economists under the term ‘resources’ understand all natural, human and man-made means that can be used to produce goods and services, i.e. benefits (Andriichuk, 2002).

In the environmental literature the term ‘ecological resources’, which denotes all material and non-material components of nature and humanity, providing an ecological balance in nature and the environment, is becoming more widely used. In a particular case, the term ‘ecological resources of agriculture’ means a set of environmental factors that determine the possibility of cultivating plants.

Agricultural production, unlike other human activities, is based mainly on natural and labor resources.

Natural resources are any components of nature used by a person for their own needs. There are different classifications of natural resources, of which the most commonly used is the following:

a) energy resources of sun and wind;

b) water resources;

c) forest resources, including recreational resources;

d) land resources, including agricultural land;

e) mineral resources;

e) fuel resources, including oil, natural gas and coal, producing more than 80 per cent of the world's energy.

According to Yu. A. Zlobin (1998), resources in agro-ecosystems are classified not by types, but by properties as follows:

a) exhaustible (oil, etc.) and inexhaustible (solar energy, wind energy, etc.);

b) renewable (biomass of plants and animals) and non-renewable (oil, minerals);

c) replaceable and non-replaceable (land area).

Another important source of resources in agriculture is the labor force, which is part of the country's population, which is capable of engaging in useful activities in this field due to physical development, acquired education and a vocational-qualification level.

Resource-saving is considered as an economic category. Resource-saving is the organizational, scientific, practical, informational activity of government agencies, legal entities and individuals aimed at reducing the consumption of resources in the manufacturing of products (without compromising quality), using high-end technology, modern equipment, optimal technological regimes.

The economy in evaluating any production relies, primarily, on such indicators as profit, profitability, net income. This approach also manifests itself when solving the problem of resource-saving. Thus, A. A. Obikhod (2016) forms a number of principles that one should be guided when solving resource-saving problems, among them: a) the principle of priority, which means saving more expensive resources among other resources; b) the principle of availability of minimum costs, i.e. protecting resources that require large expenditures for their acquisition or maintenance; c) the principle of expediency, consisting in saving those resources that produce the greatest economic effect. Obviously, the resource-saving is based on the cost factor.

From the point of view of the economic theory and practice, the attitude to resources in agriculture, like in any industry, in conditions of the market economy, obeys the rule of maximizing profits from the use of each type of the resources. Resource-saving, thus, turns out to be a secondary task, which can be realized only from the point of maintaining or even increasing the income from each type of the resources. As a result, such an orientation of the economy inevitably leads to the reduction and degradation in the agrosphere of non-replaceable and exhaustible resources – above all, these are the parameters of the quality of the agricultural land fund.

For Ukraine, such a path of development with the transition to a market economy was forced by the need to integrate into the market economy of the European Union countries.

And, nevertheless, according to R. S Blyzkyi (2009), "One of the fundamental provisions of the economic theory is the thesis that the material needs of society are unlimited, and the economic resources necessary to meet these needs are limited". Therefore, resource-saving, even in a market economy, is not only a process that affects the profit/loss ratio, but above all, the factor in protecting agricultural resources from complete degradation, when the industry itself is threatening to enter a phase of stagnation. Just this circumstance leads to the need to find other approaches to resource-saving.

The basis of agriculture is land resources. Their main feature is vulnerability in predatory use and exhaustibility in the absence of adequate replenishment.

In the world in the structure of agricultural lands arable land constitutes 28 % (1.3 billion ha), pastures – 70 % (3.3 billion ha), perennial plantations – 2 %. As the population on the Earth Globe grows, the supply of agricultural land decreases: if in 1980 the world's per capita accounted for 0.3 ha of arable land, in 2011 it was 0.24 ha. In North America per capita accounted 0.65 ha of arable land, 0.28 ha – in Western Europe, 0.15 ha – in Asia, 0.49 ha – in South America, 0.30 ha – in Africa.

According to the data published by the UN FAO, about 300 million tons of wheat, the same amount of rice, 200 million tons of barley, oats, rye, 250 million tons of corn, 100 million tons of millet, sorghum, 300 million tons of potatoes, 100 million tons of fruit, 60 million tons of legumes, 30 million tons of onions and tomatoes, 60 million tons of sugar, 20 million tons of vegetable oil, 400 million tons of milk, 100 million tons of meat are annually harvested from land on the soils of Eurasia, Africa, America and Australia.

The area of agricultural land in Ukraine in 2015 was 41 507.9 thousand hectares (73.8 % of the total area of the state). The lion's share (78.3 %) was occupied by arable land, which indicates a high rate of plowing of the territory (53.8 %), almost twice as high as in the EU countries (28 %). Perennial plantations occupied an area of 892.4 thousand hectares (2.1 %). About 240.6 thousand hectares (5.7 %) were hayfields, and pastures – 5 434.3 thousand hectares (13.0 %). In general, Ukraine, in comparison with other countries of the world and Europe, has unique opportunities for the development of highly productive agriculture.

The total use of the land fund of Ukraine from 1994 to 2015 has changed significantly (Figure. 1). During this period, the area of forests, land under construction increased due to the reduction of agricultural land.

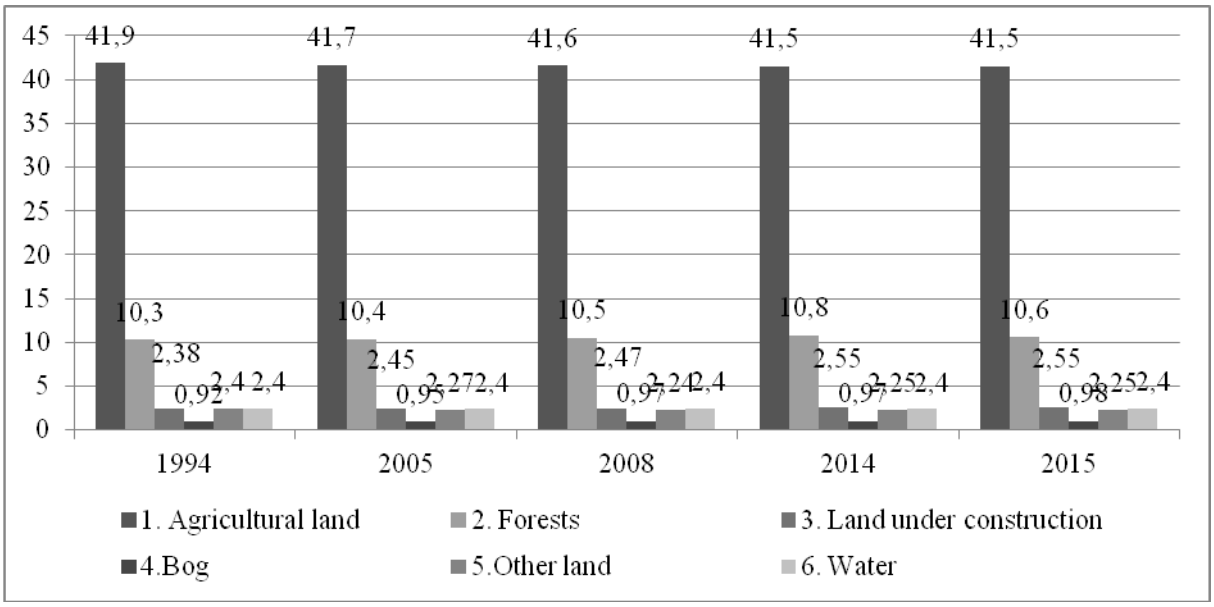

Figure 1. Dynamics of the land fund of Ukraine, million ha (developed by the author on the basis of the data of the State Geo-cadastre of Ukraine)

Quality indicators of agricultural soils in Ukraine are high. On more than 60 % of arable land the humus content is at the level of 3.5–5 and more. On more than 95 % of arable land the content of mobile phosphorus and mobile potassium is estimated from medium to very high.

Nevertheless, in the agrosphere of Ukraine the consequences of the anti-ecological intensive and only-profit-oriented agricultural use are emerging.

The analysis shows that for the land fund of agriculture both on a global scale and in Ukraine, degradation processes are characteristic. Arable land reduces the amount of humus in the soil, there are such problems as acidification, water and wind erosion, in some regions – radioactive contamination, etc. For Ukraine, in connection with the intensification of agriculture, there has been revealed an increasing pollution of arable soils with the remnants of pesticides and heavy metals, which are accumulated in the soil due to the use of mineral fertilizers.

Analysis of the actual material shows that the arable land areas, exposed to the processes of reducing natural fertility, dehumification from year to year increase and begin to occupy an increasing territory. Also, the areas of arable land, which are contaminated with residual amounts of pesticides, are growing.

In these conditions, in order to maintain sufficiently high yields of agricultural crops, agricultural workers began to apply more and more intensive mineral fertilizers. Only in the last 15 years the amount of nitrogen fertilizers applied has increased almost 2 times, phosphorous fertilizers – 1.8 times, potassium – 2 times (Figure 2).

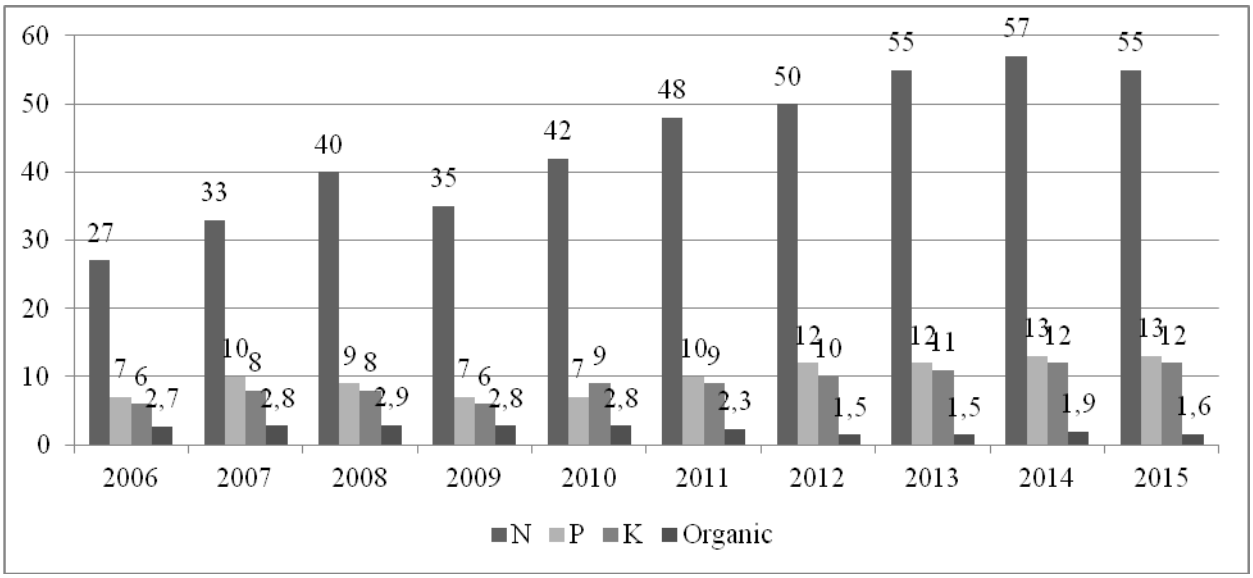

Figure 2. Dynamics of fertilizer application in Ukraine (mineral kg a.i./ha, organic t/ha) (author's developments based on data from the State Service of Statistics in Ukraine)

But this method does not allow maintaining the natural fertility of soils at a high level. Their degradation is caused by a whole complex of factors. One of the most important is inadequate application of organic fertilizers: manure, siderates or crushed and grounded plant residues.

The best organic fertilizer is the manure of cattle. But as can be seen from Figure 2, for the last decades its application (as well as the use of other organic fertilizers) decreased by 50 %.

Thus, the decrease in the use of organic fertilizers in Ukraine in recent years is due to the systemic instability of the agro-industrial complex. This means that all previously developed technologies and regulations can lose a real basis for their compliance. Traditional farming systems and fertilizer systems can exist only where the cattle stock and full crop rotations are preserved with a sufficient number of lands in cultivation, the optimal size of which is about 3 thousand hectares (A. V. Kucher, 2015).

One of the most significant diagnostic signs of soil degradation is a decrease in the content of organic substance and its main constituent, humus. Analysis of the dynamics of humus content in arable soils in the

districts of the Sumy region on the basis of 8 rounds of the survey showed that, from 1965 to 2010, over 45 years, in most areas of the region the humus content decreased, which the authors attribute to the lack of manure, siderates and other forms of organic fertilizers. The content of nutrients in Ukrainian black-earth soils is twice lower than in the lands of the Western Europe, where the era of chemicalization lasts more than 150 years, but environmental programs are being implemented in parallel.

Ukraine still has a sufficient reserve of fertile soils. Black-earth soils occupy about 60 % of arable land, which is 6.7 % of the world reserves of black-earth soils. But a hundred years ago the Ukrainian black-earth soils contained 4–6 % of humus, whereas at present only 3.3 %. With less than 2.5 % humus content in the soil, it can no longer be considered as black earth.

In the basis of the inadequate saving of such an important resource of agriculture as the fertility of the soil lies sharp decline in the number of cattle in Ukraine. If in 1990 the number of livestock was 25 million 194 thousand heads, then in 2000 it was 10 million 626 thousand heads of cattle, and in 2016 their number was 3 million 750 thousand heads (Figure 3).

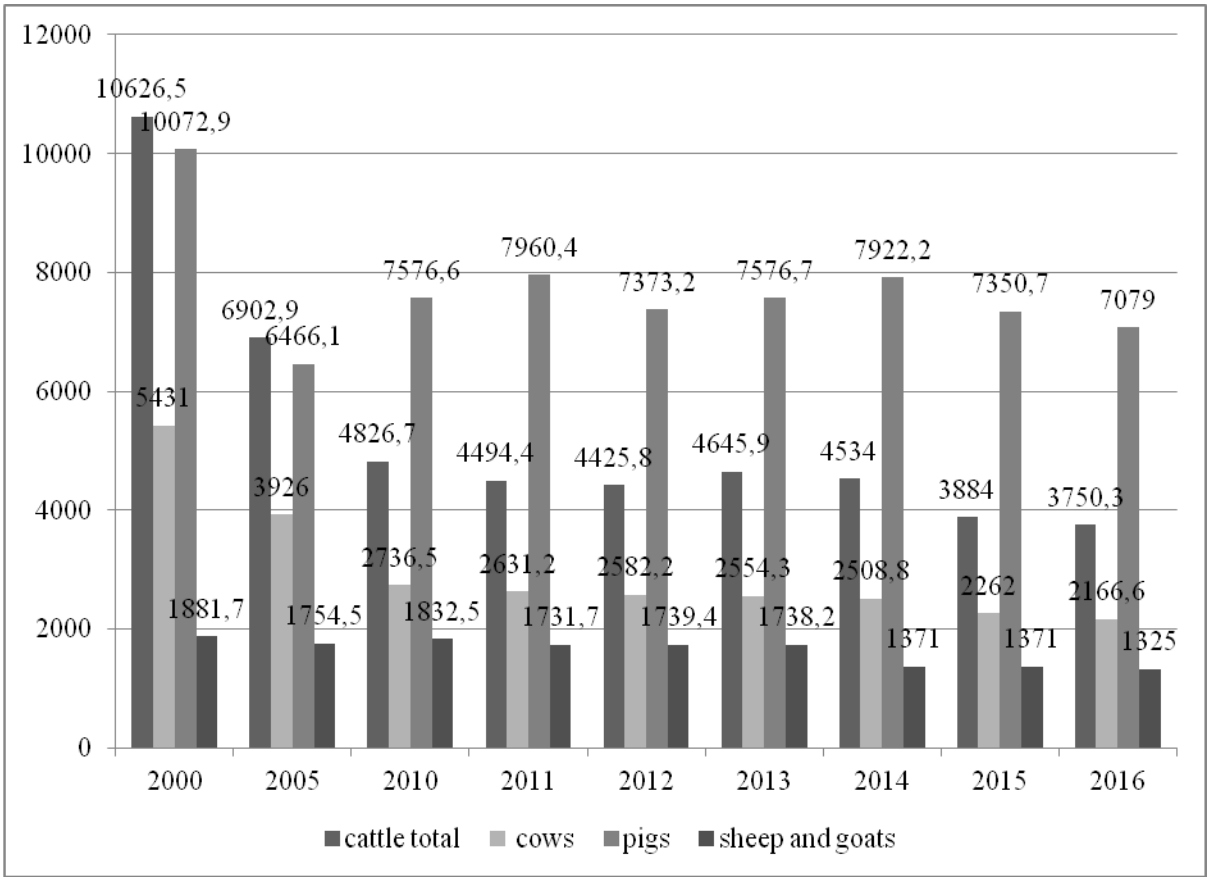

Figure 3. Dynamics of the number of livestock in Ukraine, thousand heads (author's developments based on data from the State Service of Statistics in Ukraine)

Significant damage to the fertility of soils caused violations of crop rotation. At present, it is not uncommon for a field of sunflower or rapeseed to take six fields in a 10-field rotation. In cereal rotations up to 60 % of grain crops are allowed. Such crop rotations quickly lead to a decline in soil fertility. The development of crop rotations, which, at a sufficient economic efficiency, simultaneously maintain the level of soil fertility, is an urgent task of modern agriculture.

The anti-ecological trends in the development of agriculture in recent decades have exacerbated the practice of using cultivated plants and plant residues to produce the so-called bio-fuels. The scale of this process is becoming more dangerous. The production of ethanol alone from vegetable raw materials in 40 years from 1975 to 2015 grew by 40 times. This technology has caused three side effects: a) in many countries of the world, food prices have increased substantially; b) because of the shortage of organic substances, soil fertility began to decline more rapidly; c) carbon dioxide in the production of bio-fuel is released into the atmosphere much more than used by plants for photosynthesis.

Additional emissions of carbon dioxide into the atmosphere only worsen the environment. Proceeding from this, the European Parliament in 2013 limited the production of bio-fuel from those resources that can be used in the food industry. It is also inacceptable to use post-harvest plant residues for bio-fuel production. There is only one ecologically correct technology – their grinding and backfilling in the soil.

A well-known expert in the field of nature management and ecology A. A. Obikhod (2014), based on a comprehensive analysis of the bio-fuel problem, concluded that "the current situation in the world community allows us to state that the large-scale use of agricultural products as bio-fuels will inevitably lead to a sharp aggravation of geopolitical, socio-economic and demographic problems".

In general, current use of agricultural land does not meet the requirements of rational environmentally sound land use. This is recognized by many specialists (Ambrosenko, 2016 and others). A qualitative change in land use technologies is a top priority – not only for Ukraine, but also for many other countries of the world. Soil degradation in the agrosphere is one of the components and main threats to the global environmental crisis. He writes in this connection that "protection and preservation of the soil cover of the Earth should become one of the most acute tasks of modern world environmental policy".

Based on the current situation, as the primary objectives of agriculture ecologization, it is rational to propose the following:

1. Introduction of scientifically grounded flexible crop rotations, which may be short-path, but with a saturation of legumes of at least 30–40 % of the area.

2. The revival of the livestock sector with the increase in the number of cattle to the level of complete provision of arable land with manure. This will simultaneously solve the problem of providing the population with dairy and meat products at affordable prices.

3. The use for the production of bio-fuel of only raw materials of fast growing tree species cultivated on infertile plots that are not suitable for agricultural use, biomass of algae or some types of bacteria.

Thus, the task is to develop and implement an ecological-economic system of agricultural production.

The transition to adaptive crop production assumes a wide use of resource and energy-saving and environmental technologies. The first is connected with the increase in prices for fossil fuels, the second – with the need to preserve biological diversity and high quality of habitat in agro-landscapes and the biosphere as a whole.

In the world agriculture the proportion of organic farming systems is growing. In accordance with the principles of the United Nations Food and Agriculture Organization (FAO) and the World Health Organization, which are formulated in the so-called "Codex Alimentarius" for organic food, organic farming, it is defined as "an integrated production management system that stimulates and enhances the well-being of the agrarian ecosystem, including biological diversity, biological cycles and biological activity of the soil,

which is achieved using all possible agronomic, biological and mechanical methods as opposed to the use of synthetic materials for performing specific functions within the system. The main goal of organic agriculture is to optimize the health and productivity of interdependent communities of soil organisms, plants, animals and people".

The movement toward agriculture ecologization is positively assessed in Europe. Support for agriculture is the main priority of the European Union. Over the last 20 years, EU support for agriculture has been approximately the same amount – 50–60 billion Euros per year. Such a support system solves many economic problems in agriculture; it reduces pressure on retail prices and thereby raises the profitability of food consumers.

The main obstacle to the transition to environmentally sound farming methods is not only profit orientation as such, but to a large extent the lack in the majority of agricultural specialists deep conviction of the necessity and inevitability of transforming existing intensive technologies towards increasing their environmental friendliness, as well as the lack of appropriate professional knowledge and beliefs.

The process of depletion of the irreplaceable resources of agrosphere predetermines the need to improve the system of environmental education in Ukrainian agrarian universities.

The task is to form a new paradigm leading to the ecologization of professional and mass consciousness. For this purpose Ukraine has already developed the legislative framework for the environmental protection, which includes more than 300 laws. Its implementation is facilitated by the adoption of an important document – the National Strategy of Education in Ukraine for the period until 2021. In 2011, the Law of Ukraine "On the main principles (strategy) of the state environmental policy until 2020" came into force, which defined the strategic objectives of environmental protection. The academic discipline "Fundamentals of Ecology", in accordance with the decision of the Ministry of Education and Science of Ukraine, is introduced as normative and compulsory for all specialties of higher education institutions of Ukraine. The modern cycle of disciplines of an ecological orientation has started to be formed.

Public environmental movements also became more active. But a qualitative change in the public consciousness and in the professional activity of agricultural specialists has not yet occurred. The ecological paradigm for the masses of people is still a "Chinese letter".

Most of the ministries in Ukraine are established and function on a sector basis and seek to resolve only their narrow-sector issues. Therefore, virtually all the sector programs lack environmental issues or don't pay much attention to them. Even those sector programs that have an environmental division are not linked to the strategic objectives of the national environmental policy and reflect only some aspects of waste management, energy efficiency and resource saving.

The real possibility of moving to the ecologically safe, economically justified and socially acceptable strategy of adaptive intensification of agricultural production depends, first of all, on a high level of scientific information support and on combining the achievements of different sciences that are studied by students of agricultural universities in Ukraine. Ecological education in its implementation requires an optimal combination of methods, means and forms of organization of the educational process. All the teaching staff of the higher education agricultural institutions should proceed from the premise that environmental education is not an introduction to the curriculum of 1–2 environmental courses. Environmental education is a combination

of five components: ecological knowledge – ecological thinking – ecological outlook – ecological ethics and ecological culture.

Conclusions and suggestions

Currently, there are two development vectors in agriculture: economic and ecological. Their rapprochement and removal in the future of the fundamental contradictions between them, can be achieved by focusing on saving the resource potential of agricultural production and reducing the man-made burden on the natural environment in the agrosphere. The central task of both the government of Ukraine and all people connected with agriculture with their professional activities is to achieve a sustainable state of agricultural production, which is the basis for the welfare of the country's population. The most expedient in conditions of technogenic load is resource-saving through the ecologization of agricultural activities, which should be understood as the process of targeted changes in productive forces and production relations that reduce the negative impact on the environment and ensure efficient use of resources.

It is necessary to change the paradigm of using natural resources in agricultural production. Since the soil is the basic component of the biosphere and the most important condition for maintaining life on Earth, the conservation of the ecological functions of soils and soil cover should be in the forefront of any anthropogenic transformations. From these positions, it is necessary to review all the types of activities, traditional views and rules.

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