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IMPROVING AGRICULTURAL LAND MANAGEMENT AS A TOOL FOR PROMOTING SUSTAINABLE DEVELOPMENT

Alexander A. Dubovitski (a)*, Elvira A. Klimentova (b), Valentina V. Tugaryova (c)
*Corresponding author

(a) Michurinsk State Agrarian University, 101, Internatsionalnaya, Michurinsk, 393760, Russia, daa1-408@yandex.ru
(b) Michurinsk State Agrarian University, 101, Internatsionalnaya, Michurinsk, 393760, Russia, klim1-256@yandex.ru
(c) Michurinsk State Agrarian University, 101, Internatsionalnaya, Michurinsk, 393760, Russia, tugaryova@mail.ru.ru

Abstract

The introduction of environmentally friendly farming methods in the conditions of the permanent degradation of land, soil and vegetation cover is one of the conditions for the formation of sustainable systems in agriculture. The purpose of this study is to substantiate possible directions for improving the land management system in the context of environmental improvement of agriculture in the Tambov region of Russia. The ecological impact of agricultural production on land resources is estimated by the allowed decrease in soil fertility using balance sheet tools. Calculations show that the cost of reducing soil fertility on an annual basis is 138.2 USD per hectare of agricultural land, and 384.7 million USD or 17.9% of Total agricultural production in the whole region. In our opinion, this is a sufficient justification for the need to reproduce soil fertility and controlling land degradation. The analysis made it possible to identify the reasons for the low environmental sustainability of land use, including the lack of knowledge in the field of rational use of soils, low interest in the favorable ecological state of soils and insufficient responsibility for the results of economic activity. It is advisable to expand the economic methods of implementing environmental policy, through the formation of a system of motivation and responsibility of farmers in the ecologization of land use. An important link in the promotion of biological practices should be agricultural counseling of agribusiness entities, especially small and medium-sized businesses, raising farmers' awareness of methods to improve fertility and reduce soil degradation.

Keywords: Agriculture, degradation, environmental policy, fertility, land resources, sustainable development

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1. Introduction

Currently, sustainable development is declared by the world community as the official doctrine of the development of modern society, based on the protection of the environment and improving the quality of life.

The right to equitable satisfaction of environmental needs as a basic principle of sustainable development was first formulated by the United Nations (UN) Special Commission in 1987. This concept formed the basis of the Convention on Climate Change, and the Convention on Biological Diversity, developed as a result of the UN Conference on Environment and Development in Rio de Janeiro in 1992 and supported by most countries. The most important components of the transition to sustainable development are considered to be the stabilization of the ecological situation and the improvement of the state of the environment. This vision later formed the basis of the Convention to Combat Desertification and the Paris Agreement on Climate.

Sustainable soil management, the principles of which are clearly defined by the Food and Agricultural Organization (FAO), plays a major role in achieving the Sustainable Development Goals. Their substance is to ensure the use of soils that does not harm either the functions of the soil or biodiversity. This is an ambitious task, for which the FAO has presented a number of technical recommendations that should facilitate the transition to sustainable land use, including in agriculture.

The issue of creating sustainable land use systems is addressed through the introduction of environmentally friendly agricultural practices that allow for the production of products without harming humans or natural systems (Gliessman, 2020). They are based on the wide application of soil-friendly agrotechnical techniques (biological or organic farming). Their positive impact has been proved by many studies (Verzilin et al., 2020).

However, despite the significant private and public interest in soil health, the efforts of the international community in this direction have not yet led to the desired results. Evidence of this is the ongoing worldwide processes of land degradation, which according to the FAO is understood as a reduction in the ability of soils to perform their functions. The main degradation processes are erosion, loss of organic matter, compaction, desertification, biological degradation, etc. According to the World Soil Resources Report (SWSR), about 33% of soils are in a state of varying degrees of degradation. In aggregate, as a result of agricultural use, arable land has lost between 20% and 60% of its organic carbon content.

Land degradation continues to increase due to a number of natural and anthropogenic factors. In the first case, degradation is stimulated by individual natural processes, such as rain-storms that destroy the topsoil and contribute to the formation of gullies (Morgan & Royston, 2005), or factors of climate change, including temperature, precipitation, and the frequency of extreme natural phenomena (Challinor et al., 2014; Lin et al., 2017). Natural factors, especially climate change, are characterized by a high degree of uncertainty (Azadi, et al., 2020), which determines high risks in land use.

In another case, land degradation is considered as a consequence of agricultural use focused on the getting a yield of crops in agriculture through the mobilization of soil fertility (Montgomery, 2007; Panagos et al., 2016). Anthropogenic factors also include demographic changes, technological changes, economic and social changes (Mirzabaev et al., 2016), and the socio-economic status of land users (Sklenicka et al., 2020).

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The multiple causes of land degradation are complex and interrelated. Many studies indicate that the deterioration of the quality of the soil is the result of the interaction of various natural factors with anthropogenic factors (Sklenicka et al., 2020; Sorokin et al., 2016). And it largely depends on the quality of environmental policy.

It is reasonable, as Warren (2002) notes, to study the factors of land degradation in the context of spatial, temporal, economic, environmental and cultural aspects that have a significant impact on the development of regional systems (Karpunina et al., 2020).

2. Problem Statement

The presence of difficulties in implementing the principles of sustainable development in agricultural land use, which have already existed for a fairly long period of time, indicates that they are caused by a complex of factors. The study of this complex of factors at the regional level (by the example of the Tambov region as one of the typical regions of the Central Federal District of Russia) is of great scientific and practical interest and is a problem that this work is aimed at solving.

3. Research Questions

The issues addressed in this paper directly follow from the research hypothesis that not only biophysical direct causes (natural) but also agricultural land management methods (anthropogenic) have a significant impact on the adoption of sustainable land use methods. In accordance with this, in our opinion, it is advisable to consider the following issues:

- make an economic assessment of the environmental impact of agricultural production on the land resources of the region;
- identify factor restricting the adoption of sustainable agricultural practices;
- substantiate possible directions for improving the economic mechanism of land management in regional agriculture.

4. Purpose of the Study

The purpose of this study was to substantiate possible directions for improving the land management system in the context of environmental improvement of agriculture.

5. Research Methods

The methods of logical and comparative analysis with the use of a review of information and statistical data were used as general scientific research. When deciding on the economic assessment of the environmental impact of agricultural production on land resources, we assumed the methodological approach that we have previously substantiated (Dubovitski et al., 2019, 2020). Its essence is to calculate the ecological and economic damage, which is a cost estimate of the allowed decrease in soil fertility. It is based on a balance tool that allows you to track the dynamics of the elements of soil fertility and determine the necessary costs for their replenishment (if balance is negative).

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6. Findings

The Tambov Region is located in the central part of Russia. The total area of agricultural land is 2.5 million hectares, of which 2.0 million hectares is arable land. Most of the soils (87%) are represented by leached and podzolic chernozems[1]. The region belongs to the zone of insufficient moisture and the fluctuation of the hydrothermal coefficient from 0.5 to 2.0, because of this, plants can suffer from a lack of moisture. The main observed forms of land degradation are the reduction of humus content in agricultural soils, wind and water erosion. According to data for 2018, the area of land subject to water erosion is 286.03 thousand hectares, wind erosion – 172.31 thousand hectares; waterlogging – 252.13 thousand hectares, other negative processes – 1394.6 thousand hectares[2].

The results of calculations show that the cultivation of all major agricultural crops in the region is accompanied by a negative balance of elements of soil fertility (Table 01).

Table 1. Economic estimation of environmental damage to soil fertility in the cultivation of agricultural crops in the Tambov region of Russia, 2019

Agricultural crops	Sown area, thousand hectares	Humus losses		Mineral elements losses	
		Demand for organic fertilizers, tons	Loss for the total sown area, million USD	The need for application of mineral elements into the soil, kg of active substance	Loss for the total sown area, million USD
Cereals	923.1	340.0	7.9	224619.0	138.8
Sunflower	383.1	1911.0	44.3	210961.0	130.4
Sugar beet	105.4	692.0	16.0	63483.0	39.2
Potato	24.4	37.0	0.9	9663.0	6.0
Vegetables	4.7	36.7	0.8	750.0	0.5
Total	1526.9	x	69.9	x	314.8

Source: Authors calculations using data of ROSSTAT (https://rosstat.gov.ru/)

The annual loss of humus is from 0.1 to 1.6 tons per hectare, and the loss of mineral elements is from 159.6 to 580.0 kg of active substance per hectare. The allowed losses of soil fertility elements require the appropriate application of organic and mineral fertilizers, the use of various elements of biologization of agriculture. The potential cost of measures to restore the allowed decrease in soil fertility in the region as a whole in 2019 amounted to 384.70 million USD or 17.9% of the total gross agricultural output (Table 02).

[1] Information system Soil and geographical database of Russia https://soil-db.ru/struktura-i-funkcionirovanie/dannye-inventarizaciya/dannye-po-territorii/tambovskaya-oblast
[2] Report on the state and use of land in the Tambov region in 2018. The Federal registration service across the Tambov region – Tambov, 2019. https://rosreestr.gov.ru/site/

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Table 2. Comparative indicators of ecological and economic losses from the decrease in soil fertility in the Tambov region of Russia, 2019

The cost of reducing soil fertility, in million USD	Total agricultural production (TAP) in 2019, current, million USD	The cost of reducing soil fertility as a share of TAP (%)	The cost of reducing soil fertility per hectare of sown area, in USD	The cost of reducing soil fertility per capita, in USD
384.7	2150.5	17.9	138.2	378.7

Source: Authors calculations using data of ROSSTAT (https://rosstat.gov.ru/)

In the total loss, the largest share is taken by the loss of mineral elements – 81.8% or 314.8 million USD. The loss of humus amounted to 69.9 million USD or 18.2%. Accordingly, taking into account the environmental and economic impact, instead of the reported 736.3 USD per hectare, the land yield was actually lower by 138.2 USD, or 18.8 % and amounted to 598.1 USD in 2019.

The current situation of decreasing soil fertility in the region is a direct consequence of:

- low level of organic fertilizer application (on average 0.2 tons per hectare), largely due to the stagnation of the livestock industry and the elementary lack of organic matter in farms;
- insufficient level of application of mineral fertilizers as a result of a shortage of financial resources in the farms (the removal of food elements with the harvest is several times higher than the application of mineral fertilizers);
- poor use of soil-friendly agricultural techniques.

In this case, one of the main reasons that determine the current situation is the underestimation by the management and owners of land, methods and techniques of biologization of agriculture, which can contribute to the health of soils. Agricultural consulting in the region is carried out by a budget institution “Regional information and consulting center of the agro-industrial complex”. However, the annual budget for the implementation of the state program is clearly insufficient to provide broad consulting assistance to agricultural producers in the region. For 2019, the amount of funding was only 108 thousand USD and the total number of consultations was 606 units, including 13 units for crop production. The recipients of the consultations were 191 farms, and their total number in the region is about 2 thousand.

Another important reason is the lack of an economic mechanism that encourages sustainable soil management and use. The legislative basis for managing the use of land resources in Russia is defined by the Land Code[3] , which establishes the obligations of land users and landowners to carry out measures to reproduce the fertility of land, protect land from water and wind erosion, and from other negative impacts. And the mechanism of environmental protection is provided by Law “On Environmental Protection” and consists of the following elements:

- payment for negative impact on the environment;
- state support for environmental protection;
- environmental insurance[4].

[3] Land Code of the Russian Federation of October 25, 2001 N 136-FZ (WK RF) (with amendments and additions(11.01.2011)) http://www.consultant.ru/document/cons_doc_LAW_33773/
[4] Federal Law" On Environmental Protection " of 10.01.2002 N 7-FZ (latest version (11.01.2011)) http://www.consultant.ru/document/cons_doc_LAW_34823/

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However, land protection, from the point of view of controlling land degradation, is practically not provided for in it. The payment for negative impact is provided for air, water and household waste disposal. Responsibility for the allowed decrease in soil fertility in accordance with this law is not provided, and there are no standards of permissible economic impact on the soil. State support is provided only for industrial production, and the last element, practically "does not work" (Burkov et al., 2008).

The law "On State Regulation of Ensuring the Fertility of Agricultural land" provides that a number of measures should contribute to ensuring soil fertility, including accounting, rationing, planning and monitoring of fertility indicators[5]. All this is really necessary, but it is not decisive for the formation of an interest in maintaining soil fertility.

In accordance with this, an important task of improving the management of agricultural land is the formation of an economic mechanism based on the principles of interest in the favorable ecological state of soils, responsibility for the results of economic activity. This also includes environmental education, promotion of knowledge and information about promising developments in the field of biologization of agriculture (figure 01).

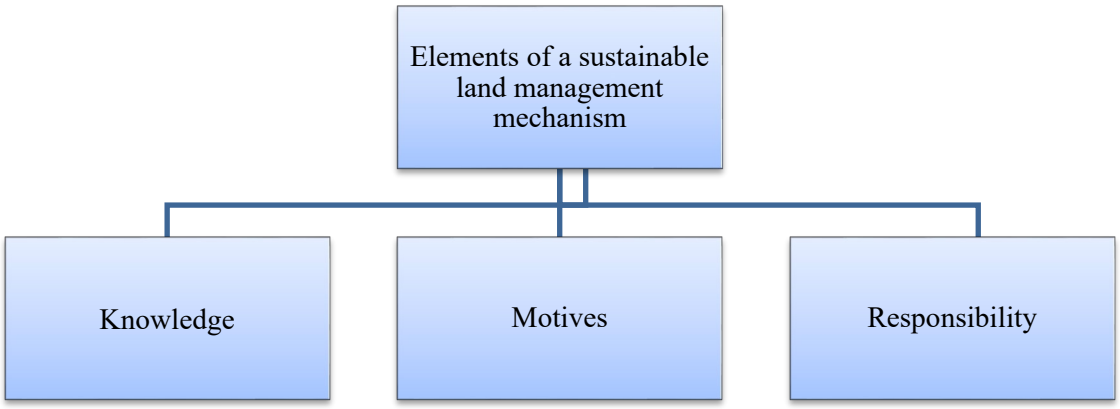

Figure 1. The scheme of sustainable land management of the region

Knowledge. An important link in the promotion of biological practices should be rapid information support for agribusiness entities, as well as providing them with consulting assistance, especially relevant for small and medium-sized businesses. It is necessary to interact with citizens, farmers and business leaders, to raise awareness of the importance of soils. It is necessary to inform about existing and develop new solutions for sustainable soil management in accordance with the principles of the FAO [6]. The first task here is to expand the parameters of the Regional information and consulting center activity. Consultations with farmers should help to better understand and comply with the requirements in the field of environmental protection and the good ecological condition of agricultural land.

[5] Federal Law No. 101-FZ of July 16, 1998 "On State Regulation of Ensuring the Fertility of Agricultural land" (with amendments and additions (11.01.2021))
http://ivo.garant.ru/#/document/12112328/paragraph/93:2
[6] FAO (2017). Voluntary Guidelines for Sustainable Soil Management Food and Agriculture Organization of the United Nations Rome, Italy http://www.fao.org/3/a-bl813e.pdf

Motives. An important factor in ensuring sustainable land use should be the formation of effective motivation of farmers in the widespread use of soil-friendly agricultural practices. The first condition for the distribution of budget subsidies to support farmers and agricultural enterprises should be the implementation of measures to restore and preserve soil ecosystems. To that end, it is necessary to develop standards of economic impact on soils (elements of soil fertility) and a list of agrotechnical measures that contribute to the protection of soils. To provide a subsidy mechanism depending on compliance with these parameters. If farmers use agroecological measures and ensure the reproduction of soil fertility, they can apply for state support.

Responsibility. This element assumes economic responsibility for non-compliance with the standards of economic impact on the soil. Farmers who do not provide reproduction of the fertility of agricultural land and protection of land from erosion should be less eligible for state support. And those who received support, but did not ensure the fulfillment of the stated requirements, may be subject to administrative penalties.

7. Conclusion

In the context of the current lack of knowledge, lack of motivation and responsibility, along with the underestimation of the environmental interests of society, the need to improve the management system of agricultural land is obvious. It is advisable to shift the priorities of the formation of the mechanism of nature management in the direction of expanding the economic methods of implementing state policy in the field of managing the process of forming sustainable land use systems. The implementation of this strategy is possible through various government interventions, ranging from the development of standards of economic impact on soils and a list of agrotechnical measures that contribute to the protection of soils, to the formation of a system of motivation and responsibility of farmers in the ecologization of land use.

An important link in the promotion of biological practices should be rapid information support for agribusiness entities, as well as providing them with consulting assistance, especially relevant for small and medium-sized businesses. Improving the management of agricultural land can contribute not only to the introduction of clean agricultural practices that ensure production without harming humans or natural systems, but also to the restoration and maintenance of the functional qualities of the soil, which are an integral part of the surrounding landscape.

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