Eco-Economic Systems of Russian Agriculture: Statistical Analysis

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Abstract: Over the recent 25 years Russia has experienced economic transformations that significantly have changed the impact of business activities on the state, structure, quality and use of natural resources: an annual decrease in the sizes of agriculturally used areas, reduction of soil fertility, destruction of the amelioration system, etc. Certainly, all this affects the economy and makes it necessary to investigate these interrelated processes in the context of an ecological-economic system. The article presents a multilateral statistical analysis of the eco-economic system of Russia, offers recommendations for improvement of the indicator system, analytical methodologies as well as proposals for implementation of the international standards into Russian statistics. It is emphasized that the asset value accounting philosophy should be developed on the basis of the specific nature of Russian statistics with application of the international practices. The article offers to start developing the macroeconomic accounts from the municipal level and then to aggregate the information at the level of a region and the country.

Keywords: Eco-economic system, natural environment, agriculturally used areas, natural resource and economic accounting.

NOVELTY

In the process of transformations of the social relations and the agricultural industry in Russia after 1991, establishing a mixed economy and market relations the influence of economic activities on the natural environment has significantly changed. Over 40 mln ha of plowed fields have been decommissioned, the system of agronomic amelioration and the rational use of natural forage grasslands have mostly been destructed, application of mineral fertilizers has reduced, soil degradation and productivity loss are taking place. Application of industrial technologies, mineral fertilizers, pesticides, other chemicals and heavy vehicles in agriculture, harmful emissions into the atmosphere and aquatic disposals, the climate change make their impacts on the agricultural industry, its productivity and effectiveness, quality of products, land resources, soil fertility and other components of the natural environment. Over the recent 25 years the changes in the natural environment and agricultural activity have resulted in the quality change of the entire eco-economic system. Thus, a new target of research into interrelations of the natural environment and economic activity has appeared; it is an eco-economic system.

However, this system has not undergone overall statistical and economic evaluation; the indicator system to a great extent has become obsolete; analytical methods making an informational basis for managerial decisions, forecasting and modeling measures for improvement of the natural environment and efficiency of the agricultural industry have not been developed yet.

In the context of implementation of Russia's targeted federal programs on development of the agricultural industry and food facility we face the necessity of a deeper statistical analysis of the eco-economic system in agriculture and on this basis we need to improve the entire system of information support for the agrarian sector of the country.

The current analytical techniques and indicators of the macroeconomic development cannot properly represent an ecological factor. It is essential to improve the methodology of the macroeconomic statistics of the natural environment and its relations with agriculture in order to collect more confident information on the eco-

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economic system of a specific region. All this makes it necessary to modify methods and techniques of the statistical analysis of ecological-economic processes, to develop new approaches to research as well as makes this research perspective more relevant.

The goal of this study is to develop the key principles of and methodological approaches to statistical analysis of the state and transformations of the eco-economic system in agriculture both at the macroeconomic and regional levels, as well as ways of raising the economic efficiency of the agricultural industry.

In this context the objectives of the study are as follows:

1. Consider the contents of the eco-economic system applied to agriculture as an object of a statistical study, define the structure and development trends of such system;

2. Summarize and improve statistical indicators of the eco-economic system in agriculture;

3. Offer and substantiate ways for the further improvement of statistical accounting of the eco-economic system in agriculture;

4. Develop a methodological approach to the analysis of the eco-economic system in agriculture; on this basis, make an economic-statistical analysis of the state and use of land and water resources in Russia applicable to agriculture, evaluate the implementation process and outcomes of the targeted programs aimed at preserving and restoring soil fertility as well as developing the water industry;

5. Under conditions of changing climate, evaluate the influence of weather conditions on the state and productivity of agriculture in the territory of the country and define trends of such influence;

6. Develop proposals on improvement of macroeconomic statistics and compilation of accounts for recording of the natural resources and economics pursuing the further development of the system of national accounts.

The research object is an eco-ecological system in Russian agriculture.

The research subject is a system of statistical indicators of the state, transformations, interconnections, mutual influence of economy and the natural environment within the eco-economic system at the regional and macroeconomic levels.

The scientific novelty of the study is the development of the key principles and methodological approaches to comprehensive analysis of a new target of research, that is an eco-economic system in agriculture. These principles and approaches are based on a set of statistical methods that helps perform multilateral investigation of the eco-economic system in the agrarian sector of the Russian Federation both at the macroeconomic and regional levels aiming at improvement of economic efficiency of the agricultural industry and implementation of international standards into the national statistical system.

METHODOLOGY AND METHODS

The statistical analysis of the eco-economic system should take into consideration the peculiarities of this target as a seamless unity of the natural environment and economic activities. We propose to make comprehensive evaluation of the eco-economic system in agriculture using a set of statistical methods presented in Figure **1**. This methodological approach to investigation of the eco-economic system helps give comprehensive evaluation of the influence made by economy on the natural environment as well as evaluate reverse interaction.

It is appropriate to carry out a multilateral study in several stages:

1. To study information, collect benchmark data on the eco-economic system and economic activity at the national, regional and municipal levels.

2. For the main areas of research (land and water resources and weather conditions), to analyze statistical indicators that comprehensively describe the natural environment and economic activity, their mutual influence including reverse interaction that is the influence of the economic activity on the natural environment and its protection.

2.1. For the main areas of research, to analyze interconnections and mutual influence of the natural environment and economic activity over time applying both absolute and average values and ratios representing the correlation of the natural environment and economic activity.

2.2. To study interconnections and mutual influence of the natural environment and economic activity applying a method of statistical grouping for the main areas of research. According to the analytical level, it is also necessary to differentiate indicators describing interconnection and mutual influence of the natural environment and economic activity.

3. To evaluate the influence of weather conditions on agricultural activities applying a correlation and regression analysis. It is appropriate to study the influence of an average annual air temperature during the vegetation period, precipitation and mineral fertilization on the yield ability of crops and potatoes.

4. To evaluate the current condition of the implementation of elements of the System of Environmental-Economic Accounting (SEEA) into Russian statistics at the municipal level.

DATA AND EMPIRICAL ANALYSIS

The necessity to study the eco-economic system in Russian agriculture is conditioned by quality changes in the mixed agriculture and the natural environment, by strengthening their mutual influence over the recent 25 years. We believe that a term of *eco-economic system* refers to the natural environment affected by the economic and social activities including mutual influence and consequences arising from it. The eco-economic system in agriculture is considered as a part (a sub-system) of the eco-economic system of the country.

The eco-economic system in agriculture includes the natural environment and economic activity (Figure

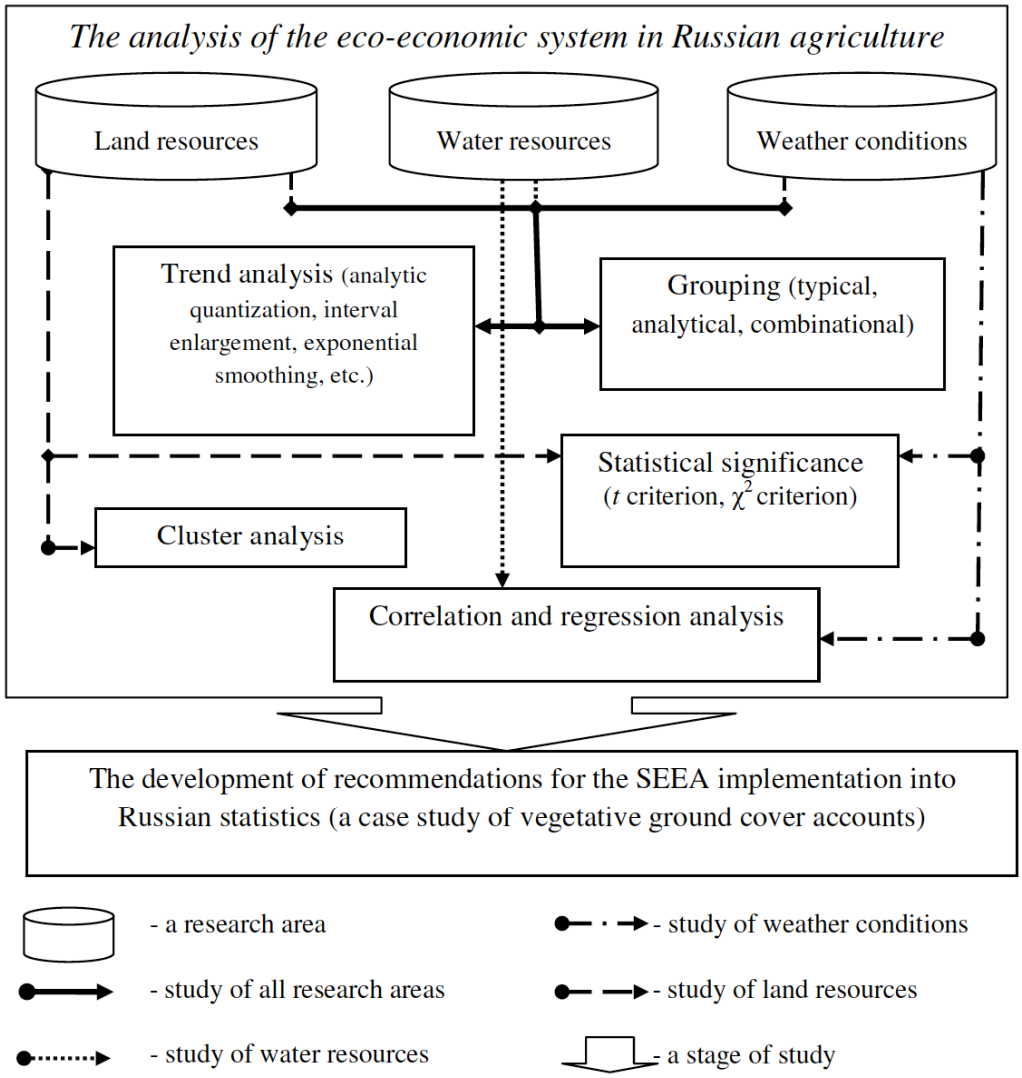

Figure 1: The comprehensive evaluation of the method applied for studying the eco-economic system in Russian agriculture.

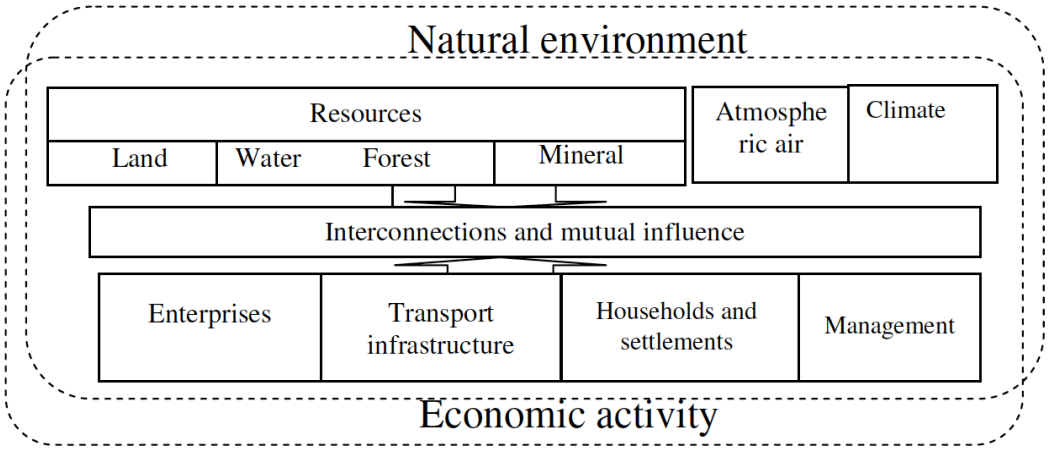

Figure 2: The chart of the eco-economic system in agriculture.

2); the constituents of the natural environment are atmospheric air, water resources (including precipitation and runoff), land resources, mineral resources, forest resources, and climatic factors. The economic activity comprises all the sectors of the Russian National Classifier of Types of Economic Activity relating to agriculture, hunting and forestry as well as other activities within the agricultural industry that exert influence on the natural environment.

The study resulted in the conclusion that a cause of deterioration of the natural environment is changes in the economy of agriculture having many structures and destruction of its production potential. In addition, the internal processes of the natural environment such as climate change are also essential.

Improvement of the eco-economic system first of all depends on improvements in agriculture. As for the further development of the statistics describing the eco-economic system, its most relevant trend is connected with the implementation of the System of Environmental-Economic Accounting (SEEA) adopted in 2012 as an international standard (System of Environmental-Economic Accounting: Central Framework, 2012). Russia has not yet completely established this system as a special sector of the national accounting and statistics describing the natural environment. By now SEEA in Russia has some major drawbacks.

The eco-economic system can be considered at the global (international), national, regional, or municipal levels. We recommend to identify the following segments of the target of research and consequently to study indicators separately describing the natural environment and the economic processes, as well as interconnections between them (Figure **3**). In general, the outcomes of the analysis how assembling statistical data on the eco-economic system is organized in Russia allow us to conclude that nowadays a significant quantity of information is collected in all the sectors, but not all the segments of the eco-economic system can be fully represented.

We offer ways of monitoring over involvement of resources into the economic activity and improving their state, namely to estimate neglected fields. In this connection, we recommend to add indicators of neglected field distribution against the years of non-utilization to the annual Form of monitoring data on fertility of agricultural lands (Form No. 5-ДД3-сх). These indicators should also be included in census schedules of the agricultural census. The estimate of fertility and quality of privately-owned lands should be made when ground plots are sold.

We believe that the analysis of the atmospheric air needs to take into account the indicators of temperature changes and precipitation over the vegetation periods; losses in agricultural products due to climate change; measures taken for developing technologies for decreasing automobile emissions into the atmosphere; measures against ozone depleters (a measure, expenses, an expected decrease, an actual decrease), etc.

Statistical data on water resources should include additional indicators describing the quantity, nature and chemical composition of storm runoffs.

In order to make a profound and significant analysis of the eco-economic system it is appropriate to conduct single time surveys of all the sectors considered focusing on collecting detailed information.

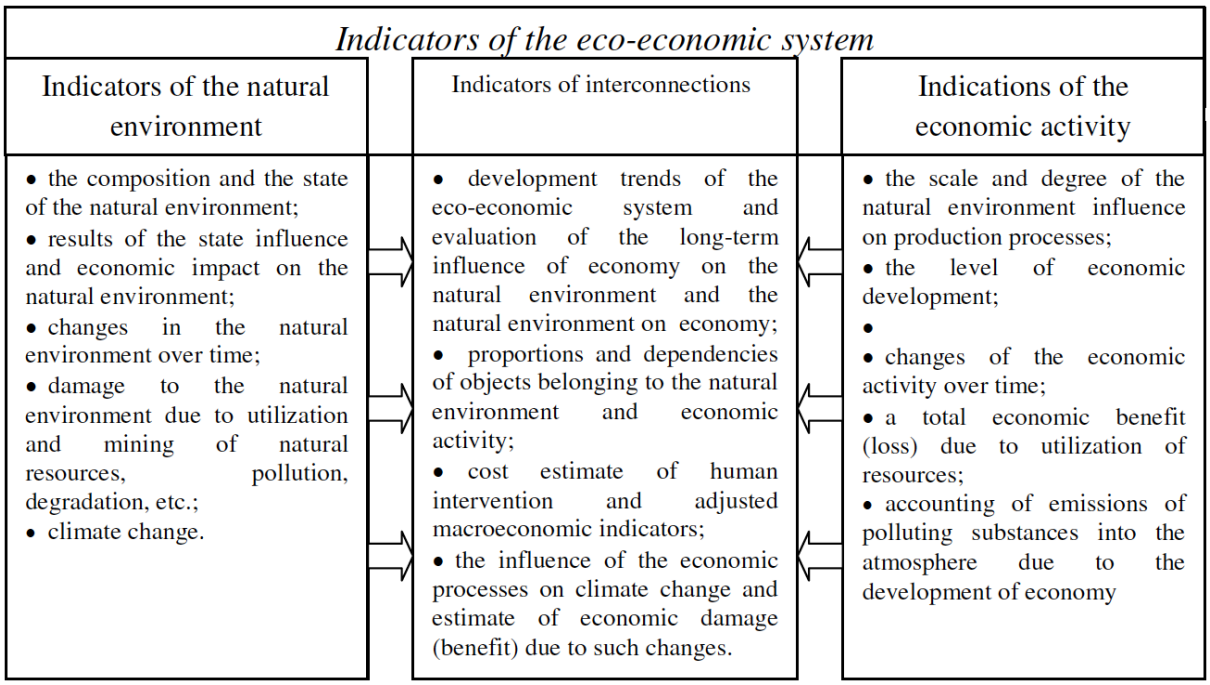

Figure 3: The indicators of the eco-economic system.

We used the proposed methodology for evaluation of land resources. Since 1990 the grade structure of land resources has undergone significant transformations, in particular the total quantity of agricultural lands has reduced by 252.6 mln ha (by 40%).

The analysis of land resources was made over three periods: 1990-1998 (the period up to Russia's financial meltdown), 1999-2005 (the period of deregulation in land resources), and after 2006 (the period of implementation of the Federal Targeted Programs in Russia).

The outcomes of the study proved that during the 1990-2016 period areas of agricultural lands reduced by 27.8 mln ha (13%), plowed fields - by 15.5 mln ha (11.7%), and areas of neglected fields increased by 4 mln ha (Table **1**). Planting acreage saw the greatest decrease by 37.7 mln ha (32%), including grain-crops - by 25.4%, forage crops - by 63.2%, potatoes - by 6.5%. In 1990 planting acreage took 89% of plowed fields, and in 2016 - only 69%.

Comparing the indicator values of the Russian agricultural census of 2006 and 2016 we found that a total quantity of agricultural lands reduced by 23.8 mln ha (14.3%), including plowed fields - by 7.5 mln ha (7/3%), pastures - by 8.7 mln ha (24.7%), hey-fields - by 3.6 mln ha (25.9%). The planting acreage increased by 4.3 mln ha, however forage crops and potatoes reduced by 17.45 and 33.3%, respectively. Cattle livestock reduced by 4.2 mln animals (17.9%), while pig population and sheep and goat population increased by 36.3% and 20.9%, respectively (Results of the All-Russian Agricultural Census, 2006. 2017).

Different quality lands stopped being used, including lands having high cadastral values and situated in the areas with favorable climatic conditions (Zhang, 2014). In the total reduction of agricultural land areas in 1990-2016 only 44% referred to the regions with the climate unfavorable for agriculture. The mentioned processes were mainly associated with a declining demand for agricultural products and general economic recession (Kamenik, 2019). The gross yield of grain decreased by 11.4 mln tons, cattle livestock - by almost two thirds, pig, sheep, goat population - by 50% and over. In result, forage reserves, planting acreage reduced, hay-fields and pastures were not used (Kharitonova, 2016).

In general, we can observe here a negative process resulting in an increase in quantities of useless lands. The irrigation and drainage system continued degrading, and areas of agricultural lands were reducing. Soil fertility did not recover properly, in particular, in 2016 the amount of organic fertilizers applied per 1 ha was 1.4 ton, while in 1990 it was 3.5 ton per 1 ha, when we had 31.4% of agricultural lands having low organic contents. As for mineral fertilizers (in conversion to 100% of nutrients), in 2016 the amount of fertilizers applied for one hectare of the total

Table 1: Trends in Agricultural Land Areas (mln ha) and Livestock (mln Animals)

Indicator	Statistical books		Changes	Russia's agricultural census		Changes
	1990	2016		2006	2016	
Agricultural lands,	213.8	186.0	-27.8	166.0	142.2	-23.8
including plowed fields	131.8	116.3	-15.5	102.1	94.6	-7.5
hey-fields	20.0	18.7	-1.3	13.9	10.3	-3.6
pastures	60.1	57.2	-2.9	35.2	26.5	-8.7
neglected lands	0.3	4.3	4.0	13.9	10.1	-3.8
Planting acreage,	117.7	80.0	-37.7	74.9	79.2	4.3
including grain-crops	63.1	47.1	-16.0	43.7	47.4	3.7
forage	44.6	16.4	-28.2	19.5	16.1	-3.4
potatoes	3.1	2.9	-0.2	2.1	1.4	-0.7
Livestock,						
including cattle	57.0	18.8	-38.2	23.5	19.3	-4.2
pigs	38.3	22.0	-16.3	17.1	23.3	6.2
sheep and goats	58.2	24.8	-33.4	22.5	27.2	4.7

planting acreage was 49 kg/ha, and in 1990 it was 88 kg/ha.

Agricultural enterprises, especially small-sized, suffer a shortage of working capital for purchasing necessary fertilizers and chemicals as well as farm machinery for their application. In the period of 2000-2016 prices for nitrogenous fertilizers increased by 29 times, for potash fertilizers - by 10 times, while prices for grains increased only by three times. The machinery fleet of agricultural enterprises also reduced. Thus, in 2016 there were three tractors per 1000 ha of plowed fields, and in 1990 this number was almost 11, that is 3.6 times higher. The plowing load per one tractor increased by 2.5 times (from 115 ha in 1990 to 305 ha in 2016). Therefore, food security under sanctions requires an upgrade of material resources.

Over the recent years 2.22 mln ha of irrigated and drained lands stopped being used or were transferred into unreclaimed lands. Land areas with application of chalking reduced by 30.4%, application of gypsum - by 87.7%, phosphorite application - by 68.1%. Since 2006 a decline of several indictors has slowed down, and some indicators even have showed a growth, however they are still far from the global rates (or even from the Russian 1990 rates).

The analysis of water resources proved that over the recent 15-20 years in general Russia increased specific available water supply per person in some way. However, in 2016 only a half of rural housing was equipped with water supply systems, and total housing resources had water supply systems and other water use utilities only in the proportion of 61%.

Though Russia ranks within the Top 10 countries in the total volume of water intake, the water volume used for agricultural purposes is among the lowest ones in the world (13% in 2015). To a large extent, it is connected with the geographical position of Russia and a decrease in areas of irrigated lands due to economic reasons. For reference, in the USA this indicator value is about 40%. in China - approximately 65%.

Over the recent 23 years, general use of fresh water in Russia reduced by 28%, especially for irrigation and agricultural water supply (by 50%). It can be explained by the fact, that in comparison with 1990 irrigated lands reduced by two thirds (in relation to the data of Russia's agricultural census 2016). In the agricultural sector a reduction of water use before 2000 in general corresponded to a decline in production. Since 2000 the agricultural production started increasing, therefore a reduction of water use might be associated with a decrease in areas of irrigated lands and in the number of livestock at major stock-raising facilities with central water supply.

At the edge of 20-21 centuries global climate change became one of the most urgent issues. The Report by the UN Commission on the Measurement of Economic Performance and Social Progress (Stiglitz and Sen and Fitoussi 2010) states that soon beside a

financial crisis we will also face an ecological one, and especially consequences of global warming. In addition, over 1,500 participants of the World Economic Forum 2014 qualified climate change as one of the main challenges for the humankind in the coming years.

Losses in agricultural products during unfavorable years result in a decreased gross value added (by to 12%). The influence of unfavorable weather conditions and economic factors on the output of products causes not only a reduction of main crops yields, but also affects planting and harvesting acreage (Zinchenko 2017). Thus, in 2010 total planting acreage of grain and pulse crops reduced by 4.4 mln ha in comparison with the previous year, and later this reduction was not recovered. In unfavorable years areas of non-harvested crops also increase: in 2010 there were 9.9 mln ha of non-harvested areas in comparison with 2.4 mln ha in 2014, when weather conditions were much more favorable.

All the above-mentioned proves the necessity of statistical study of climate and weather changes as well as their impact on the economic activity. We recommend to use grouping of the Russian regions according to different weather conditions. The analysis has showed that the critical climatic factor for Russia is heat availability, therefore long-term average annual air temperature during the vegetation period (May-July) is assumed as a grouping factor (Table **2**).

In Russia, regions with the average temperature during the vegetation period of 12.3^{o}C prevail, they comprise 84% of the country territory and one third of agricultural lands. This region group has the lowest mean score of climate productivity. In fact, these regions have only local agricultural farms. A proportion of agricultural lands in the total area of this region group makes only 4.9%, a low level of ploughness of these agricultural lands achieves 46% in comparison with 65-66% in other region groups, and this region group has the lowest level of plowed fields used for planting (63% in comparison with 66-72% in other region groups) which can also be explained by low rates of agricultural intensification (Zinchenko and Kharitonova 2014).

The middle and upper region groups include Russian regions having a higher degree of agricultural development of lands and ploughness, they produce the bulk of plant production. These region groups have relatively better soils and economic conditions for agriculture. At the same time, a productivity level of plant production here still remains relatively low due to insufficient use of plowed fields for planting, insufficient application of mineral fertilizers (the optimal level is 100-120 kg of rate application per 1 ha) and insufficiency of agricultural machinery fleet. The upper region group has an arid climate (a hydrothermal index here is 4.9 mm/^{o}C, or 33%, lower than in the lower region group), the middle region group takes an intermediate position in this aspect.

Table 2: Russian Region Grouping According to Heat Availability in May-July

Indicators	Region groups			Average
	up to 17 ^{o}C	from 17.1 to 19 ^{o}C	over 19.1 ^{o}C	
Number of Russia's regions	34	20	24	78
Long-term average annual value in May-July (reference rates):				
temperature, ^{o}C	12.3	15.6	18.3	15.0
precipitation, mm	181.0	201.1	181.8	186.4
hydrothermal index, mm/^{o}C	14.8	12.9	9.9	12.4
Mean score of climate productivity	105.8	128.2	134.7	120.8
Relative share of, %:				
agricultural lands in the total land area	4.9	31.0	63.3	11.5
planting acreage in the plowed fields	63.2	65.8	71.7	67.8
Gross crops production in the current prices (2010 - 2014), thousand rubles				
per capita	8.4	8.9	23.9	13.0
per 1 ha of agricultural lands	5.5	9.2	11.3	8.7
Application of mineral fertilizers by agricultural enterprises in 2010-2014, kg of rate application per 1 ha of planting acreage	14.8	28.8	52.5	45.4

Table 3: Indicators of Multiple Correlation and Regression Dependence of Crop Yields on Weather Conditions and Fertilizers in 2010-2012

Crops and regions	Coefficient of multiple correlation	Net regression coefficient		
		temperature, C°	precipitation, mm	fertilizers, kg of rate application
Grain crops total: all groups	0.838	0.834	0.049	0.166
including Groups II and III	0.877	1.488	0.077	0.193
Spring wheat - Groups II and III	0.702	-0.707	-	0.126
Winter wheat - Groups II and III	0.887	-	0.051	0.197

The special feature of Russia's vast territory results in different conditions which can appear in different regions in certain years, they can be both favorable and unfavorable for cropping capacity. Dislocation of agricultural production in different regions of the country may support sustainability of crop yields and agricultural productivity.

The analysis of the impact made by weather conditions and fertilizer application by agricultural enterprises on the differences in crop yield values between Russia's regions has showed their close relations in crops in general and in winter wheat in particular, during all the years (Table **3**). As for potatoes, which is mainly produced at private household farms, their yields slightly depend on weather conditions.

In the dry year of 2010 the growth rate of crop yield due to fertilizer application was 25 kg for the middle (II) and upper (III) groups at the growth rate of fertilizer - 1 kg of rate application. Then, in 2014, which was favorable, the growth rate of crop yield was 33 kg, when the rate of fertilizer application per 1 ha of planting acreage was increased by 1 kg.

In general, we may conclude that there is a strong dependence of crops productivity on weather conditions. In this context, we need a systematic analysis of weather conditions with a focus on arrangement of insurance services, establishing reserves, development of irrigation engineering, adjustment of region development programs taking into account their economic environments. Unfortunately, since 2014 statistical books missed data for the vegetation periods.

Beside temperature and amounts of precipitation, the chemical composition of precipitation make an impact on productivity and quality of crop products. We analyzed this aspect on the basis of a long-term field study conducted in the former training farm, Mikhailovskoye, belonged to Russian State Agrarian University - Moscow Timiryazev Agricultural Academy and located in the Podolsk District of the Moscow Region. This study examined atmospheric precipitation and its influence on soil fertility and soil losses in the period of 1961-2007. Amounts of precipitation and its chemical composition were investigated on a monthly basis, it provided with the data for a whole year, for a vegetation period and other periods.

During the analyzed period (41 years) variation of precipitation over a year and over a vegetation period turned out to be extremely intense (Figure **4**). According to many experts, climate change was more intense over the recent years, therefore the further study included analyses of two equal sub-periods: 1967-1986 (Period I) and 1987-2007 (Period II).

In general, in the period started in 1987 there was a significant increase in the concentration of hydrocarbonate, chlorine, sodium, and calcium. There was no increase in the concentration of potassium and nitrogen, the elements that are really necessary for plants. All this indicates the deterioration of the ecological situation.

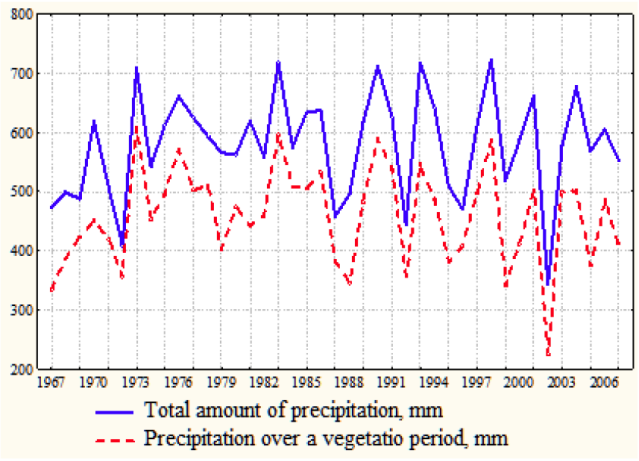

Figure 4: The total amount of precipitation over a year and over a vegetation period in 1967-2007 (mm).

In general, we may conclude that over the recent years the nature of weather processes and processes connected with them has changed. Though the amount of precipitation did not increased, fallout of chemical elements and their outwash with runoffs changed in the period started in 1987. Therefore, it is necessary to adjust the total amount of applied fertilizers in relation to substances falling out with precipitation and out-washed by runoffs.

Generally, it is necessary to take actions for reducing the negative effect of the human activities on the natural environment, in spite of the fact that Russia does not face a pressing problem of pollution of the natural environment as it features a low population density and a high degree of land availability. In the USA, the EU countries and others, pollution of the natural environment became an urgent problem long ago, they gained experience in solving these problems and we recommend to study their know-how in Russia (System of Environmental-Economic Accounting, 2014; System of Environmental-Economic Accounting 2012: Applications and Extensions, 2014; Framework for the Development of Environment Statistics (FDES), 2015) The world's major economies consistently implement the SEEA elements considering it as a framework for statistics of the eco-economic system. In 2014-2016 the Federal State Statistics Service of the RF began implementing SEEA, first of all, in part of relevant accounting and macrostatistics of expenses on protection of the natural environment. However, comprehensive and acceptable methodological approaches have not been developed yet (Dumnov and Kharitonova 2016; Dumnov and Kharitonova 2014).

We believe that the Russian Federation needs an experimental estimate of the vegetative ground cover as a study case of one of its regions, before development of methodology for the whole country. Such methodology can be applied in the territories with similar bio-climatic parameters or adjusted to the specificity of a territory. At the same time, it is necessary to make a cost estimate of assets and analyze their use at the municipal level.

We propose to start developing assets accounts from the municipal level and then to aggregate information at the regional and national levels. This study includes the account of the vegetative ground cover expressed in physical terms (Table **4**) which was compiled on the basis of data collected within a cartographical survey of lands in the Borovsk District of the Kaluga Region. This account includes agricultural lands only.

During the reporting period a part of cultivated and pasture lands stopped being used and were transferred into neglected lands. In addition, within the year under consideration a significant part of agricultural lands stopped being used and was transferred into non-agricultural lands (2,546 ha). However, we failed to make a more exact estimate as the initial data are still being collected, errors in the database are corrected and new land plots are added.

The asset accounts for lands expressed in monitory terms were also compiled on the basis of its cadastral value included in the database. The total value of lands in the Borovsk District of the Kaluga Region grew by 14.4 billion rubles within the year under consideration.

Table 4: The Account of the Vegetative Ground Cover Expressed in Physical Terms, ha

Indicator	Artificial surface	Cultivated land	Meadows and pastures	Forest	Neglected land
Opening stocks	**92.0**	**16586.6**	**4761.3**	**21936.6**	**328.0**
Addition	–	–	–	–	–
area extension	–	–	–	–	–
new plots	–	–	–	–	6568.6
Total stocks addition	–	–	–	–	6568.6
Lowering:	–	–	–	–	–
area decrease	–	5364.3	1204.3	–	–
natural loss of stocks	–	–	–	–	–
changes in land classification	–	1159.9	1386.1	–	–
Total stocks lowering	–	6524.2	2590.5	–	–
Closing stocks	**92.0**	**10062.5**	**2170.8**	**21936.6**	**6896.6**

Table 5: The Account of the Vegetative Ground Cover Expressed in Physical Terms, ha (Except Forests)

Indicator	Type f soil resource			Total area
	Low quality	Medium quality	High quality	
Opening stocks	**6258.2**	**13508.9**	**2000.9**	**21767.9**
Adfition:	–	–	–	–
changes in stocks classification	–	–	–	–
improvement of land quality	–	–	–	–
Total stocks addition	–	–	–	–
Lowering:	–	–	–	–
changes in land classification	–	–	–	–
improvement of land quality	950.8	1448.6	146.6	2546.0
Total stocks lowering	950.8	1448.6	146.6	2546.0
Closing stocks	**5307.4**	**12060.2**	**1854.3**	**19221.9**

First of all, this growth was conditioned by the incomplete compilation of the database which was still added with new information (Dumnov and Kharitonova 2016).

In addition to accounts of the total amount of lands, SEEA includes accounts describing quality of lands. The information on soil quality in the Borovsk District of the Kaluga Region was represented as a score of the 1 ha soil estimate. For this estimate, soils were classified into three classes (Table **5**). The soils of the lowest quality (up to 15 points for 1 ha) reduced by 18%, lands of the medium quality - by 12%, and lands of the highest quality - by 8% (over 40 points for 1 ha). Thus, we can state that the Borovsk District of the Kaluga Region mainly stops using lands of the lowest quality.

Generally, we can state that the cartographical database under development gives sufficient information for compilation of land accounts. However, in order to account land areas expressed in physical terms we recommend to add the indicators of soil properties describing physical, chemical and biological parameters of soils such as soil porosity, soil consistency, pH level, and microbial biomass.

At present, the issue of adjustment of the main macroeconomic indicators in view of resource depletion still remains open; the methodology for the accounting of assets value should be developed on the basis of special features of Russian statistics.

POLICY CONSIDERATIONS

Thus, we can state that the improvement of the eco-economic system requires a recovery of the country's production potential of, advanced intensification of production, a recovery of amelioration aimed at improving soil fertility, and renewal of the livestock sector. All this will result in improvement of economic efficiency of the agricultural industry and will assure the country's food security under sanctions.

The proposed methodological approach to analysis of the eco-economic system in agriculture allowed us to reveal the recent changes in the agricultural industry that made an impact on the natural environment.

Obviously, it is necessary to increase incomes of agricultural producers and to intensify the agricultural production through state support and rising of prices for agricultural products, especially at the level of small enterprises and farms. At the same time, it is necessary to develop a methodology for evaluation of damage arising from land use. Nowadays Russia has no complete regulatory and methodological documentation for evaluation of damage to the environment. Also, it is necessary to restore irrigation processes and aim to the level of 1990s, it will result in the advanced yields and growth in the planting production and ensure import substitution in vegetables, fruits and berries in the Russian south.

Weather anomalies of the recent years prove that it is necessary to arrange insurance services, establish reserves, develop amelioration, adjust development programs of the regions according to their economic conditions. The performed estimate of the amount and chemical composition of precipitation and runoffs prove that fertilizer application rate should be adjusted that can reduce the negative effect on the natural environment.

In the sphere of the macroeconomic accounting of lands we propose to make an experimental estimate of the vegetative ground cover as a study case of one of the Russian regions before the development of the methodology for the whole country. Further, such methodology and principles of macroaccounting can be appropriately transferred to the territories with similar bioclimatic parameters or adjusted to the specificity of a region.

Thus, on the basis of the obtained outcomes the study objective of the development of the key principles and methodological approach for statistical analysis of the state and changes of the eco-economic system in agriculture at the macroeconomic and regional levels has been attained; as well as the ways of raising the economic efficiency of the agricultural industry have been developed. The proposed methodological approach is a possible variant of an exact estimate of the eco-economic system in agriculture and will contribute to introduction of the SEEA elements into Russian statistics.

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