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WAYS TO PRESERVE SOIL FERTILITY BASED ON AGROLANDSCAPE

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ABSTRACT

As it is known, fertility is the most important property of soils to meet the needs of plants in nutrient elements, moisture or air and to provide conditions for their normal life. It is clear that yield of crops depends on soil quality. That is why the preservation of fertility is an important task in the implementation of agricultural production. Agrolandscape systems based on environmental based should be introduced in agriculture to solve the problem of preventing the degradation of soils, reducing water and wind erosion. Principles and methodology of landscape planning can be successfully adopted in farming systems that combine high environmental and economic indicators. During the years with unfavorable conditions such as drought or excessive moisture in farms with adaptive farming the yield is 30 % higher than in agricultural enterprises with the traditional farming system. The article discussed that the minimum value of the environment-stabilizing farm land agrolandscapes should not exceed 40% of the total land. The conducted experiments proved that the humus content in the households under consideration was increased by 0.24%. Average crop yields in the years with unfavorable weather conditions in the test farm (Kantemirovsky District, Voronezh region) are the following: grains 29 dt/ ha, sunflower 24 dt/ha, and for Kantemirovsky District, on average, 19.4 dt/ha and 17 dt/ha respectively. Stability of agrolandscapes depends on correlation between sustainable and destruct lands. Percentage ratio of agricultural lands for the sustainable agrolandscapes is determined.

Keywords: *agrolandscape, adaptive landscape system, soil fertility, Chernozem region.*

INTRODUCTION

As you know, soil fertility is the most important property of soils, which is to provide plant nutrients, moisture, soil and air for their normal functioning.
Crop yield depends on soil quality. Soil is one of the most valuable resources in the world and is by nature of a complex and dynamic ecosystem. Every year the demand for agricultural products increases, so the burden on agricultural land rises (Odum, 1953, reissued 1998).

Soil are degraded due to water and wind erosion, however the imperfect methods of land cultivation, violation of farming practices and agricultural technologies even worsen their condition. There are 196.44 million hectares of eroded land in the world that is 15% of the agricultural land («Food and Agriculture Organization of the United Nations» (FAO, 2014).

In Russia this figure is over 60 million ha of agricultural land that is more than 30%. According to «Food and Agriculture Organization of the United Nations» (FAO, 2014) Russia takes the 3rd place in the world on this indicator. In the Central Chernozem region eroded areas are more than 3 million hectares.

The aim of the study is the development of ways to increase the fertility of soils on the ecological and landscape base for sustainable land management.

The objective of the study is to determine the economic and environmental efficiency under the new introduced elements of the agricultural landscape.

MATERIALS AND METHODS

The agro landscapes in the agricultural enterprises of the Central Chernozem region of Russia are studied. Farms where agricultural landscapes elements increasing theirenvironmental sustainability are introduced, are located in Kantemirovsky district, Voronezh Region (49º 40 N, 39º 51E.), Chernyansky district, Belgorod Region (50°55’ N, 37°48’ E), Belgorod district of Belgorod Region (50°36’ N, 36° 36’ E), figure 1.

Figure 1. The Central Chernozem region of Russia

The research was carried out during 7 years, from 2008 to 2015. (A field experiment was conducted during seven years, 2008-2015).

The regions under study are characterized by temperate-continental climate, frost-free period is 140-165 days. The annual precipitation is 480-520 mm. Predominant

soil type is black soil, which are represented by subtypes of podzolized, leached, typical and ordinary chernozems. The relief on the territory of the studied farms is largely dissected by ravines, gullies and hollows. According to the degree of potential erosion hazards arable areas belong to different classes and have from a minor (2 t/ha) to critical truncation (more than 16 t/ha) (State standard 17.4.4.03-86, 1986).
The efficiency of the landscape specific agriculture was evaluated on environmental and economic indicators, among which are the percent forest cover of arable land, area under forest, ratio of environment-stabilizing and destabilizing land, plough disturbance of areas, the content of humus in the soil (WRB, 2014) , yield, cost of 1 center.
Graphical models were developed using spatial geoinformatical environment of Arcgis 10.3.All land was divided into two types: environment-stabilizing and destabilizing. The first ones increasing the environmental capacity of the agricultural landscape include forest belts, perennial plantings, shrub-stage, perennial grasses in crop rotations, ponds, ecotones, grasslands, and hayfields. The second group of lands which reduce the environmental capacity, include arable land without perennial grasses, roads, gullies, landslides. The ratio of wetlands was calculated by the formula:

$$K= \frac{A}{B}$$

Where A - environment-stabilizing areas,

B - environment-stabilizing.

RESULTS AND DISCUSSION

The following elements were put in the basis of adaptive system of farming that ensure sustainable ecosystem, high productivity, protection of soil erosion, stabilization and increase of soil fertility:

1. Differential land use. This means that arable land is cultivated by using different technologies, with different intensity. For example, in the farm under study in Kantemirovsky district four technologies, and three types of rotation such as beet, grain (without beets), soil conservation (more than 70% perennial herbs) are used. Marginal arable land is forced out from the rotation, grassing of ravine by means of perennial grasses and shrub vegetation is performed (Lopyrev, Linkina, 2012).

Figure 2.The consolidation of hollows with trees and shrubs. Belgorod district of Belgorod Region

2. The increase in the total forest covers of the territory. This is achieved through a range of activities, which includes the creation of protective forest strips on arable land, the creation of forest strips near hollows and gullets (Volkov, 2005), shrub scenes development, complete forestation of ravines.

In the studied farms blown and openwork forest strips were formed where the main species dominated is lombardy poplar (Pōpulus pyramidālis), among bushes golden currant (Ribes aureum) prevails.

3. The development of anti-erosion hydraulic engineering structures (revetments, bulkhead dams).

4. Contour mechanized cultivation. Cultivation is carried out in contour-straight-line and contour.

5. Increase in the mosaic of agricultural landscapes alternating areas of arable land, forest belts, perennial grasses, etc (Dokuchaev, 1883).

Figure 3. Contour tillage, Voronezh region

6.Development of micro wild reserves for wild fauna, ornithifauna, and entomological micro wild reserves. Example of entomological reserve is presented in figure 4.

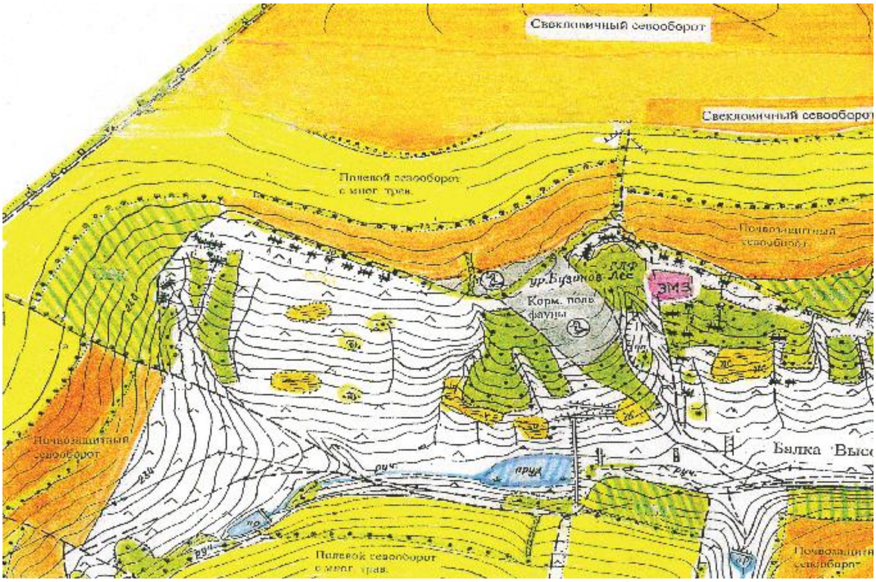

Figure 4. Example of entomological micro wild reserves, Kantemirovsky District. (Lopyrev at all, 2013)

Increasing the share of environment-stabilizing land after the implementation of the ecological-landscape system of agriculture is presented in figure 5.

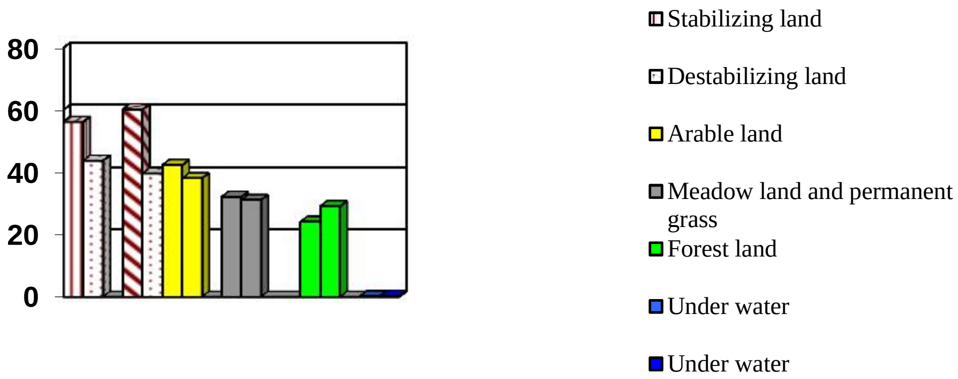

Figure 5. The ratio of wetlands in the agricultural landscape “Losovoy” before and after the introduction of agro landscape farming systems, Kantemirovsky district

Greater efficiency of the implemented activities shows in years with abnormal weather conditions (droughts or, conversely, excessive water logging). The damage from the drought is reduced, the productivity of agricultural crops in comparison with agricultural enterprises with traditional system of land management is increased (Cumani, Rojas, 2016).

The proportion of humus content is increased. Due to the soil studies carried out in 2005 by the staff of the Department of soil science under supervision of Professor K. E Stekolnikov it was proved that the humus content in the households under consideration was increased by 0.24%. Average crop yields in the years with unfavorable weather conditions in the test farm (Kantemirovsky District, Voronezh region) is following: on grains was 29 dt/ ha, sunflower 24 dt/ ha, and for Kantemirovsky District, on average, 19.4 dt / ha and 17 dt / ha respectively. Stability of agro landscapes depends on correlation between sustainable and destruct lands. Percentage ratio of agricultural lands for the sustainable agro landscapes is determined (Lopyrev at all, 2013).

CONCLUSION

As a result of activities on implementation of ecological-landscape farming systems, we can draw the following conclusions. These elements of agricultural landscapes contribute to the increase of environmental capacity, reduce erosion, and stabilize soil fertility. There is a tendency to increase the humus horizon, improve water and thermal regimes, and to increase in the types of ornito - and entomofauna as well. The need to use pesticides is reduced. Crop yields are risen up to 30% on soils with the same score of bonitet around the area.

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