Improving the Forecast of the Effectiveness of Reclamation Measures to Reduce Food Security Risks

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Abstract. The analysis of the current state and prospects for implementation of the integrated land reclamation program in Krasnodar Territory is one of the main tasks in the development of the agro-industrial complex to reduce the risks of industrial safety in the region. The article pays special attention to the crucial importance of the agro-industrial complex of the region in supporting and ensuring food security of the country on the example of Krasnodar Territory, since the Southern region makes a great contribution to the formation and development of the agro-industrial complex of the country. In accordance with the documents of the Program, Krasnodar Territory is a key element in the creation of the "main food base of the country" on the territory of the Southern Federal District on the basis of the formation of a national mega-cluster of the agro-industrial complex. The article also pays special attention to the problematic aspects and difficulties in the practice of creating and operating a reclamation complex in the regions of Southern Russia. Taking into account the accumulated experience, the key components of the integrated land reclamation of Krasnodar Territory are identified, providing for improvement of physical and physical-chemical properties of soil through the use of modern irrigation technologies, introduction of new methods for removing excess water during the growing season and expansion of the use of progressive methods of anti-erosion land reclamation. Forecasting the effectiveness of the use of complex land reclamation in the conditions of Krasnodar Territory should show its feasibility and necessity. Thanks to the implementation of comprehensive measures, it is possible to reduce soil degradation, increase the effectiveness of drainage systems, as well as irrigation in general, and ultimately get a positive economic effect. An example of such an economic approach to agricultural lands of Kuban can be the improvement of the overall organic and chemical state of soils, which is mainly reflected in an increase in the gross harvest of agricultural crops.

1. Introduction

On the globe the area of potentially suitable soils for agriculture is about 2.7-3.5 billion hectares, the processing is carried out on 1.5 billion hectares. Over the past 30-35 years, 1.3 times more areas have been withdrawn from arable land than those that are part of it [1]. This is caused by the destructive effect of soil degradation factors, among which water and wind erosions are the most common on the planet [2]. In Russia, 25.2% of agricultural land is affected by water erosion, deflation is widespread on 35.7%, about 3.8% is affected by both water and wind erosion [3]. In this context, the issue of the use of complex land reclamation in the southern regions, which allows increasing soil fertility, improves its water, air, heat and salt regimes, regulates the microclimate in the surface layer of the atmosphere, is of particular
relevance for Russia, taking into account the need to ensure the country's food security [4, 5]. A special emphasis on the southern regions is associated with the presence of Chernozem soils and a fairly high amount of active temperatures. One of the key agricultural regions of Russia is Krasnodar Territory - the volume of agricultural production in the region in 2017 amounted to 387.9 billion rubles [6].

2. Materials and methods

Complex land reclamation has a multifactorial historical impact on the development of productive forces, social structures of the territory, forms of state administration and regional self-government. The whole hierarchy of processes is based on the development of productive forces of the reclamation complex. With the increase of reclamation technologies in agriculture, technical saturation of production increases, integration of engineering, agrotechnical, hydrogeological components of the working process deepens.

In accordance with the approved Strategy of socio-economic development of the Southern Federal District of the Russian Federation until 2020, Krasnodar Territory is a key element in the creation of the "main food base of the country on the territory of the district on the basis of the formation of a national megacluster of the agro-industrial complex, including the entire range of production and innovation centers that ensure its effective functioning "from the field to the product" [7].

Therefore, taking into account the above, the issue of implementing an effective land reclamation system as a complex set of measures aimed at optimizing the processes of agricultural and forestry production, general improvement of soil productivity in the territory of Krasnodar Territory becomes critical and requires increased attention.

At the same time, it should be noted that the practice of creating and operating a reclamation complex in the southern regions of the Russian Federation has shown the presence of many unaccounted aspects in the development of laws of reclamation production. Thus, these circumstances confirm the relevance of the chosen research problem, as well as determine its conceptual basis and scientific tools of cognition.

In the last decade, intensive research has begun, including by domestic scientists, in the field of environmental management economics and the study of ecological and economic consequences of economic activity. A great contribution to the development of this direction was made by L. M. Gorev, S. I. Doroguntsov, V. M. Tregobchuk, M. A. Khvesik, B. V. Burkinsky, etc. Numerous aspects concerning the reduction of fertility and soil degradation under the influence of reclamation works are covered in the publications of M. Voloshchuk, B. Draguntsov, M. Yakimov, L. Kazimir, etc. [8, 9, 10].

At the same time, it should be noted that in the south of Russia, including in Krasnodar Territory, long-term stationary experiments took place (several decades) at the sites of industrial implementation of reclamation planter plowing [11, 12, 13]. However, observations at these stations have been discontinued in recent years, so the issues of consequences of complex reclamation measures, as well as the current agro-reclamation state of planted and non-planted saline soils in irrigated and non-irrigated conditions remained unresolved [14].

Thus, taking into account the above, the purpose of the article is to raise the question of forecasting when using complex land reclamation in the conditions of Krasnodar Territory [15]. To solve the tasks set, the method of collecting and analyzing statistical, cartographic information, materials of the survey of the state of reclaimed lands will be used [16]. An important component of the research is the identification of trends in the agroecological state of reclaimed land, geoinformation modeling of changes and the design of optimization solutions.

Complex land reclamation or optimization of land reclamation systems is the achievement of the most rational ecological balance with the help of a favorable combination of environmental components and territories with varying degrees of human transformation [17]. As part of the integrated land reclamation of Krasnodar Territory, it is planned to improve the physical and physical-chemical properties of soils through the use of modern irrigation technologies, introduce modern technologies for removing excess water during the growing season and expand the use of progressive methods of anti-erosion land reclamation [18]. According to experts, the implementation of integrated land reclamation
in Krasnodar Territory will increase the efficiency of agriculture, lead to an increase in yield by 2-3 times [19]; will expand the range of products grown; will contribute to the integrated use of land and water resources, preservation and enrichment of natural resource potential of the territory, reduction of dependence on adverse climatic factors, such as drought, dry winds, frosts, etc. [20, 21].

**Table 1.** Assessment of degradation degree of agrophysical parameters of Chernozem under various technologies of plant cultivation.

| Technology of cultivation | Soil layer, cm | Air-dry units (0.25-10 mm) % | Degradation degree | Equilibrium integrity g/cm³ | Degradation degree | Technology of cultivation | Soil layer, cm |
|---------------------------|----------------|-----------------------------|--------------------|----------------------------|-------------------|---------------------------|----------------|
| Conventional plowing to a depth of 25-27 cm | 0-10 | 58.1 | average | 1.11 | undegraded | 0-10 |
| | 10-20 | 60.7 | average | 1.28 | undegraded | 10-20 |
| | 20-30 | 43.6 | average | 1.34 | weak | 20-30 |
| | 30-40 | 50.7 | average | 1.20 | undegraded | 30-40 |
| | 0-30 | 54.1 | average | 1.24 | undegraded | 0-30 |

Soil-protective, with flat-cut processing to a depth of 25-27 cm | 0-10 | 73.8 | undegraded | 1.09 | undegraded | Soil-protective, with flat-cut processing to a depth of 25-27 cm | 0-10 |

As Table 1 shows, under the conditions of applying soil protection technologies, the structural composition of soils can significantly improve, respectively, the share of agronomically valuable substances will fluctuate between 51.8-73.8 % and 53.5-62.7 % [22]. At the next stage of the study, we will make an assessment of reclamation state of drainage systems according to the terms of excess water removal during the growing season (Table 2). The technical component of the evaluation model of the reclamation state of drainage systems can be characterized by such factors as: reclamation state of drainage systems depending on the average depth of the groundwater level; reclamation state of drainage systems according to the terms of removal of excess water during the growing season; technical condition of the elements of the reclamation system [23].

**Table 2.** Assessment of the reclamation state of drainage systems according to the terms of removal of excess water during the growing season.

| Parameters | Reclamation condition, day |
|------------|---------------------------|
| Vegetable and vegetable-fodder crop rotation | Excellent | Good | Satisfactory | Unsatisfactory |
| to 0.3 | 0.3-0.5 | 0.5-1.0 | 1.0-2.0 |
| to 0.5 | 0.5-1.0 | 0.1-2.0 | 2.0-3.0 |
| Field, fodder crop rotation, pastures | to 0.5 | 0.5-1.0 | 1.0-2.0 | 2.0-3.0 |
| to 1.0 | 1.0-2.0 | 2.0-3.0 | 3.0-4.0 |
| Hayfields | to 0.5 | 0.5-1.0 | 1.0-2.0 | 2.0-3.0 |
| to 2.0 | 2.0-3.0 | 3.0-5.0 | 5.0-6.0 |
Currently, the technical condition of on-farm drainage systems in Krasnodar Territory, due to the unprofitable activities of most agricultural producers, leads to the inability to perform the main function assigned to melioration - the removal of excess water, and their destruction creates an environmental and man-made danger [24]. In the case of introduction of a comprehensive melioration system, which, among other things, provides for the energy conversion of pumping stations, reconstruction or overhaul of drainage systems, introduction of the latest technologies for the possible guaranteed regulation of the water-air regime, it is expected to reduce the zone and timing of flooding of agricultural land and settlements by 30% [25], as well as the introduction of about 15% of the land into circulation, currently used as meadows and pastures. In addition, the implemented measures will make it possible to clean the channels that are overgrown with bushes and silted up [26].

Thus, it can be concluded that increasing yields by improving irrigation and improving the physical and chemical properties of soils is an important reserve for solving the country's food problem and increasing the efficiency of agricultural production in Krasnodar Territory, as clearly testified by the results of the field research (Table 3) [27].

| Crop            | Average irrigation rate, m³/ha | Irrigation yield, t/ha | Yield without irrigation, t/ha | Increase in yield t/ha | Yield increase % | Irrigation index |
|-----------------|-------------------------------|------------------------|-------------------------------|------------------------|-----------------|-----------------|
| Winter wheat    | 2100                          | 6.04                   | 2.99                          | 3.05                   | 102             | 2.0             |
| Corn for grain  | 2210                          | 9.57                   | 2.86                          | 6.71                   | 235             | 3.4             |
| Corn for fodder | 2300                          | 65                     | 20.3                          | 44.7                   | 220             | 3.2             |
| Soybean         | 2450                          | 2.94                   | 1.07                          | 1.87                   | 175             | 2.7             |
| Alfalfa for green fodder | 4490 | 64.1 | 19.3                          | 44.8                   | 232             | 3.3             |
| Tomatoes        | 3900                          | 57.3                   | 20.3                          | 37.0                   | 182             | 2.8             |

3. Conclusion

It should be noted that the role of irrigation, in the conditions of increasing trends of global warming on Earth, will constantly increase. Forecasting the economic efficiency of complex land reclamation measures is of particular importance. For this purpose, calculations were carried out on the example of the farm "Bioferma Kuban". The farm uses 379.7 hectares of arable land of slope areas: 38.4 hectares 8-9, 84.3 hectares 6-7, 142.7 hectares 5-6, 114.3 hectares 4-5, (natural relief in the direction of the Kuban River). The proximity to the river explains the regular appearance of heavy rains, the washouts from which wash away part of the crop, perennial bushes and even sections of asphalt.

The complex of reclamation measures provides for the creation of land terraces across the slopes; use of elements or a system of non-fallow tillage; preservation of stubble and its sealing with steam cultivators; scattering/introduction of crushed straw, stems of coarse-stemmed crops, and other plant residues.

The calculations carried out show the feasibility of anti-erosion reclamation. The cost of the increase in marketable products, with an investment of 400 thousand rubles, is 12,139.4 thousand rubles, i.e. 41.9 thousand rubles per hectare.

Summing up, we note that the progress of the modern agro-industrial complex is impossible without comprehensive land reclamation, which provides for the use of energy-saving and environmentally-friendly production technologies. Forecasting the effectiveness of the use of complex land reclamation in the conditions of the Krasnodar Territory has shown its feasibility and necessity. Thanks to the implementation of appropriate measures, it is possible to improve the physical and physical-chemical properties of soils, increase the effectiveness of drainage systems, as well as irrigation, in general, and, ultimately, get a positive economic effect.
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