Agricultural reclamation complex as a means to obtain guaranteed yields of agricultural systems

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Abstract. The article presents the economic justification of the agricultural reclamation complex, the practical implementation of which was carried out in the form of an adapted land security system on agricultural lands of the Kanevsky district of Krasnodar Krai and in the form of an investment project of a reclamation system. Two variants of the ecological and economic effect of the investment project of the adapted land security system were considered. Option 1 provided for irrigation of crops by sprinkling, the introduction of measures to protect agricultural landscapes from flooding and waterlogging, but excluded the clearing of the river section, the second option, in addition to the measures provided for in option 1, also included the clearing of the irrigation source. It has been established that in conditions of shortage of runoff during the growing season of agricultural crops, option 2 allows obtaining guaranteed high yields of agricultural crops and managing the reclamation state of the soil.

1 Introduction

The Agricultural Reclamation Complex (ARC) is a system of environmental protection measures aimed at restoring and protecting the resource potential of agricultural landscapes and preserving soil resources from pollution. The development of the ARC can be carried out only at the system level with the inclusion of a subsystem (natural environment–land and water resources), which relies on resource-saving technologies and processes that ensure the balance of substances and increase the reclamation state of the soil. The ARC preserves the natural environment, which includes land and water resources, which are the basis of agricultural production.

The ecological efficiency of the ARC is ensured by clearing riverbeds from silt deposits to natural morphological parameters in order to prevent flooding and waterlogging of agricultural landscapes. Economic efficiency is achieved by obtaining a guaranteed crop yield when commissioning restored agricultural landscapes that were previously degraded from flooding and waterlogging or dried up.

2 Materials and methods

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An important element of the ARC is adapted land security systems (ALSS) for the management of resource-saving technologies. They provide the necessary protection of agricultural landscapes from degradation caused by natural phenomena and environmental pollution by agricultural enterprises. ALSS increase the profitability of production at a higher technogenic level of “agrolandscape:technology”, ensure guaranteed yields of agricultural crops.

With man-made impact on the geosystem, the natural-man-made agricultural landscape should receive a new state with improved agro-resource potential. The control of the main parameters of the ARC provides monitoring, which allows you to simulate man-made components of the system. Taking into account this approach, a man-aged ARC model has been developed (Figure 1).

Fig. 1. Model of agricultural reclamation complex

With a comprehensive assessment of the projected facilities, the risks of irrigation are determined, which are expressed in the amount of the necessary runoff for an acutely dry year with 95% security, crop shortage due to flooding of land and untimely drainage of water, assessment of the land reclamation condition. Initial monitoring determines the state of water and land resources of the territory for making decisions on the direction of investments. Forecasts of the balance of the flow volume before and after clearing are carried out, which makes it possible to assess the irrigation capacity of the river and make recommendations for further water management use of the site. The volume and quality of bottom sediments for use in agricultural production are determined. Surveys and research are the basis for the development of investment projects of the ALSS.

The practical implementation of the ARC was carried out in the Kanevsky district of the Krasnodar Territory for the ALSS investment project near the village of Chebasskaya.
The construction of irrigation systems of a new generation was carried out, the restoration of the water content of the sections of the steppe rivers Chelbas and its tributary the Vodianaya Beam, the removal of excess surface and groundwater from the lands on which irrigation systems were built.

Economic activity affects the water quality of steppe rivers (Table 1).

<table>
<thead>
<tr>
<th>River</th>
<th>Upper current</th>
<th>Middle current</th>
<th>Lower current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chelbas</td>
<td>2.2 – 2.5</td>
<td>2.5 – 2.7</td>
<td>2.6 – 2.7</td>
</tr>
<tr>
<td>Sosyka</td>
<td>2.7 – 4.0</td>
<td>4.0 – 6.5</td>
<td>6.5 – 8.0</td>
</tr>
<tr>
<td>Beysug</td>
<td>1.5 – 1.8</td>
<td>1.8 – 1.9</td>
<td>1.9 – 4.0</td>
</tr>
</tbody>
</table>

Data analysis shows that a set of measures is needed to reduce the total mineralization of river water. The lower course of the rivers is the most degraded. The feed base of hydrobionts is shrinking. To restore the fodder base, it is necessary to increase the water capacity of ponds and improve the water quality in rivers. The same conditions are needed for the development of irrigation.

To restore land and water resources, it is necessary to clear the channels of silt deposits.

Ecological damage to the ecosystem of rivers should be taken into account by compensation costs for the restoration of biological resources, which should be included in investments to determine the ecological and economic efficiency of the complex of measures. Compensation costs include the cost of biological reclamation caused by flooding of land by the river, payments for damage caused to biological resources, monitoring, payment for emissions of pollutants into the atmospheric air, etc.

The analysis of investments in the development and implementation of an agricultural reclamation complex was carried out at the cost of an average irrigated hectare for the considered farms of the steppe zone of the Krasnodar Territory of JSC Rodina on an area of 2000 hectares.

The project uses circular type "Otech" sprinklers. During irrigation, a stable yield of sugar beet is provided – 100 t/ha, soybeans – 4.0 t/ha, winter wheat – 9.5 t/ha, corn for grain – 10.0 t/ha. The yield under irrigation is on average 2.5 times higher than on bare.
The investment project is estimated to cost 320,451 thousand rubles in the prices of 2022.

An investment project can be effective only through a set of compensatory measures, increasing the irrigation capacity of the source, selecting crop rotation crops and the availability of water resources.

As an assessment of investment, the following were taken: the cost of the irrigation system, the average income from irrigation, the costs associated with operation, servicing of the loan, net discounted income, the profitability index and the payback period of the investment.

3 Results and discussion

Works on the restoration of water bodies include preparatory work; clearing of sections of the riverbed; biological reclamation of temporary hydraulic dumps. Before the start of the work, work is carried out to clear the territory of forest, shrub and reed vegetation for temporary dumps of soil, the construction of land roads, geodetic breakdown and fixing of plots on the ground, cutting of the vegetation layer of soil with its transportation to the dump.

When carrying out construction and installation work on clearing the section of the beam of the Water tributary of the Chelbas River for an investment project on the irrigation system of JSC "Rodina", the clearing area was 6.9 hectares. The total volume of the developed bottom sediments is 73.78 thousand m$^3$ along the length of the beam section 2 km. According to the performed hydrological surveys, the thickness of the sediments in the water body varies from 2.00 to 0.30 m. After the end of the sediment development from the first parking lot, the excavator is moved to a new position, from which all the remaining undeveloped soil should be captured. The largest possible step of the excavator can be found either graphically by postponing the cutting radius from the standing point in the direction of movement of the excavator. The next parking lot of the excavator is selected so that all the soil remaining unassembled in the previous parking lot is developed from it.

To increase the efficiency of the work, the development of the soil will be carried out without additional shifts and movements, which is achieved by choosing the type of excavator. The clearing soil removed by the excavator is stored in temporary dumps located along the left bank of the water body, outside the coastal zone. After drying, the clearing soil is loaded into dump trucks and taken out for further use in the interests of the customer. There are two temporary dumps used for dewatering and drying of the removed bottom sediments, located on a total area of 79,000 m$^2$ and a total volume of 73.78 m$^3$. Recultivation works were often included in the preparatory period and assumed the technical stage of recultivation before the start of the main work on clearing the river. The stage of technical recultivation also included such works as the construction of access roads, drainage and drainage and water protection structures to protect recultivated areas from storm and flood waters.

The biological stage of reclamation consisted in the restoration of the soil cover. The work of this stage should be carried out in accordance with the intended use of the reclaimed territory and agrotechnical requirements for soil cover, since the land on which the organization of temporary dumps is carried out is not suitable for agricultural purposes.

At the biological stage of soil restoration, the following was carried out: the choice of the direction of soil use (haymaking); the choice of the most biologically productive vegetation species, creating a large biomass and providing; high speed of the biological cycle; the reconstruction of the humus horizon with vegetation and organic residues.

Approximate costs for the implementation of a set of measures to clear the Vodianaya Beam River for 1 km of the site are determined in the amount of 513,685 thousand rubles (in prices of 2022).
measures to protect agricultural landscapes from flooding and waterlogging, but excluded the clearing of the river section. The irrigation source was accepted, in this variant, in a "conditionally satisfactory condition", but there were risks associated with a decrease in crop yields due to a lack of irrigation water. Table 2 shows the ecological and economic efficiency of the investment project for option 1 at a rate of 0.12.

<table>
<thead>
<tr>
<th>Investment efficiency of the project</th>
<th>The value of indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project's investments include a set of compensatory costs, without clearing the river section, thousand rubles.</td>
<td>320,451.00</td>
</tr>
<tr>
<td>Payback period of the project, years</td>
<td>7.5</td>
</tr>
<tr>
<td>Net discounted income, thousand rubles.</td>
<td>218,917.40</td>
</tr>
<tr>
<td>Yield Index (PI)</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Option 2 took into account the irrigation of crops by sprinkling, the introduction of measures to protect agricultural landscapes from flooding and waterlogging, the restoration of water content and bioproductivity of the irrigation source by clearing the channel of the Vodianaya beam and the Chelbass River. In this version of the project, water resources are in relatively “good” condition after the application of a set of adapted technologies. Table 3 shows the ecological and economic efficiency of the ALSS project (option 2).

<table>
<thead>
<tr>
<th>Investment efficiency of the project</th>
<th>The value of indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>The project's investments include a set of compensatory costs, without clearing the river section, thousand rubles.</td>
<td>378,552.66</td>
</tr>
<tr>
<td>Payback period of the project, years</td>
<td>8.5</td>
</tr>
<tr>
<td>Net discounted income, thousand rubles.</td>
<td>160,816.58</td>
</tr>
<tr>
<td>Yield Index (PI)</td>
<td>1.4</td>
</tr>
</tbody>
</table>

The risks of investments in option 2 are minimal, the water capacity of the channel section increases at a normal level by 2.5 times, the volume of water is sufficient for irrigation of the culture, the integral risk indicator is less than the critical value. From the analysis of the main indicators of the projects, it can be seen that the first option is more attractive from the perspective of BDD and PI. However, given that the cultivation of crops is not constantly provided with a high probability of runoff in the conditions of drought in the south of Russia, to which the Krasnodar Territory geographically belongs, a certain supply of water in the source is required, therefore the first option should not be considered a priority project of investment construction. The second variant of the project makes it possible to sustainably obtain guaranteed high yields of agricultural crops, and to manage the irrigation condition of the soil.

Taking into account the fact that the Russian Federation is implementing a state program for the effective involvement in the turnover of agricultural land and the development of the reclamation complex of the Russian Federation, which provides for state subsidies to agricultural producers up to 50% of the reimbursement of the costs incurred in the construction of reclamation facilities, construction costs are reduced. Taking into account state subsidies, the payback period of ALSS investment projects is decreasing, and for the Rodina JSC project it will be 5 years, and the profitability index for the project will increase to 2.06.
4 Conclusion

It can be concluded that the provisions of the agricultural reclamation complex meet the requirements of investment construction in the conditions of the steppe zone of the Krasnodar Territory. Investments in the development of ARC to obtain maximum yield should be carried out in a comprehensive manner, where the main element of the system should be the ALSS project, including resource-saving and adapted technologies "agrolandscape technology". The return on investment will be ensured only when the risks of water availability and water quality of the irrigation source are minimal.

References


