

# Anti-erosion reclaim development and its economic efficiency

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**Abstract.** This paper considers the issues of the efficiency of agricultural production in the context of the globalization of the markets for agricultural raw materials and food and the increased competition in this regard. Modern realities and the adopted new Doctrine of Food Security of the Russian Federation, adopted in 2020, require an immediate solution to the problems of ensuring the country's food security by increasing the production of high-quality, environmentally friendly, and, most importantly, economically competitive agricultural products, which is not possible without intensifying production processes. However, the pursuit of high yields and high efficiency of agricultural commodity production often leads to the degradation of the prickly factor of production, namely, land. The paper presents the results of the analysis of the level of land degradation in the Republic of Tatarstan and identifies priority areas for combating erosion in agriculture. Measures to combat soil erosion are experimentally substantiated. The practical significance of the research results lies in the fact that they can not only contribute to the development of the agro-industrial complex and other sectors of the economy, improve soil fertility, the dynamic growth of agricultural products, reduce the disposal of agricultural land and create new jobs but also ensure the preservation and restoration of the Volga River. The results show that the ecological efficiency of one anti-erosion structure in combination with soil protection measures protects an average of 120 hectares of land from further development of erosion processes and is economically paid off by the results of two years of economic activity on protected lands.

## 1 Introduction

The efficiency of the functioning of the agro-industrial complex depends not only on the entrepreneurial activity and the ability of entities managing the land but also on the state of agricultural production factors. Earth, according to A.A. Zotov, F.N. Safiollin, E.S. Isaicheva, D.F. Khafizov, M.M. Khismatullin was, is, will be the main wealth of any country in the world. Therefore, the creation of a system of efficient, economical land use in terms of importance and relevance should be one of the leading places in the political and socio-economic life of the Russian Federation, including the Republic of Tatarstan [1–6].

Unfortunately, the productivity and ability of soils to self-heal have declined significantly in recent years. The alienation of nutrients from the harvest, dehumidification and erosion of soils, pollution and littering of land, an increase in anthropogenic pressure, and high plowing of agricultural land lead to the destruction of natural landscapes and ecosystems. This fact is reflected in the works of F. N. Safiollin [7], A. A. Zotov [4], I. M. Minnekhametova [8], F. N. Mukhametgaliev [9].

Irrigation and drainage reclamation, cultural engineering, and anti-erosion work in combination with agrochemical measures are the important factors for ensuring high efficiency of agricultural production, as well as the

reproduction of soil fertility (A. R. Zakirova) [10, 11]. Leading scientists and practitioners in the field of agriculture I. A. Kayumov [12], G. S. Klychova [13, 14], A. M. Sabirov [15], Khismatullin M. M. [16] take into account the current market conditions and make a number of recommendations. They recommend that on reclaimed lands, first of all, cultivate vegetables, feed for livestock, develop seed production, and other most valuable and high-margin crops.

## 2 Materials and methods

The study is based on a theoretical and methodological basis that allows using the possibilities of interaction and complementarity between the fundamental provisions and the concept of land reclamation science. The basis of the theoretical and methodological base is the works of foreign and domestic scientists, practitioners A. A. Zotov [1], F. N. Safiollin [2], V. G. Grebennikova, I. A. Shipilov [17], D. I. Faizrakhmanov [18], V. A. Aksanov [19], D. F. Khafizova [20], I. A. Kayumov [7]. This study is based on international and domestic legal norms governing relations arising in the process of carrying out anti-erosion work, and the implementation of agricultural policy.

The methodological basis of the study is system analysis, within which the following approaches are applied: a constructive, deterministic, retrospective, and statistical.

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During the study, the following were used: monographic, abstract-logical, calculation-constructive, and economic-statistical methods. The information base of the study was the official data of the Federal State Statistics Service, the Ministry of Agriculture of the Russian Federation, the Ministry of Agriculture and Food of the Republic of Tatarstan, the Federal State Institution "Management of Tatmeliovodkhoz", planning and reporting documents of agricultural organizations, materials of scientific conferences, materials contained in monographs, reports Research Institute, data obtained in the course of the author's analysis and calculations.

### 3 Results and discussion

Under the influence of natural, climatic, and anthropogenic factors, the scale of water erosion is increasing every year, causing enormous damage not only to agriculture but also to large and small rivers (ecology) of the region. The territory of the Republic of Tatarstan is characterized by great dissection, which is the basis of soil erosion. The development of soil erosion is facilitated by such a factor as a high degree of plowing of farmland (76.6%) with a low forest cover of arable land (3.3%, with optimal values of 4.7–7%).

The studies of the dynamics of changes in the quality indicators of lands revealed a clear trend towards a decrease in soil fertility and deterioration of the general environmental situation in the agro-industrial complex of the Republic of Tatarstan.

The scale of water erosion, the progressive degradation of the soil cover, and the damage caused by erosion processes to the agriculture of the republic have reached impressive proportions. So, in the Republic of Tatarstan, there are more than 21 thousand active ravines, their total length exceeds 29 thousand kilometers. As a result of the erosion of the fertile soil layer, more than one thousand hectares of agricultural land are annually taken out of circulation (S. R. Suleimanov) [21].

Compared with 1960, only due to soil erosion, the area of arable land has decreased by 247.5 thousand hectares. This is the territory of three regions of the Republic.

The areas of agricultural land subject to water erosion increased by 925 thousand hectares, the number of active peaks of ravines by 7450 pieces, and they occupy an area of 114 thousand hectares (V. A. Aksanov) [19].

The area of arable land requiring anti-erosion measures has more than doubled over the past 40 years and reached 2 million hectares. Snowmelt and stormwater from each hectare are washed off an average of 22 tons of fertile soil per year. The loss of humus for this reason in the whole country is about 700 thousand tons annually, which is equivalent to the introduction of 10 million tons of organic fertilizers. In other words, almost half of the applied mineral

fertilizers are used for covering losses from flushing.

The area of erosion-hazardous agricultural land is 2263.2 thousand hectares, of which 1390 thousand hectares of arable land are subject to water erosion processes – 42%, including 6.7 of a strong degree, 254 of an average degree, and 1,129 thousand of a weak degree. ha. There are 21 thousand ravines with a total length of more than 29 thousand km, of which more than 21 thousand km are in the water area of the Volga River [22].

In the Republic of Tatarstan, more than 70% of the agricultural land area is located on slopes of various steepness: including arable land on slopes steepness:

- up to 1 degree – 42.4%,
- 1–3 degrees – 52.0%,
- 3–5 degrees – 5.6%.

According to F. N. Salakhutdinov [23], L. F. Sitdikova [24], N. M. Asadullina [25], a positive role in reducing erosion processes is played by the construction of anti-erosion structures for reclamation purposes, some of which, in turn, are a source of water for irrigated lands.

In the Republic of Tatarstan in different years, more than 880 anti-erosion and reclamation hydraulic structures (dams) with a total volume of more than 360 million m<sup>3</sup> (useful – 283.6 million m<sup>3</sup>) were built and put into operation. The main part of these hydraulic structures was built in accordance with the approved design and estimate documentation, considering the volume of water accumulation: up to 500 thousand m<sup>3</sup> – 395 pieces; up to 1 million m<sup>3</sup> – 166 pieces; more than 1 million m<sup>3</sup> – 78 pieces (A. K. Subaeva) [26]. Tatarstan ranks first among the regions of the Volga Federal District in terms of the total area of lakes and reservoirs. In addition to reclamation purposes and watering of territories, they serve as a reliable tool designed to improve the ecological situation in the river basin of the Volga basin by reducing by at least 80% the volume of diffusion flows caused by erosion processes on sloping agricultural lands.

According to the state statistics authorities since 1968, 1681 reservoirs have disappeared on the territory of the republic for natural and anthropogenic reasons, including siltation [11]. Ponds and lakes built by damming ravines located on agricultural lands subject to erosional washout are exposed to the most active siltation. On them, the siltation rate reaches 10 to 50 mm per year, which is significantly higher than the average sedimentation rate typical for the territory of the Republic of Tatarstan [11].

Since 2013, as part of the implementation of the long-term republican target program for the overhaul of hydraulic structures, more than 450 facilities of 887 existing structures have been brought into the standard technical condition (Fig. 1). They accumulate more than 150 million m<sup>3</sup> of water, it also allows saving agricultural



**Fig. 1.** Hydraulic structures in the Republic of Tatarstan.

land from the effects of water erosion on an area of 44.7 thousand hectares. During the spring passage of flood waters, the protection of the population and objects that fall into the zone of possible flooding is ensured. Through repair and restoration work, an increase in the technical reliability and stability of hydraulic structures was achieved. Thus, the threat of emergency situations at dams during the spring passage of flood waters through hydraulic structures is reduced [12].

The efficiency of anti-erosion measures is an aggregated assessment of environmental and economic damage prevented because of the implementation of environmental anti-erosion measures. Environmental efficiency (prevented environmental damage) is determined depending on the degree of reduction in the intensity of the above negative processes because of the implementation of anti-erosion measures. The environmental efficiency of the measures is the follows.

1 anti-erosion structure in combination with soil protection measures protects an average of 120 hectares of land from further development of erosion processes.

The cost of a complex of anti-erosion measures, including an anti-erosion pond is 2.5 million rubles.

The cost of production from 120 hectares with a yield of 30 centners of grain from 1 hectare:

$120 \times 30 \times 1500 \text{ rubles/c} = 5.4 \text{ million rubles. in year.}$

The payback period is two years.

One of the effective methods for reducing erosion processes is agroforestry. As part of the implementation of targeted programs for the development of land reclamation, agroforestry work is carried out in the republic, more than 2.5 thousand hectares of protective strips are planted annually. From 2016 to 2021, work was carried out on an area of about 11 thousand hectares. in the amount of more than 800 million rubles (about 150–160 million rubles per year).

**Table 1.** Financial support for the implementation of reclamation programs implemented in the Republic of Tatarstan in 2018–2020 (the table was compiled by the authors based on the analysis of internal documents of the Federal State Budgetary Institution “Department “Tatmeliovodkhoz”).

Directions of funding	Years			
	2018	2019	2020	Total
For the construction, and reconstruction of reclamation systems and hydraulic structures from the budget of the Russian Federation for federal facilities million rubles	142.1	113.0	117.7	372.8
Capital repairs of ponds and hydraulic structures from the budget of the Republic of Tatarstan, million rubles	92.7	58.1	89.8	240.6
Construction, reconstruction, and overhaul of irrigated and drained lands, million rubles	62.3	46.9	70.2	179.4
Establishment of anti-erosion and field forest plantations, million rubles	150	186.5	150	486.5
In total for 3 years involved in land reclamation	447.1	404.5	427.7	1279.3

At the same time, there is an objective need in the republic to continue restoration work on hydraulic structures. The reason is that many facilities remain at risk of emergencies caused by the destruction of dams and flooding of nearby areas. In addition, a serious environmental pollutant, including rivers, is the use of pesticides and mineral fertilizers. About 2,000 tons of pesticides and more than 190,000 tons of mineral fertilizers are used annually on farmland in the republic. In addition to preventing river silting, erosion control structures delay the runoff of chemicals and pesticides used in agricultural formations. Thus, according to the results of a joint inventory of the Ministry of Emergency Situations of the Republic of Tatarstan and specialists from the Ministry of Agriculture and Food of the Republic of Tatarstan and the Tatmelioratsia company, as of January 1, 2021, 160 additional hydraulic structures require repair work. According to expert estimates, more than 840 million rubles of funds at current prices are required to bring them into a standard state.

The fact of siltation of many reservoirs and the development of degradation processes of the water body in connection with this, which necessitates their cleaning from bottom sediments, is also alarming. The conducted studies indicate that the low-fertile lands of the Predkama zone, which are most prone to erosion, can be protected by the correct selection and cultivation of legume-cereal perennial grasses on a large scale. In this case, it is possible to stop the development of erosion processes, and radically improve the fertility and structure of the gray forest, light gray, soddy podzolic, and dark gray soils of the analyzed region (V. G.

Grebenkov, I. A. Shipilov) [17]. This method of combating the manifestations of soil erosion is less costly and affordable for a wide range of agricultural formations.

Also, this method helps to reduce the negative impact of drought on the performance of economic activities of agricultural organizations. For example, sowing perennial ryegrass from the legume family is the best way to reduce the negative effects of moisture deficiency. The reason is that the tap root system of alfalfa, goat's rue, and red clover draws water from such deep layers of soil, which is completely inaccessible to multi-cut ryegrass. In the same way, legumes start growing earlier in the spring and shade perennial grasses in the first cut.

As a result, the application of this method makes it possible to increase the economic efficiency of agricultural production both in crop production and animal husbandry. This result is confirmed by several studies by L. T. Vafin [27], V. M. Kosolapov [28], M. M. Khismatullin [29], and A. R. Valiev [30]. This method practically does not require a large amount of public investment. It is enough for agricultural formations to form their crop rotations widely scientifically reasonably, including legume-cereal perennial grasses.

## 4 Conclusion

In connection with the foregoing, we propose the following measures to improve the technical reliability and stability of hydraulic structures that are in pre-

emergency and emergency conditions. We consider it expedient to include in the program for the protection of the Volga measures for the repair and cleaning of bottom sediments of hydraulic structures located in its water area and a set of rehabilitation measures aimed at restoring the ecological status of this reservoir.

We also consider it important to include in the program the construction of new anti-erosion structures on ravine-beam systems located in the Volga basin. This set of measures is necessary in order to significantly reduce polluted flood runoff and fix the growth points of ravines.

The construction of anti-erosion hydraulic structures will provide water for irrigation of about 57 thousand hectares of arable land. On the whole, according to expert estimates, in order to guarantee the provision of the republic's population with essential foodstuffs, it is necessary to have at least 100.000 hectares of irrigated land.

Taking this into account, we consider it necessary to include in the developed program of measures to create annually at least 5 thousand hectares of shelterbelts, afforestation of ravines, and steep slopes located in the Volga water area with annual funding of 300 million rubles.

The implementation of the proposed measures will ensure the preservation and restoration of the Volga River and will contribute to the development of the agro-industrial complex and other sectors of the economy, will ensure an increase in soil fertility, a dynamic increase in agricultural production, a reduction in the disposal of agricultural land and the creation of new jobs.

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