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## CROP PRODUCTION

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### AGRICULTURE IN CRIMEA DURING WATER SHORTAGE

Review article

#### Abstract

The article deals with the aspects of agricultural development in the Republic of Crimea during water shortage. The article analyzes the progress of amelioration activities within the framework of the "State Program for the Development of Agriculture and Regulation of Markets for Agricultural Products, Raw Materials and Food of the Republic of Crimea". The study demonstrates the methods of adaptation of the base branch of the agro-industrial complex to new realities, which include both the agronomic techniques and the measures to improve the rational use of water resources for irrigation of agricultural land. The study examines not only the current changes in crop production, animal husbandry and processing industry, but also in foreign markets. The research contains an analysis of the environmental consequences of intensive use of groundwater for irrigated agriculture.

**Keywords:** Russia, Crimea, water shortage, state program, agriculture, adaptation methods, amelioration, environmental consequences.

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### СЕЛЬСКОЕ ХОЗЯЙСТВО КРЫМА В УСЛОВИЯХ ВОДОДЕФИЦИТА

Обзор

#### Аннотация

В статье рассмотрены особенности развития сельского хозяйства в Республике Крым в условиях нехватки водных ресурсов. Проанализирован ход выполнения мелиоративных мероприятий в рамках реализации «Государственной программы развития сельского хозяйства и регулирования рынков сельскохозяйственной продукции, сырья и продовольствия Республики Крым». Показаны способы адаптации базовой отрасли агропромышленного комплекса к новым реалиям – как агрономические приемы, так и меры по повышению рациональности использования водных ресурсов для полива земель сельскохозяйственного назначения. Рассмотрены происходящие изменения не только в растениеводстве, животноводстве и перерабатывающей промышленности, но и на внешних рынках. Проведен анализ экологических последствий интенсивного использования подземных вод для орошаемого земледелия.

**Ключевые слова:** Россия, Крым, дефицит водных ресурсов, Государственная программа, сельское хозяйство, способы адаптации, мелиорация земель, экологические последствия.

#### Introduction

In April 2014, the Ukrainian authorities, for the political reason of destroying the economy of two federal subjects of the Russian Federation – the Republic of Crimea and Sevastopol, a federal city of importance – stopped the supply of water resources of the Dnieper river through the North Crimean channel to the Peninsula, directing this flow to the Black sea instead. The closure of the canal, built from the Kakhovka Reservoir in Ukraine to Kerch with the effort of all the republics of the USSR (1961-1971) reduced the region's water supply by 85%. The water of the Dnieper river (the source of which is located in Russia) from May to October flowed through the channel to the off-stream reservoirs of the Crimea, and was used not only for the agricultural needs and industrial fishing, but also to supply water to the cities [1]. It was not possible to reduce the water deficit by transferring a part of the Kuban or Don water resources from the mainland to the Peninsula due to the lack of excess flow in these rivers. Thus, reliance had to be placed on local surface and underground water, which began to be redistributed

across the territory to the areas of greater distress. According to the plan developed by the Ministry of Natural Resources and the Environment of the Russian Federation, water supply for drinking and household needs of the population was urgently established by the summer of 2014, but the water-intensive sectors of the economy remained in distress.

## Main body

*State Development Program.* Compared to 2013, the scale of irrigated agriculture in the Republic of Crimea in 2014 sharply decreased: the area decreased by 10 times – down to 13 thousand hectares, the volume of water resources used for irrigation – by 33 times (from 527 to 16.2 million cubic meters) [2]. In 2015, the republic began implementing the "State Program for the Development of Agriculture and Regulation of Markets for Agricultural Products, Raw Materials and Food of the Republic of Crimea for 2015-2017" (SM RK 20.10.2014 No. 423) (hereinafter – the state program). This document contains the subprogram "Agricultural Amelioration". Hydro-amelioration is the most effective way of ensuring the sustainability of agriculture in case of extreme climate events (frequent droughts), which must be carried out in conjunction with its other types aimed at improving the quality of the soil, which, in turn, can increase the yield of major crops up to two or more times.

In the course of its implementation, the state program made the necessary adjustments (changed the number of included subprograms, clarified its goals, set tasks for the implementation of specific projects, etc.) and the implementation period was extended twice: first until 2020 [3], then until 2025. The subprogram "Development of the Amelioration Complex of the Republic of Crimea" for the period from 2020 to 2025 sets the following objective: to ensure food security of the Republic by preserving and increasing soil fertility in the face of climate variability, conducting comprehensive land reclamation and increasing their production potential. It is also planned to put into operation 17.1 thousand hectares of the ameliorated land by 2025 due to the reconstruction, technical re-equipment and the construction of new amelioration systems for general and individual use, which are aimed to help increase the volume of agricultural production. The allocated budget to meet the set goals amounts to 1,831 million rubles, including 1,286 million rubles from the federal budget, 68 million rubles from the budget of the Republic, and 477 million rubles from extra-budgetary sources. Time will tell whether these plans are destined to come true.

*Methods of Adaptation.* In crop production, wet crops are being replaced by drought-resistant ones. Not only rice, but also soybeans have been discarded from the cropping plans. The Crimean farmers have switched to growing more drought-resistant varieties of wheat, barley, peas, flax, sunflower, etc. Scientists in different organizations, such as the Institute of Agriculture of Crimea, the P.P. Lukyanenko National Center, the All-Russian Research Institute of Lupine, etc., are involved in both breeding new drought-resistant crop varieties and acclimatization of existing Russian selection. In particular, the researches look for a replacement for the wet soybean crop, alternative to which can become white Lupin. It is planned to create an innovative agricultural valley based on the Crimean Federal University. There is a tendency to increase the area of vineyards and perennial plantings. The plant nurseries are being revived as well. Among the effective agronomic techniques, no-till farming is being utilized: when grain is sown on untilled land and then covered with crushed plant remains. With this technique, the soil will retain 15-20% more moisture than with traditional plowing [4, P. 161, 173-182].

The rational use of water resources is being improved both by using various irrigation methods for agricultural land and through treated wastewater. In 2017, 61 % of the area was watered using the drip irrigation systems. In 2019, the irrigation of perennial crops was carried out using drip irrigation, wide coverage sprinklers were used on forage and grain cultures, and vegetable cultures were irrigated via drip irrigation and micro-irrigation. The region already uses more than 23 million cubic meters of treated wastewater per year for irrigation. The task is to increase this volume since 150 million cubic meters of wastewater are discharged annually (of which 40 million are provided by Simferopol). Treated wastewater can be used to irrigate forest belts and tree nurseries, including fruit trees. However, according to the current sanitary norms, wastewater is prohibited for watering vegetables, potatoes and berries [5].

The changes are taking place in the livestock and processing industries as well. The lack of water resources [6, P. 128] does not allow for the production of forage crops in sufficient quantities for livestock, which leads to the depletion of animals. Despite the 2015 increase in the number of farm animals compared to 2014, the volume of production of livestock products (meat of all types (in live weight), milk, wool, and eggs) has decreased. In 2019, there was an increase in cattle, sheep, goats and poultry compared to 2018 (during a severe drought in the Crimea). The growth of livestock was achieved at the expense of agricultural organizations and farms, while the residents of rural regions reduce the number of livestock or refuse to keep it. The prices on the domestic dairy products keep rising. Some processing enterprises, such as the dairy plant in the town of Saky, are also raising prices for their products. The revival of the traditional Crimean branch of agriculture – sheep and goat farming — has begun, which had been in decline for the period from 1985 to 2013 (the number of sheep and goats decreased by 6.7 times during this period). All the reserve land of the region is given for the farming of these animals. Milk processing factories have begun to produce popular goat cheese. With the state support, it was possible to increase the number of sheep and goats by 6% in five years. At the beginning of 2020, there were more than 174 thousand of these animals in the republic. Among other further development plans in the industry, there is a plan to build sheep farming complexes that can house up to 7640 head of sheep.

The structure of export products is undergoing changes [7]. In the period from 2015 to 2017, the Republic of Crimea harvested a record amount of grain, some of which were then exported to Syria, Iran and Iraq. However, in 2018, due to a drought that led to crop failure, grain exports were suspended. But there is another reason why it is impractical to sell products grown on irrigation abroad: it is a concealed form of water trade. Instead, it is planned to supply Syria with sunflower oil and sunflower husk briquettes for heating purposes, the production of which has been mastered in the republic for the first time. The negotiations on possible supplies of high-protein oil and press cake to Turkey and Iran are underway. The regional project "Export of Agricultural Products" aims to ensure the revenue of \$7 million from the agricultural products sold abroad in 2024.

The main export product is poultry meat, the main importing countries are Abkhazia and the parts of the Donetsk and Luhansk regions that are not controlled by Kiev.

*Irrigated agriculture.* During 2015, about 800 hectares of farmland were put into operation, for irrigation of which a total of 12.97 million cubic meters of water resources was supplied. All the effort was done with federal support that amounted to more than 134 million rubles. Expenditures of the republic's budget amounted to 7 million rubles, agricultural producers have spent a total of 157 million rubles [8], [9]. In 2017, the area of irrigated land increased to 14.3 thousand hectares. 16.9 million cubic meters of water resources were used for irrigation, most of which (60%) went to perennial plantings. 18% of water was used for irrigation of gardening and household plots, 8% – for vegetables, 6% – for grain and industrial crops, and 2% – for forage crops. In the period from 2018 to 2020, subsidies from the federal budget in the amount of 416.4 million rubles were provided to support hydro-amelioration activities [10].

In 2018, the total irrigation area increased to 17.8 thousand hectares. The water (19.1 million cubic meters) was supplied to farmers from various sources: reservoirs (52%), ponds (18%), rivers (15%), wells (14%) and springs (1%). However, there wasn't enough moisture. In June, the Republic of Kazakhstan imposed a state of emergency in six of the fourteen agricultural regions. The area of total loss of crops exceeded 10 thousand hectares. The average yield for grain crops was 1600 kg/ha – 2 times less than in 2017, the grain yield saw a two-time decrease as well – 906 thousand tons. However, the region's own needs (350-400 thousand tons) were fully met. The drought led to a shortage of vegetable and fruit crops [11].

During the implementation of the state program for the period from 2015 to 2019, 34 wells were drilled, 10 containment ponds with a total volume of 2760 thousand cubic meters were excavated, and protective forest plantations were planted on an area of 12.7 hectares. However, the task of increasing the area of irrigated agricultural land to 50 thousand hectares [15] by 2020 has only been partially fulfilled – up to 20.5 thousand hectares (with the volume of irrigation water equaling 24.6 million cubic meters) [16]. The agro-industrial complex of the Republic of Crimea (with the amount of state support exceeding 12 billion rubles in the period from 2014 to 2019) fully meets the needs of the population in wheat, poultry meat and partially in vegetables. The autumn of 2019 was dry, and the winter was snowless. Since the beginning of 2020, Crimea has received 2.5 times less precipitation than required. Such a drought has not been observed on the Peninsula for more than 20 years, and this has negatively affected crops. However, the farmers have managed to collect one million tons of grain with an average yield of 18.8 tons per hectare. According to the scientists of the Crimean Federal University, in order to restore the water balance of the Peninsula, it is necessary to get an annual precipitation rate in the coming winter [12].

*Environmental impact.* The lack of water flowing in from the Dnieper river has put Crimean farmers in need of using artesian water for irrigation of arable land. [13]. In the North of the Peninsula, underground storage facilities were reactivated, new wells were drilled, and a limit on the use of water resources was set, however some of the farmers conducted well drilling without a license. An intensive and uncontrolled use of artesian waters has led to a decrease in their volume and salinization, the first signs of which were recorded in 2014. Irrigation of fields with highly mineralized water leads to a decrease in crop yields by 20-30% since plants cannot obtain many useful substances from it due to the increased salt content in the soil. In addition, compared to the river water, underground water has a colder temperature. This makes plants experience stress during irrigation, which negatively affects the yield. In 2015, the steppes of Crimea showed signs of soil salinization.

In 2018, the lakes dried up almost completely, the land in the fields cracked, and even resistant sunflowers died. Saline patches appeared not only in the North, but also in the Central part of the Peninsula. This problem is solved by replacing sodium with calcium in the soil via phosphogypsum, a waste product of the chemical enterprise "Titanovye Investitsii" located in the city of Armyansk. The amount of phosphogypsum accumulated from the enterprise is sufficient for the improvement (desalination) of soils. 14.2 thousand tons of this chemical were introduced in the region on an area of 1.9 thousand hectares in the period from 2016 to 2017. However, the environmental aspect of the use of phosphogypsum requires further study [14].

## Conclusion

The deliberately created shortage of fresh water in Crimea that has been further aggravated by droughts has led to significant structural changes in the agricultural sector. The volume of irrigated agriculture has sharply decreased, and wet crops have been replaced by drought-resistant ones. Due to the lack of forage, the volume of livestock production has decreased, but the revival of the traditional industry for this region – sheep and goat farming — has been revitalized. All these factors have affected the processing industry – dairies have begun to produce goat cheese. The export structure has become dominated by products made from drought-resistant crops. Priority is now being given to the non-irrigated agriculture. The task of increasing the area of irrigated land set under the state program has only been partially completed. Excessive use of groundwater has led to salinization of agricultural land and the disruption in water balance. The desalination of the soil and restoration of the water balance will take years and require a lot of funding.

## Gratitudes

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## Conflict of Interest

None declared.

## Конфликт интересов

Не указан.

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