***A policy brief developed on results of SWAT and RIOS model***

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**Overview for Decision Makers**

**(policy brief)**

based on the findings of the study in the area of the Arys-Turkestan region as part of the CAREC/ICARDA Project “Evaluation of the ecosystem services to increase the efficiency of water use in agriculture."

**Background**

Local population in the area of the watershed of the Bugunski Reservoir, which includes three villages: Bugun, Stari Ikan and Karashyk, mainly practice an irrigated agriculture, represented by cotton, fruits and vegetables. Livestock farming is also developed, represented by large and small cattle, mostly within households. Currently, the area is experiencing a general decline in the production volumes of agricultural crops, including cotton. The main reasons of which are: the decline in the volumes of water supplied mainly from the Syr-Darya River and the Bugunski Reservoir, flooding and salinization that take suitable lands out of the turnover. The latter occurs, partly because of the old or broken drainage networks, leading to the flooding of soils. Land resources are also contaminated with pesticides, residues of the fertilizers from the fields, which also impair the productivity of these lands and the quality of harvests. Under these circumstances, it is necessary to revise the use of water and land resources in the territory, in order to identify new alternatives for agriculture and water management, which may lead to the sustainable development of the region.

**Purpose of the study**

The study was intended to identify alternative methods of agriculture, to propose alternative methods of irrigation with changing to crops that require smaller amounts of irrigation water. The following alternative practices were proposed: I. Sprinkler irrigation and drip irrigation as the most efficient management of irrigation water; II. Reduction of the volumes of the application of fertilizers; III. Replacing cotton with crops requiring less water (alfalfa, grapes, and pomegranate).

**Findings of the study**

*By the RIOS model (A model assessing the effectiveness of investments).*

The study was based on the findings of the survey conducted in three villages located in the watershed of the Bugunski reservoir. It was found that about 60% of farmers in these villages agree to switch from cotton to alternative crops and to the alternative methods of cultivation of the agricultural crops, for example, to growing such crops as pomegranates and grapes, alfalfa with the use of drip irrigation. Some respondents also expressed their willingness to continue the practice of growing cotton using a drip irrigation technology that would reduce the amount of water used in the cotton production.

The following methods of agriculture in the territory were proposed: cultivation of drip irrigated cotton, cultivation of sprinkler-irrigated alfalfa, and the creation of drip-irrigated orchard with a total volume of the required investment of $100 million. In accordance with the proposed methods, three scenarios were modeled for the development of the region, depending on the volume of investments directed to these methods. (Table 1)

According to the **A scenario:** Directing 50% of the investments to the drip-irrigated orchards, the total water conservation will be 199.9 million cubic meters per year, which will reduce the volume of the water taken from the Bugunski reservoir approximately by 16%. In addition, the area of lands to be converted will be 37.4 thousand ha. According to the **B scenario:** Investing 70% of the total budget for the drip-irrigated orchards would have resulted in water savings of $ 229.2 million cubic meters per year, which would reduce the volume of water taken from the reservoir by 18%. The land required for conversion for all three types of agricultural crops would be about 38.5 thousand hectares. According to the **C scenario:** Investing 30% for drip-irrigated orchards, the water saving would be 181.0 million cubic meters per year, which would reduce the volume of the water supply from the reservoir by 15%. The land converted according to these types of crops would be 36.5 thousand hectares.

**Table 1. Scenarios of the region development proposed by the model.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Methods** | **Scenario А:** ($100 million) | | | **Scenario B:**  ($100 million) | | | **Scenario С:**  ($100 million) | | |
| Planned budget **(%)** | Converted land,  **(thousand ha)** | Water saving  **(mln.m3/y)** | Planned budget **( %)** | Converted land,  **(thousandha)** | Water saving  **(mln.m3/y)** | Planned budget **( %)** | Converted land,  **(thousand ha)** | Water saving  **(mln.m3/y)** |
| Drip-irrigated cotton | 30% | 10,7 | 51,9 | 20% | 7,1 | 34,6 | 50% | 17,9 | 86,6 |
| Sprinkler irrigated alfalfa | 20% | 6,7 | 14,0 | 10% | 3,3 | 7,0 | 20% | 6,7 | 14,0 |
| Drip-irrigated orchards | 50% | 20, | 134,0 | 70% | 28,0 | 187,6 | 30% | 12,0 | 80,4 |
| **Total** | 100% | 37,4 | **199,9** | 100% | 38,5 | **229,2** | 100% | 36,5 | **181,0** |

Overall, as can be seen from the scenarios, the biggest water saving will be achieved in case the land under cotton cultivated by flooding will be converted to drip-irrigated orchards. It should be noted that the total area of the researched area is 128 000 hectares.

By the *SWAT model (A model evaluating the soil and water resources)*

In this model, two scenarios were compared: the baseline scenario, i.e. as it is with the cultivation of flood irrigated cotton and an alternative scenario with the conversion of land for drip irrigated cotton (21,109 ha), alfalfa (13,589 ha) and grapes (5,740 ha). At the same time, the required costs would exceed the costs in the RIOS model approximately by $14 million. With the use of an alternative scenario, it would be possible to achieve water savings of about 355 million cubic meters. In addition, the volumes of the return flows of water from the agricultural fields would have been decreased by 0.5% compared to the baseline scenario. The water quality would be improved, because the losses of phosphorus and nitrate nitrogen from the fields would have been decreased by 0.8% and 4.6% respectively. The volumes of nitrogen fertilizers would amount to 78 kg/ha for drip-irrigated cotton, 13 kg/ha for drip-irrigated grapes, and for alfalfa the fertilizers would not have been applied. In comparison, under the baseline scenario, nitrogen fertilizer for cotton, irrigated by irrigation method would have amounted to 190 kg/ha.

So, the researched area experiences a shortage of water, worsened by the climate change and weather conditions. It requires an adoption of the most beneficial scenarios for further development of the region. A number of alternative ways was considered for the transition from the long-standing practices of the irrigated agriculture requiring large volumes of water to the most water-saving crops and technologies. The benefits from the introduction of such alternatives have been shown. In particular, an annual saving of water taken from the Bugunski reservoir for the irrigation needs is possible by 15-18/%. A significant decrease in the volume of applied fertilizers and the volume of return waters from the fields is shown, which in turn will improve the quality of soil and water resources.