Economic Assessment on Ponds Construction for Utilization of Waste Water in Arid Zone of Uzbekistan

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Abstract: Waste water from cattle-breeding complexes is known to be saturated with minerals and can directly influence productivity of crops and increase fertility of soil. Also, use of waste water for cultivation of agricultural crops saves fresh water sources and creates a possibility to meet increasing vital needs of the population in potable water. The research presented in this article is aimed at study of ponds construction to collect drains in a cattle-breeding farm and using the waste water for cultivation of agricultural crops which is necessary for efficient use of water resources. Realization of gathering waste water to deliver it for irrigation of crops in the conditions of shortage of water resources was recommended on the basis of economic calculations.

Key Words: Economic assessment, Industrial crops, Utilization, Uzbekistan, Waste water.

1. Introduction

Under the conditions of economy modernization in Uzbekistan, an important factor is application of effective utilization of natural resources, in particular water resources. Currently, special attention is paid to implementation of alternative methods in water management systems in the country to solve arising water problems within the realization of various programs.

Population growth in the region requires ensuring the need in foodstuff, acceleration of rates of agricultural production. Therefore, to obtain water resources in necessary and sufficient volumes for irrigation it is expedient to apply widely water-saving technologies. Agriculture in the Republic of Uzbekistan is known to suffer from shortage of water resources, and further aggravation of this situation is observed nowadays. Social and economic problems related to water supply sufficient for maintenance of vital needs of the population living in the catchment area of the Amu Darya River Basin (the Republic of Karakalpakstan, Khorezm, Bukhara, Navoi, Kashkadarya and Surkhandarya provinces) necessitate introduction of innovative solutions directed to water-saving. From this point of view, further improvement of the water economic system, the economically and ecologically effective one, to save the surface and underground water resources as well as their rational use is of extreme urgency.

Taking into account further aggravation of this problem against the pressing need in water resources and deficiency of water in the region, searching alternative sources of water for irrigation is of great value. Along with the integrated water resources management, the importance of use of drains as an additional water source for agricultural irrigation is being emphasized. Countries with arid and semi-arid conditions, which practice wastewater treatment and reuse, such as Spain, France, Italy, Israel, Greece, Portugal, Cyprus, Malta, Tunisia, and Egypt. However, only Israel, Cyprus and Tunisia, and Jordan, already practice wastewater treatment and reuse as an integral component of their water management strategies (Choukr-Allah and Hamdy, 2010).

There is quite dated literature on various aspects of economics of wastewater irrigation (Martijn and Redwood, 2005; Qadir et al., 2010; Raschid-Sally et al., 2005) that testifies necessity to make detailed cost benefit analysis for implementation of waste water use for irrigation needs in the areas taking into account local conditions of land and water use.

The major consumer of water in Uzbekistan is irrigation farming: during the vegetative period, on the average 42 km³ of water are used for irrigation. Taking into account that the annual level of waste water in Uzbekistan makes 2.4 km³ (Ramazanov et al., 2009), effective utilization of this resource contributes to saving other kinds of water resources, in particular fresh water in surface bodies of water and underground sources; it will also serve as one more approach to achievement of sustainable water consumption in the country. Several investigations of waste water utilization in agriculture have been conducted in Uzbekistan which included effectiveness of waste water use (Serikbaev et al., 2014; Lev and Artukmetov, 1990).

Waste water differs in its origin and is subdivided into household, industrial, sedimentary, cattle-breeding waste water and collector and drainage water. Utilization of waste water in agriculture, in particular cattle-breeding waste water in irrigation, holds the important place in protection of water bodies from pollution and facilitates rational use of water resources. When evaluating the economic efficiency of waste water, it is expedient to apply various approaches proceeding from its kinds.

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2. Methods

The economic assessment of the wastewater reuse in agriculture depends on regional viewpoint, comparing its economic costs and benefits. It is unlikely that schemes could be economically justified with reference only to agriculture. Although farmers considered as net beneficiaries from using treated wastewater, compared with their previous or alternative sources of water, this depends very much on local circumstances, and in any event their net benefits are unlikely to offset the full costs of the scheme. The net impact of the project on the local and downstream environment is very site-specific, and there are likely to be both benefits and costs (FAO Water Report 35, 2010).

The estimation of the purposes of building a system of waste water irrigation is carried out on the basis of comparative analysis. Comparative assessment of capital investments is considered prior to the beginning of the project implementation or in the course of choosing an effective method and techniques of irrigation.

If drainage and waste water are intended for regular use in separately selected areas, allocated expenses can be equal to the ones for irrigation of new areas because to gather drainage and waste water and deliver them to the selected areas an irrigating network should be built.

Also it is necessary to reveal an economic benefit of building an irrigating network for irrigation of the selected area. Economic efficiency of water facilities comes to light as follows:

\[ E = \frac{B}{\sum X} \leq E_s \quad (1) \]

Where E- is coefficient of capital investments effectiveness;  
- standard factor for the branch of economy (it is equal 0.12);  
B- gross benefit;  \( \sum X \)- is general expenses (X) for the areas being irrigated;  \( \sum X = X_{wrm} + X_{ag} \)- total expenses spent for water and agriculture industries (Yakubov and Akhmedov, 2004).

3. Results and Discussion

The expenses allocated for cultivation of cotton on 1 hectare area are given in Table 1.

Efficiency of application of capital investments is calculated as follows:

\[ E = \frac{B}{\sum X} = \frac{140400}{1329600} = 0.10 \]

If \( \leq E_s \), it is possible to assert that expenses in a fixed capital become covered and operation of the construction is effective which is proved by the ratio between the term of covering the funds allocated for building of the construction and the period of effective operation of the enterprise.

Table 2 shows the ponds of various sizes; the quantity of means necessary for their building are calculated proceeding from the current market prices. The farmer should choose one of the tank types proceeding from the number of cattle stock in the farm, taking into account the necessary volume of water used for cotton cultivation per 1 hectare area.

The table presents options of ponds of various sizes with instructions in means necessary for their building taking into account current market prices at the time of the research. These parameters are based on the quantity of animals in a farm. The farm which breeds 480-530 cattle heads dumps 3,250-3,600 m³ of sewage a year on the average. The basic part of drains is formed during spring and autumn. When choosing the corresponding size of a pond for cattle-breeding sewage, it should be taken into consideration that the pond is used 3-4 times during the vegetation period. Therefore, there is no necessity in construction of a pond with the volume of 4,000 m³. Thereupon, the estimation of the size of capital means needed for building a pond has been made using the effectiveness ratio.

Building ponds of options 1 and 2 were found to be inexpedient for the farm due to small tankage and storage

| Table 1. Costs and benefits of cotton cultivation per one hectare. |
|---|---|---|
| Indicators | Conventional notation | Value |
| Total expenses, in soums | \( \Sigma X \) | 1 329600 |
| Fee in Water Users Associations, in soums | \( X_{wua} \) | 30 000 |
| Funds applied in agriculture, soums | \( X_{ag} \) | 1 299 600 |
| Taxes and other payments, soums | T | 71 500 |
| Amortization expenses, in soums | A | 1 200 000 |
| *Gross production cost, in soums | GPC | 2 670 000 |
| Yield, centner | Y | 30 |
| Gross production, in soums | GP | 2 741 500 |
| Benefit, in soums | B | 140 400 |
| Total expenditure, soums | \( TX=\Sigma X+A \) | 2 601 100 |

Note: Calculated on the basis of the operation card for 2011-2015.  
* Gross Production Cost calculated by using GPC = \( J \times Y \), where, \( P \) is production procurement price, \( Y \) is yield

| Table 2. Costs of waste water storage ponds construction in relation to their sizes. |
|---|---|---|---|---|---|
| Size | Type 1 | Type 2 | Type 3 | Type 4 | Type 5 |
| Width (m) | 20 | 20 | 20 | 20 | 25 |
| Length (m) | 20 | 25 | 30 | 30 | 25 |
| Depth (m) | 2 | 2 | 2 | 2 | 2 |
| Pond volume (m³) | 800 | 1000 | 1200 | 1500 | 1250 |
| *Construction cost in Uzbek soums | 12000000 | 15000000 | 18000000 | 22500000 | 18000000 |
| **US Dollars | (5, 5, 94) | (6, 3, 36) | (7, 7, 64) | (9, 5, 51) | (7, 6, 41) |
| E- Efficiency | 0.41 | 0.26 | 0.1 | 0.12 | 0.04 |

Calculated by the author in the current prices;  
**Calculations made using an exchange rate for September 2014, where 1 US Dollars = 2355. 69 Uzbek soums
capacity of the dumped drains volumes. In addition, it is necessary to take into consideration that the effectiveness ratio of capital investments in agriculture will make \( 0 \leq E \leq 0.12 \).
The analysis of key parameters of expenses and time of payback of option 4 showed that the effectiveness ratio of capital investments made -0.12 that is \(<0\). In this case, the farm suffers losses that negatively influence the farm activities. Options 3 and 5 are the most acceptable; with option 5 being thought the best one when one takes into account all the parameters.

Annual amortization costs of the basic capital investments in gathering waste water and construction water systems are calculated as follows:

\[
A = \frac{CI}{15} = \frac{18 000 000}{15} = 1 200 000 \text{ soums/year}
\]

Where \( CI \) is the capital investment for construction (based on the Table 2).

Here amortization costs are estimated for 10-15 years on the average taking into account the covering of the basic capital investments in the minimum term and under condition of profitableness in the first years. In the above calculations, taking into account long-term operation of the construction, the term of 15 years was chosen.

4. Conclusion

It is proved scientifically, that use of waste water in cultivation of agricultural crops increases of cropping capacity and protects the fresh water sources. In result of water-saving a possibility of meeting more and more increasing vital needs of the population in potable water can be created. Also, saving mineral fertilizers for agricultural crops will result in reduction of expenses and increase incomes of farmers. Economic efficiency of ponds construction in cattle-breeding farms for gathering waste water and its use for irrigation of one hectare of a cotton field is proven on the basis of the presented calculations. Realization of gathering waste water and delivering it to the areas under crops in the conditions of water shortage is recommended to prevent the deficiency of water for irrigation needs.

References


