IRRIGATION WATER EFFICIENCY ON IRRIGATION SYSTEMS OF KAZAKHSTAN

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Abstract: *Irrigated agriculture is the largest water consuming industry in agricultural sector of Kazakhstan consuming up to 70% of the total water resources consumed by all sectors of the economy. One of the methods for increasing the irrigation water efficiency is the construction of technically advanced irrigation systems, allowing use of water-saving irrigation technology: drip irrigation, enabling to save irrigation water by 20-30% and increase the productivity by 2.0-2.7 times.*

KEYWORDS: IRRIGATION, PRODUCTIVITY, EQUIPMENT, HARVEST, IRRIGATION RATE, SPECIFIC WATER CONSUMPTION

1. Introduction

Irrigation in Kazakhstan is an objective necessity in transforming natural systems, conversion of deserts and semi-deserts in highly productive agricultural lands, irrigation is designed to make a significant contribution to the agri-food program of the country and social and economic wellbeing.[1] Irrigated agriculture, which occupies 2 335 thousand hectares or 7% of the total sown area of agricultural production in the country, in case of optimal land and water resources use it could become a reliable sector of agricultural production and provide up to 30% of total crops production. Strategically important for Kazakhstan products such as cotton, rice, sugar beet, tobacco, vines, melons are grown only on irrigated lands. Irrigated agriculture is the largest water consuming industry in agricultural sector of Kazakhstan consuming up to 70% of the total water resources consumed by all sectors of the economy. High water-intensive irrigation in agriculture is caused by the lack of standardization and regulation of the water supply to the irrigation system, non-compliance with irrigation regime and optimal irrigation rates.

2. Methods and study results

Collection and processing of irrigation systems data is conducted from industrial organizations and farms to measure water use when cropping. Experimental studies on crops irrigated lands in southern Kazakhstan.

The demand for water is not the same for a variety of crops. If the irrigation rate for wheat in the South Kazakhstan is in the range of 800-1600 m^3/ha, for maize is 3000-4000 m^3/ha, for sugar beet and perennial grasses irrigation rate reaches 5000-6000 m^3/ha.

Irrigation water efficiency in cultivation of crops on irrigated lands is a function of irrigation rate and yield. The higher yields and lower irrigation rate mean higher irrigation water efficiency. In the Northern Kazakhstan for spring wheat cultivation with yield of 1.5-2.0 t/ha water demand is 2-3 times lower than in the semi-desert areas of the Kyzylorda and South Kazakhstan regions, in spite of the possibility of obtaining higher yields of spring wheat up to 2.5 t/ha.

Analysis of irrigation water efficiency on irrigated lands shows that the highest productivity is observed in the cultivation of vineyards 1.0-1.30 US dollars per 1 m^3 of water consumed, while cotton 0.22-0.26 US dollars per 1 m^3 of water consumed. Multiannual average of actual data on the volume of water (gross) consumption per 1 tonne of produce and the irrigation water efficiency in the cultivation of crops on the irrigated lands of Kazakhstan is presented in Table 1.

Table 1. Specific water consumption by crops and irrigation water efficiency on irrigation systems.

Agricultural crops	Specific water consumption, m^3/t	Irrigation water efficiency, US dollars per 1 m^3 of water
Rice	7500-9000	0.06-0.08
Cotton	5500-7000	0.22-0.26
Corn for grain	1500-2000	0.10-0.14
Sugar beet	600-800	0.25-0.28
Cereal	1400-1700	0.11-0.16
Vegetables	500-700	0.24-0.27
Melons	180-260	0.19-0.21
Orchards and vineyards	800-900	1.0-1.3
Perennial herbs	2500-3000	0.07-0.09

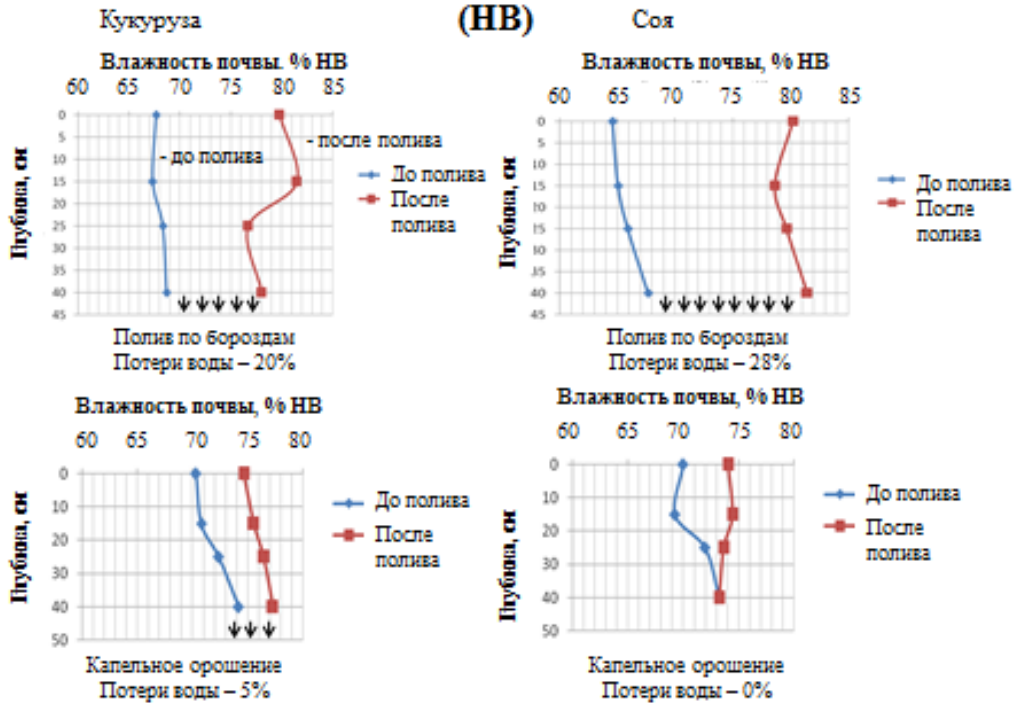
Irrigation water efficiency depends on the irrigation technique and technology. When drip irrigation technology employed water consumption per ton of produce is lower and crop yields higher. [2]

During experiments on irrigated lands of Talgar district, Almaty region, maize under drip irrigation water technology the irrigation rate is 250-200 m^3/ha, over the irrigation period - 4300 m^3/ha, for soybeans 240-180 m^3/ha and 3600 m^3/ha, respectively (Table 2). In case of furrow irrigation the water consumption rate for corn is 1200 m^3/ha, irrigation rate - 9900 m^3/ha, for soybean 8500 m^3/ha and 6400 m^3/ha, respectively. The soil moisture varied with furrow irrigation over the period from 60% HB to 83% HB (Figure). Water losses during irrigation constituted 20-28%. Drip irrigation compared with surface irrigation allows to maintain optimum soil moisture in the range of 70-80% HB and increase crop yields by 2.5 times. Irrigation water efficiency under drip irrigation for soybean 7 times, maize 4 times higher than under furrow irrigation.

Table 2 *- Irrigation water efficiency when watering corn and soybeans with furrow and drip irrigation*

Farm	Agricultural crops	Irrigation norm, m^3/ha	Irrigated area, ha	Yields, t/ha	Gross output, t	The volume of water consumed, thousand m^3	Irrigation water consumed per unit of agricultural produce, m^3/t	Irrigation water efficiency, tons / thousand. m^3
Irrigation ditch, furrow irrigation								
LLP Kyzylzharyn	Soybean	6150	246	2.90	713.4	2568,9	360.1	2.78
Farm Baitkai	Corn	9800	3	4.12	12.36	47,429	383.6	2.61
Farm Badenko	Corn	5350	22	4.12	90.64	189,84	209.4	4.77
Drip irrigation								
LLP Kyzylzharyn	Soybean	3600	246	7.25	1783.5	88,56	49.7	20.1
Farm Baitkai	Corn	4300	3	8.24	24.72	1,29	52.2	19.2
Farm Badenko	Corn	4300	22	8.24	181.28	94,6	52.2	19.2

Soil moisture in percent of field capacity



Drip irrigation system in the Sairam district of South Kazakhstan region is installed on an area of 160 hectares. Water intake from Aksu river flow to the sump with dimensions 30m * 120m = 3600m^2.

From the sump water is supplied by two 4AMN31S brand pumps in discharge pipes. The total length of the discharge pipes are 8.0 km including 300 mm diameter pipes 4.5 km; 270 mm diameter pipes 3.5 km. On the route of the main pipeline five containers are mounted with gravity filter system. Each container irrigates a land block with an area of 32 hectares. In one land block are 4 fields, each with an area of 8 hectares. To each container penstock is connected (steel pipe with diameter of 125mm), which has a regulating valve. The pipeline of 200 m length reaches the center of the block, where 4 valves are placed with 80 mm in diameter, from which water is supplied to the temporary sprinklers (fire) hoses with a diameter of 80 mm, a total length of 1600 m, i.e. each field of 200 x 400 m size has 2 threads with length of 400 m made of fire hoses. From the fire hoses set out droppers with holes (plastic tubes with a diameter of 10 mm), length 400 m in both directions.

On each field 242 droppers are placed. The total length of the droppers on a field of 8 ha is 48.4 km or per hectare of irrigated land accounts: 48.4 km/8 ha = 6 km of polyethylene pipes. On 160 hectares of irrigated land 960 km of polyethylene pipes are laid.

Watering of tomatoes is done in blocks, i.e. from each container, water is supplied for 5 blocks, then from each of the valve (4 pcs) one field is watered. Each field is watered for 6 hours. Each block is watered within 1 day, i.e. 6 hours * 4 fields = 24 hours. Every 3 hours washing of filters is performed in the container for 60 seconds. The irrigation technology is shown in the diagram of drip irrigation.

Tillage and fertilization: plowing - April; planting seedlings - tomato - May; cultivation - after planting; weeding by hand, during the growing season 2 times; inter-row cultivation of soil - manually.

Irrigation plot is divided into 2 types of row spacing:

1-row spacing of 1.90 m.

2-row spacing of 1.45 m.

Average row spacing 1.68 m.

Chemical treatments from pests and Boleyn were performed every 9 days. Mineral fertilizers were applied via irrigation water in the amount of 750 kg/ha of potash; 750 kg/ha of superphosphate and 1 t/ha of ammonium nitrate. Pesticides were not used.

Experimental studies have shown that drip irrigation system is effective compared with furrow irrigation, the amount of water during the growing season in the area of drip irrigation in the Sairam district is:

- with the surface irrigation (furrow) 4500 m^3/ha * 160 = 720.0 m^3

-with drip irrigation 756 m^3/ha * 160 = 120.96 m^3

Irrigation water economy in drip irrigation case is: 720.0-120.96 = 559.04 m^3 or 83.2% and the efficiency of irrigation water use is 2.7 times higher than with furrow irrigation.

3. Conclusion

Irrigation water efficiency of irrigation systems of Kazakhstan depends on many factors, in particular the structure of sown crops, land use intensity, and used technology. One of the methods for increasing the irrigation water efficiency is the construction of technically advanced irrigation systems, allowing use of water-saving irrigation technology: drip irrigation, enabling to save irrigation water by 20-30% and increase the productivity by 2.0-2.7 times.

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