5. Possibilities of gradual transition to water conservation irrigation technique

5.1. Major trends of irrigation technique development

Surface furrow irrigation is most widely spread in the region (70% of irrigated area); then stripe irrigation (26%) and check irrigation (4%). It is explained by the fact that this method is "universal" for various climatic zones and relatively simple; besides, water level in canals is insignificantly higher compared with command area surface.

Under limited water use irrigation water is distributed extremely unevenly over area particularly in new irrigated zone. Total water diversion to local irrigation network can be less than crop water requirement and consumption but separate fields are not irrigated at all or irrigated by collector-drainage water while other fields are irrigated by high norm with reduced number of irrigations.

Actual irrigation regime and technology mostly do not meet designed ones. This leads to low irrigation water productivity at field level. Irrigation norm is exceeded by 2-3 times amounting for 2000-2500 m^3/ha and number of irrigations is reduced down to 2-3.

One of the reasons is willing to cut labor cost, lack of fuel and machinery for soil tillage after irrigation. Actual furrow irrigation level is characterized by low mechanization and labor productivity. At the same time this method is adjusted to various climatic zones and has potential for perfection based on irrigation technique optimization and irrigation facilities modernization.

5.2. Main problems connected with water saving irrigation methods introduction and ways of their overcoming

At the moment, inconformity between agricultural production and industrial production (energy) price (latter is close to the world prices) does not create farms incentives for irrigation technique improvement. Such incentive should be decisive factor of advanced technique application. Past experience shows that attempts made by states and ministries to stimulate advanced technique by force were futile. Achieving potential yield together with water consumption decrease is possible through: drip irrigation, sprinkling, field laser leveling. This technology permits to cut water consumption by 10-40% compared with furrow irrigation. But these methods require substantial capital investments, for which yield should be increased by 20-30%. Under future water availability decrease advanced methods introduction is inevitable.

Most effective are such methods as in-soil, drip and sprinkler irrigation. In each case decision should be made based on technical-economic evaluation. In this connection, let us consider water saving technologies cost in comparison with possible benefit from these technologies introduction based on current prices.

Traditional cotton furrow irrigation on automorphous soil within III hydromodulus region is taken as a basic version. Technical-economic indicators developed by Uzvodproekt and SANIIRI are taken as advanced irrigation technique characteristics (first 4 columns of Table 4).

Cotton water consumption under cotton yield 3.5 t/ha is near 6.75 th.m^3/ha. Water expenses "gross-field" under average efficiency КПД$_{поля}$ = 60 % is 10.8 th.m^3/ha. With advanced irrigation methods water saving from 2500 th.m^3/ha (optimal furrow irrigation using rigid and flexible tubes – КПД$_{поля}$ = 78 %) to 4200 th.m^3/ha (in-soil irrigation - КПД$_{поля}$ = 98%) can be achieved.

Table 4 | Technical-economic indicators of irrigation methods under their optimal application (according to Uzvodproekt and SANIIRI)

Irrigation methods and technical means	Capital investment in irrigation network and technique		Operation cost	Water conservation efficiency	Water expenses "gross-field" for yield 3.5 t/ha		Possible water savings	Required investments per 1m³ of saved water			Approximate term of revenue		Annual expenses for water saving	Annual expenses for water saving system		From WUFMAS-98 assessment for 68 cotton fields for yield 3.5 t/ha			Designed indicators "cost-benefit"	
									including:											
	Total	including irrigation equipment cost			With water conservation technique	Present level (average field efficiency is 0.6)		Total	construction worksстроительно-монтажные работы	Irrigation equipment	Capital investments in irrigation network	Irrigation equipment				Farm expenses for yield production	Yield cost	farm profit	Farm expenses for yield production plus water saving	Farm profit with water saving
	$/ha	$/ha	$/ha		m³/ha	m³/ha	m³/ha	$/m³	$/m³	$/m³	years	years	$/m³	$/m³	$/ha*year	$/ha	$/ha	$/ha	$/ha	$/ha
Furrow irrigation using flexible and rigid tubes taking start from flumes	2 390	90	50	0,78	8 300	10 800	2 500	0,96	0,92	0,04	20	3	0,02	0,08	195	360	760	400	555	**205**
The same taking start from closed network	2 050	115	50	0,78	8 300	10 800	2 500	0,82	0,77	0,05	20	3	0,02	0,07	185	360	760	400	545	**215**
The same using stationary closed systems	3 680	60	25	0,78	8 300	10 800	2 500	1,47	1,45	0,02	20	5	0,01	0,09	218	360	760	400	578	**182**
The same using one-side earthen ditches	1 960	85	20	0,82	7 900	10 800	2 900	0,67	0,65	0,03	8	8	0,01	0,09	265	360	760	400	625	**135**
The same with discrete regulation of water supply to furrows and flexible and rigid tubes tking start from from flumes	2 530	140	55	0,85	7 600	10 800	3 200	0,79	0,75	0,04	20	5	0,02	0,06	203	360	760	400	563	**198**
The same with discrete regulation of water supply using tubes taking start from closed network	2 215	165	55	0,85	7 600	10 800	3 200	0,70	0,64	0,05	20	5	0,02	0,06	191	360	760	400	551	**210**
Sprinkling by mobile machines	3 400	1 200	100	0,8	8 100	10 800	2 700	1,26	0,81	0,44	20	8	0,04	0,13	360	360	760	400	720	**40**
Sprinkling by stationary systems	7 025	960	330	0,85	7 600	10 800	3 200	2,20	1,90	0,30	20	8	0,10	0,24	753	360	760	400	1 113	**-353**
Drip irrigation	8 170	4 810	150	0,95	6 800	10 800	4 000	2,05	0,84	1,21	10	10	0,04	0,24	967	360	760	400	1 327	**-567**
In-soil irrigation	6 690	3 940	100	0,98	6 600	10 800	4 200	1,59	0,65	0,94	20	10	0,02	0,15	632	360	760	400	992	**-232**

Note: When capital investment calculating prices of 1984 were revised taking into consideration rate 1$US=1 ruble.

Required investments per 1m^3 of saved water amount for (Fig.6):

From 0.65 \$/m^3 (one-side irrigation ditch) to 2.20 \$/m^3 (stationary sprinkling) under annual operation cost:

From 0.01 \$/m^3 (one-side irrigation ditch) до 0.10 \$/m^3 (stationary sprinkling) and annual operation cost on water saving systems:

From 0.06 \$/m^3 (regulation of water supply to furrow using rigid and flexible tubes) to 0.24 \$/m^3 (stationary sprinkling).

According to WUFMAS-98 results obtained from 68 cotton fields in 1998 in Uzbekistan under cotton yield 3.5 t/ha, average operation cost 360 \$/ha and cotton price 760 \$/ha, farms had profit 400 \$/ha.

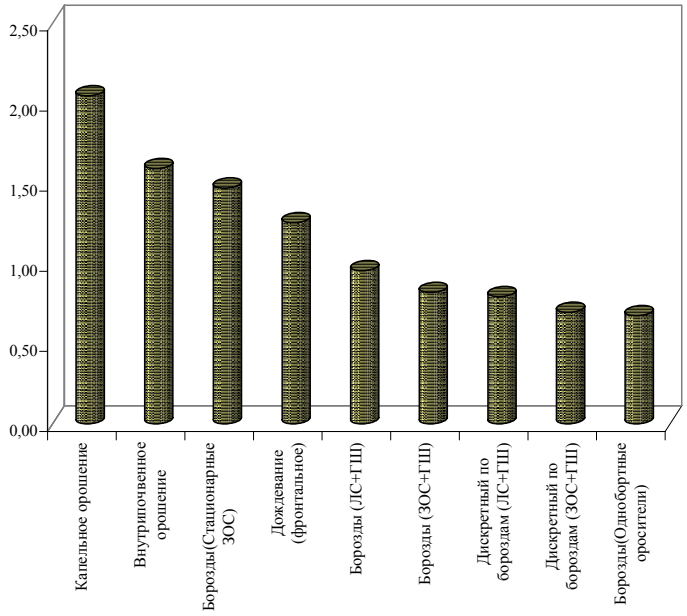

Fig. 6 | Required investments per 1 m^3 of saved water

Thus, when introducing costly water saving methods with regard for expenses connected with introduction real farm profit under current prices for raw cotton and inputs will be reduced and introduction of in-soil, drip and sprinkler irrigation is impossible without state support (Fig. 7).

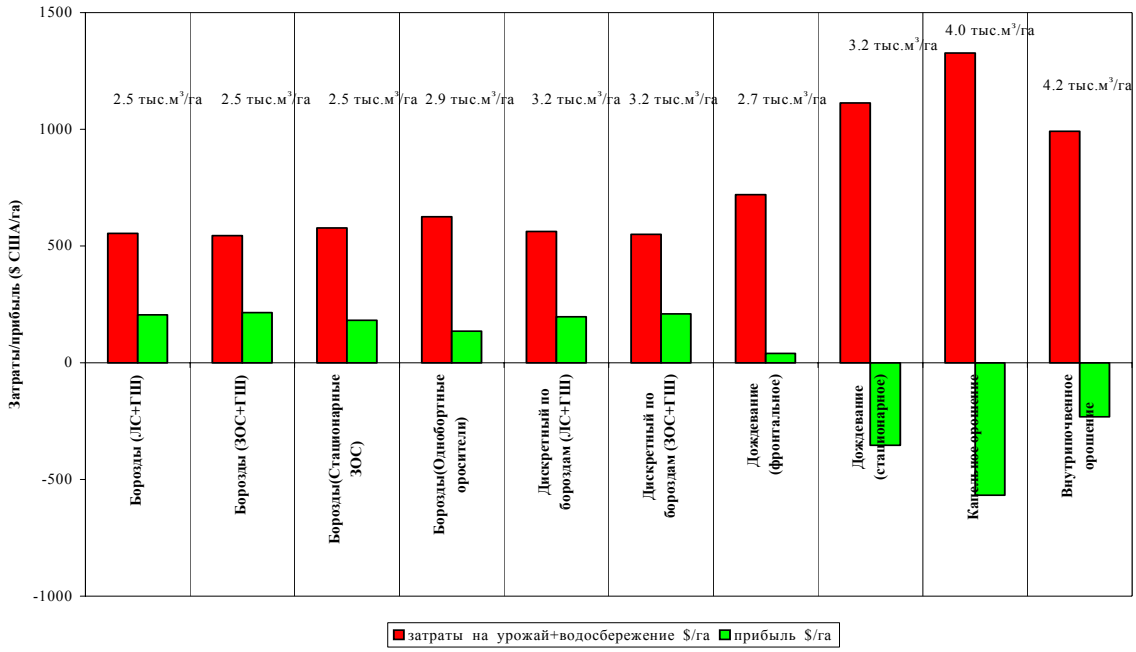

Fig. 7 | Farms' expenses and profit under water saving introduction (on example of cotton with yield 3.5 t/ha in III hydromodulus region)

In the nearest future existing methods (furrow, stripes and check irrigation) can be improved through technology optimization and reproduction of some forgotten rational methods.

Under current socio-economic situation following organizational forms of advanced irrigation technique introduction are possible:

- creation of experimental plots in basic farms and technological map development on these plots in connection with irrigation technology and economic effectiveness;
- demonstration on these plots effective use of irrigation technique and training specialists and trainers;
- formation of order packages for typical irrigation modules adjustment to specific natural-production conditions.

System of introduction should be developed based on recommendations worked out on experimental plots: at first stage – within separate farms and further – within local irrigation systems. Such approach will allow to receive real effect from water saving and irrigation productivity increase. Additionally, irrigation technique will be properly operated and repair-rehabilitation base will be established.

Alongside, it is necessary to develop incentives for advanced irrigation methods application in private and lease farms. Soft credit system is necessary for farmers to purchase advanced irrigation technique, particularly drip and sprinkler irrigation. Presently, advanced metods introduction is limited by inputs deficit.

In these conditions priorities selection is very important. Priority methods and technologies are as follows:

- irrigation systems with chronic low water availability;
- massifs with water lift;
- irrigated areas with soil of high permeability and complicated relief;
- irrigated areas in flow formation zones because excessive water spending negatively impacts water quality and land reclamation state in middle and lower reaches.