Conclusions and suggestions on the direction 1, section 1 «Irrigation regime and main agricultural crops water consumption norms».

24 pilot projects from all over the region were collected, including 7 pilots on irrigation experimental regime and cotton water consumption norms; 10 pilots are dedicated to winter wheat, barley and maize for grain and silo; 9 pilots - for rice, 3 pilots - to lucerne and other - to fodder and melons. Irrigation regime of all crops excluding rice was studied under different pre-irrigation moisture.

1. Under water resources deficit one of the main directions of the water resources rational use and conservation strategy is development and realization of the set of measures on water saving with due regard for natural-climatic conditions and possibilities of the Central Asian states in the nearest perspective.

Optimal irrigation norms (irrigation regime) establishing providing high yields of agricultural crops is a ground for development of measures on water saving in the irrigation systems. Scientific -research institutes of Central Asia has done big job in this direction:

- wide investigations on main agricultural crops irrigation regime based on study of pre - irrigation soil moisture impact on biomass formation during the development phases have being conducted;
- main agricultural crops biological requirements during the development phases are determined;
- methodology of crops irrigation regime calculation is developed.

Nevertheless, irrigation regime parameters suggested by scientific-research institutions are based on results of tests under different water conditions and their application need to be corrected particularly as to consumption norms. In this connection «analysis of irrigation regime and agricultural crops water consumption norms» is included in common evaluation.

2. Analysis shows that soil water regime is a main factor predetermining crops physiological growth and development and to the end their yield. Optimal water factor is determined by soil moisture regime, which is created under irrigation. Irrigation regime of main agricultural crops, including rice, was studied under different values of pre-irrigation soil moisture. In the most tests on cotton soil moisture change limits were taken as 55 -80 % field limit moisture capacity (FLMC) and for other crops they were 60-90 %. As a result soil pre -irrigation moisture limits were established for all crops under which irrigation norms and water consumption norms are optimal and high yields can be achieved. From figure 1 is clearly evident, that cotton yield, expressed in relative units, changes itself within the limits of 0.7 - 0.8 FLMC and it depends on root layer's moisture formation conditions. For cotton under conditions of automorphous soils optimal pre-irrigation moisture is 70*70*60 and 70*80*60 of FLWC; for hydromorphous soils it is 70*80*70 and 80*80*60 of FLWC. For half-automorphous soils the moisture 70*70*60 of FLMC is found optimal. Within the given limits of pre-irrigation moisture yield was achieved from 35 c/ha (stony soil with little thickness in Leninabad province in Tadjikistan) to 45 -50 c/ha (dark serozem rich in humus in Gissar valley and light serozem in Tashkent, Surkhandarya and Andizhan provinces of Uzbekistan) for automorphous soils.

Water consumption norms are 8.5 -10 th.m^3/ha from which 85 -90 % is covered by water supply, e.i. irrigation norm is 7.2 -8 th.m^3/ha (table 1). Relations between yield growth and irrigation norm are described for automorphous soils by second degree parabola

$Y= - 0.615x^2+11.55x-6.75$. Correlation coefficient is rather high ($r = 0.84$). For hydromorphous soils maximum cotton yield under optimal pre-irrigation moisture is 40-44 c/ha for formation of which 6.3-7.5 th.m^3/ha (water supply share is 65-70 %) water is spent. But in hydromorphous soils subjected to salinization in order to prevent secondary salinization and decrease concentration of soil solution it is necessary to conduct winter-spring operational leaching by norm 3-4 th.m^3/ha. In saline half-automorphous soils maximum yield is achieved (32 -35 c/ha) under cotton water consumption 8-9.5 th.m^3/ha (water supply share is 75-80 %). Nevertheless, in many state farms like Pakhtaaral, Malek, Akaltin, Krupskaya in Hunger steppe; Besharik, Yakkatut in Fergana province following optimal pre-irrigation moisture 70*70*60 and 70*70*70 40-43 c/ha cotton yield was achieved under 7.5 -8.5 th.m^3/ha (net) from which 3 -3.5 th.m^3/ha as a winter-spring leaching. In control plots yield did not exceed 24-30 c/ha under similar irrigation norms.

It is worth to note that in all tests following optimal soil moisture (irrigation regime) minimum water losses are achieved as for surface runoff so for deep percolation providing by that lowest water expenses for yield unit growing and irrigation water high productivity.

In all test plots under optimal options of irrigation regime specific water expenses for growing period were as follow: for hydromorphous soils - 96.5 m^3/c (net) and 117.8 m^3/c (gross); for half -hydromorphous soils - 65-83 m^3/c (net) and 101 m^3/c (gross); for automorphous soils - 190 and 250 m^3/c respectfully (table 1). But for saline hydromorphous soils specific water expenses within a year increase by 2 -2.5 times at expense of soil leaching and are within the limits 175 -200 m^3/c. In control versions specific water expenses per yield unit in all versions are 20 -30 % higher compared with optimal regimes and vary from 250 m^3/c (1.06. Uz, hydromorphous soils) up to 356 m^3/c (1.04. Tadjik).

Under conditions of production even in most developed farms like state farms Savay, Pakhtaaral, Akaltin, Malek, Pravda (Yangiarik district of Khorezm province) specific water expenses are 220 -280 m^3/c and for other provinces they are from 350 -450 m^3/c (Andizhan, Tashkent, Surkhandarya provinces) up to 300 -800 m^3/c (Khorezm province, Republic of Karakalpakstan).

Under optimal irrigation regime water saving as a whole is 10 -22 % against control versions. In optimal versions irrigation water productivity varies from 0.4 up to 0.9 kg/m^3 under FAO efficiency criterion 0.4-0.6 kg/m^3 , while in control versions it is within the limits of 0.3-0.4 kg/m^3

3. It is widely known that under cotton irrigation high pre-irrigation moisture cuts down irrigation interval but number of irrigations increases. Under optimal irrigation regimes (pre - irrigation moistures) irrigation interval equals to 14-18 days while under pre-irrigation moisture 60*60*60 it achieves 25 -28 days that promotes water losses increase and causes crops' stress.

Table 1. Evaluation of irrigation water expenses per cotton yield unit.

Under optimal pre-irrigation soil moisture regime 8-10 irrigations are being performed during the growing period by norms 700 -1100 m^3/ha for automorphous soils and 4 -5 irrigations by norms 770 -1230 m^3/c for hydromorphous ones. The main advantage of frequent irrigations by small norms under properly selected irrigation technique is water expense for moisture formation only within root layer. Under optimal irrigation regimes soil moisture within the root zone (0-1.0 m) after irrigation varies within the limits of 93 -97 % of FLMC while in control versions it exceeds FLMC on 3 -5 % specific water expense increases up to 2 -2.5 kg/m^3 e.g. FAO upper limit (1.8 kg/m^3).

4. As experiments in cotton irrigation regime show frequent irrigations by small norms (700 -1100 m^3/ha) for automorphous soils and 800 -1200 m3/ha for hydromorphous ones even under furrow irrigation with optimal elements but without regulating devices create favorable conditions for water flows management providing equal moisturing over the plot. In this case furrow irrigation technology approximates to discrete and high frequency - pulse irrigation.

The following irrigation technique elements were taken for the tests: for automorphous soils - furrow length L = 100 -150 m, discharge g =0.15 l/s; for hydromorphous soils L =200 -250 m, g =0.7-1.0 l/s. Under conditions of production all over Central Asia irrigation is performed with breakage of irrigation regime and violation of furrow irrigation technology. This is one of the main reasons for irrigation water productivity decrease.

Practically, irrigation norms achieve 1.5–2.5 th. m^3/ha under limited number of irrigations (1.5 -3 irrigations) for hydromorphous soils; 4-5 irrigations for automorphous soils instead of 5-10 irrigations needed. This explains low field efficiency which under current conditions does not exceed 0.2 -0.35 against 0.7 – 0.84 achieved on pilot plots.

5. From tests with other crops the following limits of pre-irrigation moisture of FLMC, under which the highest yield and the lowest water expense were achieved, are represented.

Winter barley -70*70*70 under automorphous soils, yield 44.5 c/ha, water consumption 3850 m^3/ha, water supply share 22 %. Specific water expenses per yield unit 86.5 m^3/c, irrigation water productivity 0.6 -1.15 kg/m^3 against FAO 0.8 -1.0 kg/m^3.

Maize for grain - 80*80*60 and 70*80*70 under automorphous soils, yield 68-120 c/ha, water consumption 4200 -7400; water supply 3500 -6150 m^3/ha, specific water expenses per yield unit 0.8 -1.8 kg/m^3 against FAO 0.8 -1.6 kg/m^3.

Maize for silo - 80*80*80, yield 340 -460 c/ha, water consumption 7250 -7400 m^3/ha, water supply 6500 -3250 m^3/ha. Under half -automorphous soils optimal pre-irrigation moisture is 70*70*60 under which maize yield for grain varies within the limits of 80-95 c/ha, water consumption 6400 -7400 m3/ha, water supply share 2540 -6000 m^3/ha. Under these conditions irrigation water productivity is 0.8 -1.8 kg/m^3 (FAO 0.8 -1.6 kg/m^3). In control versions with pre-irrigation moisture 60*70*60 of FLMC irrigation water productivity does not exceed 0.5 -1.0 kg/m^3.

Lucerne - 90*90*90 for 1-st year and 80*80*70 for 2-nd and 3-rd years, yield 70 -100 and 150 -170 c/ha under water expense 6500 -7300 m^3/ha (KzylOrda province) and 7000 -8300 m^3/ha (Karakalpakstan), water supply share 30 -55 %, ground water share 45-70 %.

Under half -automorphous soils optimal pre-irrigation moisture is 70*80*70 and 70*70*70 of FLMC. This moisture provides hay yield 176 -250 c/ha under water consumption 8.5-9.9 th. m^3/ha and water supply 6500 -7000 m^3/ha.

Under this moisture regime the highest irrigation water productivity is achieved (2-2.5 kg/m^3) (FAO 1.8 g/m^3).

For rice soil moisture is not the most important, but flooding of checks with water and keeping water layer in checks according to phases of development. From 4 options of flooding regime (1-permanent flooding without flow; 2 -permanent flooding with flow equal 50 % of water supply; 3 -discrete flooding (9 days flooding with water layer 10 -15 cm and 6 days without water supply); 4 - shortened) latter is found to be most effective as for water saving so for yield increase. Under this option maximum yield was achieved (50 -60 c/ha) under water supply 22 -28 th. m^3/ha on saline hydromorphous soils, where water supply share was 9-10 th. m^3/ha. In other control versions yield varied within 24 -40 c/ha under the same irrigation norm. The best results were achieved on the background of close horizontal drainage and vertical drainage under vertical filtration rate changes within 6 -10 mm/day (6 -10 th. m^3/ha per season), created by these types of drainage. Rice yield was 50 -66 c/ha. This filtration rate provides the best flow within the rice field's checks that helps to avoid surface release from the rice field. Under optimal flooding regime the lowest specific water expenses per yield unit were achieved (362 -457 m^3/c - gross) while in control versions they were 600 -1220 m^3/c.

6. Information's statistical processing shows close relation between crop yield increase and total water consumption. For wheat, maize for grain and lucerne this relation can be described by linear equation and for cotton under automorphous and half-automorphous soils by the second degree parabola. Certain dry biomass and yield of agricultural crops fits to each level of water consumption and irrigation norm (table 2 and figure 4).

Cotton maximum yield on automorphous soils is 45-50 c/ha under 9.5-10.5 th. m^3/ha total water expense; on half-automorphous and hydromorphous soils under similar level of water consumption. Water supply share is 55-75 %, the rest is covered by groundwater and soil moisture formed under water recharge irrigations and winter-spring leaching. On automorphous soils crop water consumption is covered at expense of water supply (87 -90 %) and partly due to precipitation. Water consumption norm increase or decrease over given values even under intensive agro-technique leads to cotton yield reduction.

7. Main agricultural crops yield is in compliance with irrigation norm's «limit» and covers minimal crop biological demand (table 2 and figure 5).

But water consumption regulation according to crop yield planned level does not meet requirements of leaching regime of irrigation. At the same time even allocated limits are used at the low level of efficiency. According to WUFMAS survey field water use efficiency over 28 representative farms, which are located in different conditions, varies within 0.16 -0.19 and 0.3 -0.35 that is 2.0 -25 times lower compared with 1985 -1990. There are possibilities to increase field efficiency up to 0.5 -0.6 through the realization of organizational-operational measures.