Lessons learned and prospective problems to be solved in the future

As it is found from summarizing and analysis of 143 pilot projects in irrigation and drainage, submitted by the national groups from 5 states, in size from 5-10 to 2500-13500 ha, that positive results were achieved in field tests on 4 major directions:

- irrigation regime and crops water consumption norms;
- management of soil water-salt regime and meliorative processes on background of drainage, irrigation and leaching on saline lands;
- drainage water re-use in place of its origin;
- optimal irrigation methods, irrigation technique parameters;

Introduction of positive results allowed:
1) to combat soil salinization on background of drainage and leaching;
2) to achieve certain level of water saving increasing irrigation systems efficiency;
3) to define effectiveness of saline collector-drainage water application in places of its origin and reveal possibility of river flow's water-salt regime regulation at the expense of salt removal reduction.

The main result of these researches was increase of irrigated land and irrigation water productivity.

Nevertheless, these results have been achieved under availability of water and other resources. But current situation in irrigated agriculture is characterized by the following:
- water resources deficit and their quality worsening;
- aggravation of ecological-meliorative situation, soil salinization and degradation;
- sharp reduction of technical level of all elements of hydromeliorative systems and, especially, on-farm and drainage ones;
- financial constraints for on-farm systems upgrading;
- transition to the market economy and connected with it changes in agricultural production;

In the near future these changes could grow and that requires elaboration of new principles and approaches in irrigation and drainage.

I direction: In Central Asia during the Soviet time cotton prevailed in crop rotation. Because of that this crop was studied in the best way. During recent time attention was paid to rice. Now crop pattern has been changed considerably. Large areas are now under cereals: wheat, maize, barley, vegetables and melons, that determines directions of future research:
- feasibility study and selection of the most profitable agricultural crops with regard for water resources deficit and their quality as well as market requirements;
- making more precise irrigation regime and water consumption norms for cotton, rice, vegetables and melons;
- development of methodology for calculation of irrigation regime and water consumption norms based on FAO principles (reference evapotranspiration) and local approach;
- verification of the optimal limits of yield reduction for different crops coming from under-irrigation;
- amplification of water allowance zoning of irrigated lands of Central Asia;
- establishing of pilot plots on irrigation scheduling for different agricultural crops according to the CROPWAT methodology in representative regions of Central Asia.

II direction. Out of 5.2 mln. ha of irrigated lands in Central Asia 4.7 mln. ha are covered by certain type of drainage. Last time drainage systems' technical state sharply aggravated. On the other hand, water resources scarcity and their quality worsening reduced effectiveness of desalinizating measures. In this connection main efforts should be addressed to elaboration of the set of organizational-technical measures to increase workability of existing drainage systems and their reliability. Coming out of above the following directions of research have to be covered:

1. Assessment of technical level of the local and regional drainage systems according to operational services data and development of set of organizational-technical measures on their workability and efficiency improvement including:
   - grounding and selection of indicators and criteria of assessment of the drainage systems' technical state and workability;
   - development of methodology of evaluation and selection of organizational-technical measures on drainage systems' efficiency increase with regard to investments from the state budget;
   - assessment of existing large drainage systems' efficiency and development of the set of measures to improve their workability in the nearest future;
   - definition of technique and technology of the repair-rehabilitation works, economically expedient level of technical state rehabilitation.
2. Amplification of norms of operational leaching regime of irrigation and development of technical-organizational measures to accelerate soil desalinization under minimum irrigation water expenses with respect for its quality and drainage system's workability:
   - establishing working regime of drainage systems providing the best management of soil water-salt regime;
   - amplification of soil optimal meliorative regime for different hydrogeological-soil-meliorative conditions with regard to drainage system's workability;
   - determination of optimal limits of leaching irrigation regime (requirement to desalinization) with regard to level of drainability and irrigation water quality;
   - amplification of norms and terms of operational leaching carrying out with respect for year humidity;
   - selection and development of chemical-technical and technological measures to accelerate soil desalinization providing minimum water expenses.

III direction. Within the Aral Sea basin about 36-38 cu.km of collector-drainage water are formed, out of this amount 18-19 cu.km (51%) are returned to the river trunk bringing 110-115 th.tn of salt and only 8-10% are re-used for irrigation. This process makes big damage not only to drinking water supply, but to other economy branches as well and, especially, to agriculture, increasing irrigation water salinity in the lower reaches. At the same time, results of researches in Central Asia and all over the world show, that saline collector-drainage water could be re-used for irrigation and leaching.

To re-use collector-drainage water effectively it is necessary to ground possibility and economic expediency of collector-drainage water re-use for "in-contour" development of irrigated farming and desert lands irrigation ("green desert") to improve water resources quality in their sources and ecological-meliorative processes within the landscape-geomorphologic structures.

The main directions of the program are determined by above conditions and are as follow:

1. Retrospective analysis of collector-drainage water's volume and quality depending on year humidity and water-reclamation measures starting since 50-es. Re-assessment and amplification of resources available and collector-drainage waters quality on large zones of their origin is undertaken with regard for hydromeliorative systems modernization and whole strategy of water resources use and conservation independently of sources.
2. Visual survey and analysis of long-term changes in land fund depending on irrigated farming development and on this basis to amplify areas suitable for collector-drainage water re-use over countries and planning zones with respect for soil bonitet and return water formation.
3. Analysis of the world experience as well as experience of the Central-Asian countries in drainage water re-use for irrigation and on this basis selection and grounding of crops and their distribution over the planning zones with regard to water quality and hydrogeological-soil-meliorative conditions.
4. Development of methodology for calculation of irrigation regime, crops water consumption norms and identification of parameters for saline irrigation water.
5. Elaboration of the set of water-meliorative measures, innovative agro-technique providing optimal ecological-reclamation processes under collector-drainage water re-use.
6. Development of mathematical-economic model and establishing of data base for feasibility study on collector-drainage water re-use.
7. Selection of pilot plots over the 5 countries on base of existing areas of collector-drainage water re-use and introduction of innovative technology taking into account foreign-expertise (Israel, USA, Egypt) with regard to its formation and withdrawal for irrigation.

   Those should be 8 plots with size 150-200 ha observed for 2 years similarly to the WUFMAS program in order to receive all economic, social, agrotechnical parameters (2 plots in each country, except 1 plot in Kyrgyzstan and Tadjikistan). Monitoring system encompassing all soil-climatic zones and crops will be created. On the base of monitoring results to define soil processes trend, effectiveness of different technologies, ecological stability and economic expediency.

   Taking into consideration 4-year monitoring within the WUFMAS sub-project of the Tacis WARMAP Project is expedient to use well-known monitoring system WUFMAS stressing attention on saline collector-drainage water re-use.
8. Organization of 3 pilot plots (in Kazakhstan, Turkmenistan and Uzbekistan) with size of 30 ha each according to Israeli and American technology of wood vegetation irrigation (project "green desert") in desert zone. On these plots saline water use will be demonstrated, bio-drainage efficiency and desert soil fertility increase.
9. Feasibility study for collector-drainage water re-use in wide scale and creation of "green desert" in different natural-economic conditions of the Aral Sea basin.

IV direction. In irrigated farming of Central Asia surface irrigation is most spread: furrow irrigation for cotton, stripe and flood irrigation for cereals and grass, check irrigation for rice. Surface irrigation will be maintained in the near future as well. Drip and sprinkler irrigation will be applied on experimental plots for assessment of their effectiveness.

Experience shows that high efficiency of surface irrigation is achievable:
For furrow irrigation –0.82-0.88
For stripe irrigation – 0.84-0.86
To compare: for drip irrigation – 0.94
For sprinkler irrigation - 0.90

At present time, when agriculture is under re-structuring, use of perfect types of irrigation is limited by financial deficit. In these conditions choice of priorities is very important. Drip and sprinkler irrigation is very expensive and need economic evaluation because water saved could not cover expenses needed.

Coming out of above the objects of priority have to be irrigation systems of lower water availability, where water lift is needed, soils with very high permeability. Here furrow irrigation has low efficiency, low irrigation water productivity, high losses for percolation and superficial releases. Intensive irrigation leads there to ravines formation. Along with assessment of water use efficiency it is important to evaluate irrigation water distribution equity over the irrigated area. Only combined consideration of these factors could assist to evaluate real water resources use rationality.

The following tasks have to be solved:

- Assessment of actual and really achievable efficiency of irrigation water use depending on irrigation technique under agriculture re-structuring.
- Comparison of local and international classifications for assessment of irrigation technique elements and proposals on single classification for the region in order to use it in adapted calculation program (CROPWAT (FAO)).
- Comparison of actual and “normative” elements of irrigation technique and assessment of “normative” meanings of irrigation technique elements and, especially, on-field irrigation water use efficiency.
- Assessment of irrigation water use productivity at the on-field level (using data from WUFMAS and pilot projects).
- Development of proposals on introduction in water requirement calculation program (FAO CROPWAT) of coefficients to take into account actual irrigation efficiency which are typical for Central Asia.
- Development and introduction of optimized elements of irrigation technique connected with irrigation scheduling.
- Assessment and analysis of data, obtained on this pilot plots, and preparation of proposals on used models correction.
- Formation of single data base on the factors of irrigation technique (slope gradients, water permeability, water allowance rayons, etc.) within the water-economic regions of the Aral Sea basin.
- Establishing priorities of innovative irrigation methods use over water-economic regions with regard to water allowance zoning, water lift areas and areas with soil of high permeability.
- Development of proposals on normative acts simulating perfection of irrigation technique at the level of irrigated plots, farms, etc. (privileges for credits, machinery, fertilizers, irrigation water limits. Juridical and economic base of incentives).

- Development of methodology of irrigation techniques comparison.
- Development of pilot projects and assessment of water saving technologies efficiency in different water-economic regions.
- Development of the system and program of water saving technology introduction for 3 stages of development

Ist stage

- Nearest 5 years. Urgent measures of water saving with maximum use of low-cost technical decisions and local experience of rational water use.

2nd stage

- 2005-2010. Attraction of the most economic and locally adapted technical decisions from the world experience.

3rd stage

- 2010-1020. Far perspective. Alternative methods of water saving and irrigation technology. Usage of solar and wind energy, etc.