MINISTRY OF AGRICULTURE AND MELIORATION
OF THE KYRGYZ REPUBLIC

DEPARTMENT OF WATER MANAGEMENT AND MELIORATION

NATIONAL POLICY DIALOG ON WATER POLICY
AND INTEGARATED WATER RESOURCES MANAGEMENT
IN KYRGYZSTAN

MODERN IRRIGATION TECHNOLOGIES RECOMMENDATIONS ON IMPLEMENTATION IN KYRGYZSTAN

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EUWI
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Accepted abbreviations and notation conventions

ASC	Agricultural Service Cooperative
DIS	Drip Irrigation System
EAEU	Eurasian Economical Union
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FaL	Fuels and Lubricants
GAFSP	Global Agricultural and Food Security Program
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HELVETAS Swiss Inter-cooperation	Swiss development organization
KR	Kyrgyz Republic
KRII	Kyrgyz Research Institute of Irrigation
MAM KR	Ministry of Agriculture and Melioration of the Kyrgyz Republic
NDWP	National Dialogue on Water Policy
RDW	Research and Development Works
SDC	Swiss Agency on Development and Cooperation
SNiP	Building Code (standards and regulations)
TEA	Technical and Economic Assessment
TCIC	Training, Consultation and Investment Center
UNECE	UN Economic Commission for Europe
UNDP	United Nations Development Program
UNO	United Nations Organization
USAID	Unated States Agency for International Development
WB	World Bank
WUA	Water Users Association

Foreword

This report was prepared as part of the National Dialogue on Water Policy and Integrated Water Resources Management in Kyrgyzstan with support from the UNECE. The basis for preparation of report was the request of the Government of the Kyrgyz Republic to implement a set of measures aimed at improving irrigation technologies and introduction of effective methods of crop irrigation, including drip irrigation.

The report presents the results of the second phase of the study "Modern irrigation technologies and possibility of its application in Kyrgyzstan". In the first phase[1] review of current state of the national food market and situation in the agriculture and irrigation sectors in Kyrgyzstan has been prepared, and experience of advanced crop irrigation technologies in the Kyrgyz Republic and other countries was summarized. On the basis of this experience the expediency of further pre-emptive use of modern technologies of furrow irrigation, sprinkler irrigation, and drip irrigation on the territory of Kyrgyzstan was established. Sprinkler and furrow irrigation has been practiced in the country for many decades. Therefore, in accordance with recommendations of the NDWP Coordinating Council, this report focuses on justification of possibility of adaptation of drip irrigation technologies in Kyrgyzstan.

For this purpose, previously collected baseline data was updated and supplemented, the analysis of problems and risks that restrict the use of advanced irrigation technologies in Kyrgyzstan was carried out, and recommendations on priority composition of irrigated crops for the different regions of Kyrgyzstan were developed. The report contains sections that generalize the experience of implementation of drip irrigation technology at all stages of the process, from the Feasibility Study and design of systems, and ending with operation and maintenance of the system. In addition, the report includes an extensive list of information sources containing additional information on the entire range of issues of application of DIS.

The report was prepared by the National Experts Apasov R., A. Atakanov, K. Valentini, P. Zhooshev, and G. Adzhygulova. Erkin Orolbaev coordinated the work of Experts and Consultants. Peep Mardiste carried out overall project management on behalf of the UNECE.

It is expected that the recommendations and findings of the study can be used as a systematized information base for officials responsible for development of the agrarian sector of KR and for other stakeholders.

[1] *See https://www.unece.org/fileadmin/DAM/env/documents/2015/WAT/NPDs/KG-irrigation-technologies-RU.pdf.*

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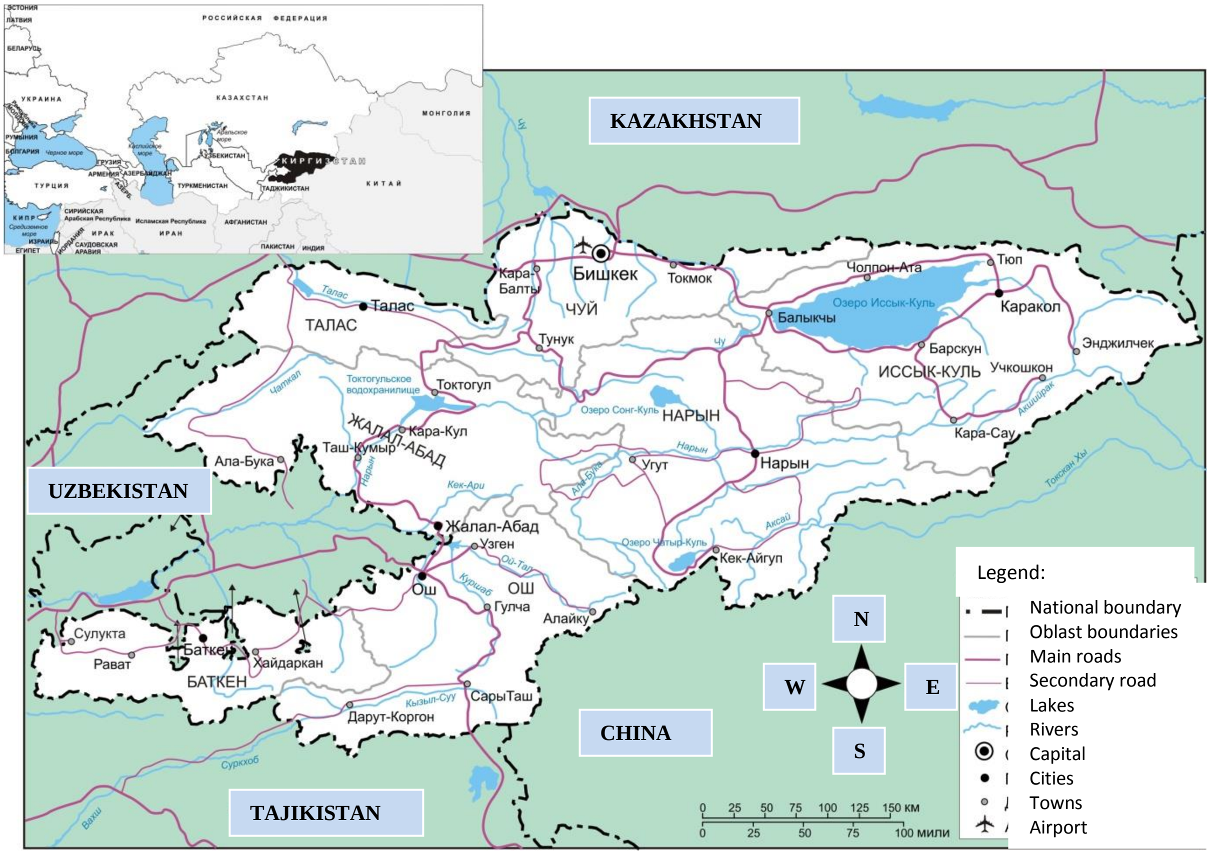
Introduction

For Kyrgyzstan, which is located in the arid zone, the availability of adequate supply of water resources of acceptable quality is critical factor for sustainable development, comfortable living conditions, and meets the comprehensive needs of the population in water, food security and environmental conservation. However, in the last decade in the Republic more and more clearly emerge the signs of increasing scarcity of water resources associated with global warming. These symptoms are further exacerbated by high growth of country population and, consequently, water consumption, as well as excessive loss of water in all sectors of the national water infrastructure.

Since the emerging trends of reduction of water resources have a long-term character, it becomes evident the need to plan and implement the appropriate preventive measures at the national level. Taking into account that in the Kyrgyz Republic about 90% of domestic water consumption is used for irrigated agriculture, there is no doubt that most of the potential reserves of water savings can be created by reducing water losses in irrigation systems and directly on the irrigated areas through application of the advanced technologies of crop irrigation.



I. Recommended mainstreams of development of modern crop irrigation technologies in Kyrgyzstan

The main impulses to use the advanced irrigation technologies for irrigated agriculture entities could be the following:

- Natural desire to increase revenues by increasing the yield and gross output of irrigated crop production;
- Commitment to reduce water consumption and related costs;
- Ensuring sustainable production activities in the shortage of water resources and to minimize the associated risk factors through the introduction of water-saving irrigation methods;
- Striving to increase productivity and reduce the cost of manual / physical labor at watering, and, ultimately, the desire to provide more comfortable conditions for production of agricultural output.

Additional incentives for use of DIS may be the following:

- Possibility to reduce contamination of fields by irrigation only a basal layer of the soil and, as a consequence, reduce the workload associated with mechanical treatment of spaces between rows;
- Saving of mineral fertilizers supplied with irrigation water into the root layer of the soil;
- Reduction of ripening time and increasing quality of crop production due to the fact that during the growing season the plants do not suffer from drought stress and / or excessive watering;
- Possibility to prevent water erosion of the soil, probability of which is more significant in other methods of irrigation;
- No restrictions on the use of DSI on the fields with difficult terrain and on the different soils;
- Possibility to secure productive forces and creation of new jobs in the rural areas, due to improvement of working conditions and development of infrastructure for transportation, storage and processing of the products.

It is obvious that these motives the most noticeably can be manifested at the favorable macroeconomic situation in the Republic, with high level of prices for crop production and full support of the agricultural sector entities by the State. The following statistical data allow us to objectively judge the extent to which these conditions correspond to the current situation in the Republic.

1.1. *Trends of change of the situation in Kyrgyzstan in 2015*

In the first phase of the study we used data from official statistics of the Kyrgyz Republic for the 2010-2014. These materials were discussed at the NDWP meeting in Kyrgyzstan and it was suggested that projections based on the data from previous years may not be entirely correct, because after the accession of Kyrgyzstan to the EAEC in 2015 the macroeconomic situation in the Republic could change significantly. In this regard the additional data have been collected and compiled describing the change in situation in the Republic up to the 3rd quarter of 2015. It should be emphasized that the formal accession of Kyrgyzstan to the EAEC has held in May 2015. Therefore in the period of completion of the project the possible consequences of this process had not yet acquired a sustainable feature. Nevertheless, the comparison of the updated statistics for the first six months of 2015 with those for 2014 already reveals some characteristic trends.

Among the favorable factors we may include stabilization of the inflation rate in the Kyrgyz Republic (in the period from January to August 2015 the inflation rate reduced by 0.25%) and the positive dynamics of real GDP (excluding the contribution of gold mining industry) by 4.4%. However, this growth was mainly achieved due to the development of services and to a lesser extent due to the increase of industrial (mostly - mining) production. Growth in agricultural production is mainly due to the development of the livestock industry and amounted to 2.4%. In addition, there was a decrease by 4.3% of production of food industry products based on processing of agricultural raw materials. In general, the specific proportion of the agricultural sector contribution reduced by another 0.9% and amounted to 9.5% of GDP.

According to preliminary data of customs statistics, the Kyrgyz Republic's foreign trade turnover in January-June 2015 amounted to $2.71 billion, decreasing compared to 2014 by 13.5%. In the trade turnover structure the share of exports were 26.3%, imports - 73.7%. Export delivery in January-June 2015 decreased by 2.6%, imports - by 16.8%. The overall decline in foreign trade had a negative impact on the volume of imports of foodstuffs. Of particular note it is the reduction in supply of fruits by 3.4 times and vegetables by 1.8 times, as well as the reduction in import of mineral fertilizers by 28%.

During the year, dynamics of the national currency exchange rates in the Kyrgyz Republic was influenced by the worldwide situation, primarily due to the currency movements of the US Dollar, the Russian Ruble, the Chinese Yuan, and the Kazakh Tenge. If by the end of 2014, the ratio of currency KGS / $ was about 61/1, by November 2015 it changed to 70/1. Permanent drop in the KGS rate given the triple prevalence of the import volumes over exports of products was a negative factor for economic development of the Kyrgyz Republic. At the same time, in the long term this trend could have a positive impact on the expansion of export of agricultural products.

Apart from weakening of the national currency, in recent time the price dynamics experienced a serious impact from the slowdown of economic growth in countries that are major trading partners of the Kyrgyz Republic (Russia, China, and Kazakhstan), the decline in world prices of petroleum products, as well as seasonal fluctuations in prices of food group commodities. For example, only a seasonal factor can explain an increase in average market prices for fruit and vegetable products in January-April 2015 by 4.8%, while prices for sugar fell by 2.8%, dairy products and eggs – by 1, 9%, and meat – by 0.7%, etc.

However, the results of a natural correction in prices closer to the autumn of current year as a result of entering into the markets of agricultural products of the new crop yield, it can be concluded that in general over the past year market prices for food products in the Kyrgyz Republic, including crop products, slightly increased, on average, no more than by 3%. For comparison, it is worth noting that according to forecasts of a number of eminent experts published at the end of 2014, the prices of these products soon after the accession of Kyrgyzstan to the EAEC may increase by 8-20%, and in the short term will be equal to the prices in Russia.

As the price indices substantially depend on changes in the cost of oil on world markets, it is worth to clarify the situation in this area in Kyrgyzstan. Against the sharp fall in world prices of crude oil in the first half of 2015, the cost of various grades of petrol in Kyrgyzstan has decreased by an average of 15% and diesel fuel - by 3.4%, compared to the same period of

2014. In June - August 2015 it was a temporary increase in fuel prices, but later, in September-October, prices of petroleum products in Kyrgyzstan once again slightly decreased.

Since the crop productivity depends essentially on the use of mineral fertilizers, it could also be of interest the situation with provision of fertilizers for agricultural sector of the Kyrgyz Republic in the current year. According to the MAM of the Kyrgyz Republic, with a total annual demand for these products about 350 thousand tons, no more than 30% of this amount (mostly nitrogen fertilizers) are annually imported to the Republic. At the same time the potash fertilizers practically are not used in the country, although the annual need for them is about 60 thousand tons. The demand for phosphate fertilizers is about 80 thousand tons/year, but this year it was imported less than 15 thousand tons. According to data for September 2015, wholesale and retail prices for ammonium nitrate imported from Russia and Kazakhstan accounted for 18-25 Som / kg, imported from Uzbekistan to the southern regions of the Republic - 16-19 Som / kg. Prices for Russian carbamide did not exceed 24-27 Som / kg, and for the Kazakh ammophos - 28-32 Som/kg. Overall, in 2015 there has been some decline in prices for nitrogen fertilizers, compared with 2014, for example, for ammonium nitrate imported from Uzbekistan, about 4 Som/kg. At the same time it is regularly observed efforts of some private commercial firms to sell mineral fertilizers at substantially inflated retail prices. According to forecasts of the MAM KR, in the coming months it is expected a slight increase in prices of most types of mineral fertilizers.

The most important trend that not related to the economy, of course, is a significant increase in water content of surface water sources throughout the Republic in 2015. After a series of previous dry years water consumption, for example, in Naryn River almost doubled compared to 2014. In the period from January to October 2015, in the Kyrgyz Republic it was not marked shortage of irrigation water as the water inflow into the irrigation reservoirs increased by more than 30%. It allowed expanding the acreage of irrigated crops by 0.4% and increasing the supply of water for irrigation at least by 6-10%. According to preliminary estimates, in 2015 it is expected increasing the yield of forage and vegetable crops due to improving the water supply. At the same time this year is characterized by growth of emergencies related to mudflow and spring flood phenomena in the foothill areas of the rivers. Frequent change of dry and humid years in the recent decades, most likely is a consequence of global warming and has a significant impact both on the environmental situation in the Republic, and on the sustainability of agricultural activities. Although the overall improvement of the hydrological situation in the Kyrgyz Republic in 2015 is clearly positive, in the short term it may also have unintended consequences in terms of reducing motivations of the agricultural sector entities to implement water-saving production technologies.

The structure of agricultural crops in 2015, compared with 2014 has not changed significantly. In general, the area under grain crops, still account for about half of all arable land, which is less than in the previous year by only 1.9%. The share of wheat has decreased from 57.7% to 51.5%, barley and corn, by contrast, increased from 26.5% and 15.6% to 30.3% and 17.7%, respectively. The gradual decline in wheat production in the Kyrgyz Republic in recent years is due to the objective difficulties of competition of domestic producers with more efficient suppliers from Russia and Kazakhstan. With regard to fodder crop it is indicated moderate growth in acreage of about 6%. Compared with 2014 the most significantly reduced the crop area under industrial crops: cotton - 61.1%, sugar beet - 69.0%, tobacco - 28.6%. Also there was some decrease of the acreage of leguminous plants by 6.2% and oil-yielding crops by 2.0%. The decrease of industrial crops planting is due to, first of all, the low world prices for these products, as well as due to the shortage of irrigation water in 2014, which resulted, for example, that in the Chui Valley beet growing was unprofitable. At the same time, it is the marked increase in acreage planted with potatoes, vegetables and melons, as well as rice (respectively, 7.1%, 14.5%, 15.1%, and 6%). Increased attention to production of vegetables, melons and fruits in the current year can be explained by the expectations of expansion of exports of these products, especially to Russia, after the entry of the Kyrgyz Republic to the EAEC, as well as the reduction in import volumes due to the weakening of the national currency and other objective reasons. Increased production of fodder crops is obviously also related to the development prospects of the export of meat and dairy products to the EAEC countries.

In conclusion, it should be noted that the recent accession of Kyrgyzstan to the EAEC zone creates favorable conditions for development of agricultural production in the Kyrgyz Republic. For example, for local producers it will be positive the reduction of trade barriers for export of their products to the zone countries, imports from the EAEC of agricultural machinery, equipment, fuel and so on. For ordinary consumers a positive factor should be the reduction of prices (by reducing customs duties and barriers) of not only imported but also domestic types of food and other products, especially those, in production of which imported components are used.

On the other hand, soon it should appear a stronger competitive environment in the economic area. First of all, it is expected the market pressure from manufacturers from Russia, Byelorussia and Kazakhstan with more competitive experience on the domestic food industry and the agricultural and financial sectors. These challenges can become an additional incentive to implement measures to increase the capacity of agro-industrial complex of Kyrgyzstan and provide the basis for development of agricultural cooperatives, allowing reorganizing the small farms to large vertically and horizontally integrated enterprises with competitive ability. From this perspective, the introduction of advanced irrigation technologies in Kyrgyzstan will promote these processes.

1.2. Review of support measures for the producers of agricultural products

Earlier, in the interim report on the implementation of the first phase of the project it was justified the assumption that the large-scale introduction of advanced agricultural technologies will be impossible to organize without the full support of the State.

> According to Taalaybek Aidaraliev, the Minister of Agriculture and Melioration, the country is actively working to raise awareness about the use of this irrigation system *[“DIS” – author’ note*]: “... we hold seminars, meet with the local residents. Today, drip irrigation introduced nearly on 600 hectares of land throughout the country. By the end of the year we plan to increase this figure to 4 million hectares. But for implementation funds and investments are required”.
> *Information agency «24.kg», 24/07/15*
> http://www.24.kg/obschestvo/16739/

In this respect, the data of world practice, in particular, the statistics of the Organization for Economic Cooperation and Development for 2012-2014, shows that the subsidies in the agricultural sector of the EU countries sometimes already exceed half of the value of production of farmers. For example in Finland, they are about 72%, Switzerland - 76%, Sweden - 47%, Austria - 44%, etc. In economically developed countries outside the EU, the level of the State support of the agrarian sector is also quite large and is, for example, in Japan - 72%, in Canada - 25%, and in the USA in different years ranged from 27 to 40%. As per one hectare of arable land in European countries, specific subsidies account for an average of €280 /ha, including in France - €350 /ha, the Netherlands - €475 /ha, in Romania - €130 /ha, in Latvia - €95 /ha, in Russia - €80 /ha, in Ukraine before 2014 - about €55 /ha. It is noteworthy that after the introduction of well-known economic sanctions by some countries with regard to Russia, in 2015 the Government of the Russian Federation in the framework of the import substitution of agricultural products significantly expanded support measures to the national agricultural sector and processing industry.

The most common measures of financial support in foreign countries include direct government compensation payments for the procurement of resources for manufacturing of equipment, fertilizers, pesticides, fodder, etc.; payments for damages from natural disasters, from damage associated with the reorganization of production (e.g., reduction of cultivated areas); subsidy per unit of area or head of livestock; payments in the form of funding of targeted research programs; etc.

In addition to direct financial support measures, other preferences in favor of agribusiness entities may include:

a) Tax benefits, including:
- Reduction of the taxable income of farmers through accelerated depreciation of machinery and equipment;
- Tax credits, tax abatements on profits of small businesses and temporarily unprofitable agricultural enterprises;
- Benefits (discount prices) when buying new equipment and using new technologies;
- Tax incentives for investment in agriculture;
- Tax benefits when using the reserve and other funds;

b) Protection of the national farmers by:
- Introduction of quotas on imports of agricultural products[2];
- Taxation on imports of agricultural products.

c) Introduction of special subsidies to encourage the introduction of environmentally friendly farming practices;
d) Introduction of temporary quotas for production of certain agricultural products and payments for non-use of agricultural lands, as a measure to prevent overproduction of these products;

[2] *For comparison: an average current tax rates on import of agricultural products in developed countries account for 43.1%, in developing countries – 18.7%, in countries with transition economy – 13.3%. As a result of these measures, the prices for agricultural products in EU, USA, Japan and other developed countries relative to the wages are considerably lower than that in developing countries.*

e) Introduction of temporary intervention prices. For example, if in the EU countries internal market prices for certain types of food fall below a specified level, the EU countries are buying these products to raise prices to that level.

Of particular interest may be the experience of supporting the agricultural sector in the neighboring countries of Central Asia, such as Uzbekistan and Kazakhstan. In this regard, it is appropriate to mention that in the Resolution of the Cabinet of Ministers of the Republic of Uzbekistan from 2013 "On measures for the effective organization of implementation and financing of the drip irrigation system and other water-saving irrigation technologies", it is provided for the construction of drip irrigation systems at the expense of the share of capital of the State "Reclamation Improvement Fund of irrigated lands" and own means of enterprises, including lax credits of commercial banks. In addition, legal entities of Uzbekistan, introducing the drip irrigation systems, are exempted from payment of the single land tax for 5 years. In Kazakhstan, for example, under the section of integrated program "Agribusiness 2020" on support the development of horticulture and viticulture it is provided for the following types of support:

a) Subsidies of up to 40% of the costs of planting and cultivation of orchards and vineyards in the areas of more than 5 hectares with the cheapening of the cost of the seedlings up to 40%;
b) Subsidies of up to 50% of the costs for purchase of fertilizers and herbicides of local production and up to 30% for the purchase of similar imported products;
c) Subsidies for 40% of the costs for purchase of fuel and electricity;
d) Reduction in price by a half (from 14 to 7%) of interest rate for leasing of agricultural machinery;
e) Subsidizing the cost of payment for irrigation water supply at 20-90%, depending on the irrigation method.

Ultimately, the overall support measures provided for by the above program of Kazakhstan expect reimbursement from 20 to 80% of the costs of farms in implementation of the agribusiness development projects.

As compared to the international practice, the current level of the State support for agricultural producers in Kyrgyzstan (at 2.5% of the value of agricultural products in 2015) seems inadequately low, even taking into account the limited capacity of the State budget of the Kyrgyz Republic. Thus the main measure of support in the last three years was provision of preferential interest rates on loans for development of the agricultural sector (with terms of 10% of annual interest rate and with a maturity date of 24 months) as part of the programs "Funding for agriculture". For these purposes in 2014 and 2015 the Ministry of Finance allocates 5.2 billion Soms per year. Starting from 2015, it is also provided for the issuance of preferential loans from the Russian-Kyrgyz Fund under the terms of 7% of annual interest rate, and with a deposit with a two year maturity. For comparison - the national commercial banks, such as "Aiyl Bank", currently lends at 12% annual interest rate, but with a maturity of 5 years. Therefore, the MAM KR in 2015 works out new options for providing lax credits, in terms of providing for a reduction in interest rates on loans and an increase in their maturity date, along with the differentiation of interest rates over the years.

In terms of further provision of the State support of agricultural sector of Kyrgyzstan the results of a sociological survey of farmers and peasants are notable, which was initiated by the World Bank (data of the consulting agency “M-Vector” for August 2013). In particular, this survey found that only 24% of households in KR invest in the development of their production, with 75% of households have never received support from the State, 1% got it regularly, 10% occasionally, and 14% only aware that such support exists. The survey data also show that the most costly items in the budget of households in crop production are sowing and harvest works, rent of equipment, purchase of seeds, fuel and lubricants, as well as wages of seasonal workers. At the same time, according to the rural respondents, the priority types of the State support can be establishment of preferential prices for fuel, seeds of hybrid varieties and the first reproduction, as well as for mineral fertilizers. Next in order of priority it was indicated such desired support measures as the provision of loans on more favorable terms, discounts on the purchase of agricultural equipment, assistance in marketing and regulation of prices for agricultural products. These requests, along with experience from neighboring countries, primarily Kazakhstan, should certainly be taken into account when planning further measures to support the development of advanced agricultural technologies.

1.3. Legal and information basis for introduction of advanced irrigation technologies in Kyrgyzstan

The main effective strategic documents of the KR, in which the priorities of agricultural sector are designated, are the “National Strategy for Sustainable Development for the period 2013-2017 years” and developed in support of this Strategy the “Program of the Government of the Kyrgyz Republic on transition to sustainable development for 2013-2015 years”. In particular, in Section 8.2 “Development of agriculture” of this Program, the main objective in agriculture indicated the creation of conditions for the growth of production; improving quality of products, and providing food safety of the country. To achieve this goal, it was recognized as a priority objective the rational organization of use of land and water resources. In the “Action Plan of the Government of the Kyrgyz Republic for 2015 to strengthen the national economy,” approved on 20.02.2015, the measures for development of agriculture include the development of advanced irrigation systems in all regions of the country. To strengthen the coordination of actions in this direction based on the Order of the Ministry No 50 as of 02.24.2015, it was established the “Center for introduction of modern progressive resource-saving technologies in agriculture”.

In the three Oblasts of Kyrgyzstan are establishing the systems for drip irrigation of lands. “According to the Government Office of the KR, the issue of implementation of drip irrigation systems was discussed in the Ministry of Agriculture. The First Vice Prime Minister Tayirbek Sarpashev said that the country has launched projects to introduce this technology. “In Kemin Rayon of Chui Oblast the drip irrigation systems are installed on an area of 400 hectares. The similar systems will be installed on 300 hectares in the Kara-Suu Rayon of Osh Oblast and on 10 thousand hectares in Kadamjai Rayon of Batken Oblast. At least $ 30 million of investments will be spent for this projects,”- said the official.
In 2014 in the Kyrgyz Republic the drip irrigation systems were operated on an area of only 140 hectares.
Information agency «24.kg», 16/04/15
http://www.24kg.org/ekonomika/10831/

Despite this, the direction of investment projects in the agricultural sector in the current year was mainly focused on the rehabilitation and construction of irrigation infrastructure, while from 16 items of the Action Plan only the project "Financing of leasing of agricultural machinery" can be attributed to the support measures of agricultural producers. Along the way, it should be noted that by the autumn of this year, 10 of the 16 planned measures have not been implemented yet due to lack of funding. Therefore, due to the limited possibilities of the national economy in 2015, most of the projects in one way or another connected with the introduction of advanced irrigation technologies, carried out with the financial support of international organizations and other foreign investors. Brief description of these projects is presented in Table 1.

Table 1

Name of Project	Terms of implementation (years)	Amount of investments, $	Mainstream of project activity
1. SDC Project "National Water Resources Management"	2014-2017	7.7 mln.	• Providing technical assistance to water management institutions and water users; • Training of water users on advanced technologies
2. WB Project "Intra-farm irrigation -2"	2011-2015	15 mln.	• Training of water users on advanced irrigation technologies; • Delivery of control facilities
3. GAFSP Project "Funding of irrigation and drainage systems rehabilitation under the WUA management"	2014-2018	38 mln.	• Provision of agricultural consultancy services; • Training of water users on advanced irrigation technologies
4. HELVETAS Project Swiss Inter Cooperation "MIT (micro irrigation technologies)"	2010-2017	30 thousand/year	• Establishment of demonstration plots using DIS; • Training of water users on DIS technologies; • Supply of DIS equipment
5. HELVETAS Project Swiss Inter Cooperation "Effective use of water"	2009-2017	100 thousand/year	• Training of WUAs and farmers; • Establishment of demonstration sites on water saving technologies; • Supply of irrigation equipment
6. USAID Project "Agro Horizon" "Support of demonstration fields on drip irrigation"	2015	15 thousand	• Support the implementation of DIS on 7 demonstration sites in four Oblasts of the Kyrgyz Republic; • Organization of 8 Training seminars
7. Project of the USA Embassy in the KR "Establishment of demonstration plots on drip irrigation"	2015	30 thousand	• Establishment of two demonstration gardens with application of DIS in Osh and Batken Oblasts of KR
8. FAO Project "Support of rural women in increase of	2015	-	• Establishment of 12 demonstration gardens with

economy”			application of DIS in Chui and Naryn Oblasts of the KR
9. GIZ Project “Adaptation to climate change”	2015-2020	-	• Support of farmers in Batken Oblast in implementation of DIS
10. UNDP Project “Establishment of demonstration plots on drip irrigation”	2015	2.5 thous and	• Organization of implementation of DIS on two demonstration plots in Batken Oblast

The data of Table 1 shows that the implementation of most of the projects related to the practical development of DIS technologies on small demonstration plots began only in 2015. Therefore, at present there is not accumulated information sufficient to draw objective conclusions about the possibility of large-scale introduction of these technologies throughout the Republic, based on the specific indicators of capital investments, growth of yield, payback periods, and so on. However, there are already first encouraging evidences of the receipt of net income of 20-30 thousand Som /ha for the first year of implementation of the DIS for fruit-and-berry crops in Osh and Naryn Oblasts, as well as vegetable crops in Osh and Chui Oblasts. Also noteworthy is the information on the actual specific indicators of prices of installed DIS equipment, purchased mainly in China and Turkey, which vary depending on the schemes of planting and types of plants within 57-94 thousand Som /ha for orchards and up to 120 thousand Som /ha for vegetable crops (e.g., tomatoes).

With a limited amount of modern data on application of the advanced irrigation technologies in the Kyrgyz Republic, it is appropriate to take into account the useful experience of practical implementation of DIS conducted by the Specialists of KNIIIR during 1980-1990 years. In particular, in the course of this work, two pilot DISs were implemented on areas of 5 hectares for irrigation of vineyards in the Batken and Lyailyak Rayons of Batken Oblast, two DISs on areas of 1.5 hectares and 38 hectares for irrigation of apricot and apple orchards in Balykchy Plodovinsovhoz and the Issyk-Kul Rayon of Issyk-Kul Oblast. As a result of these works it was found that the use of drip irrigation technology in combination with other advanced agricultural activities (fertigation and so on.) provides:

- Rising the level of yield, compared with surface irrigation methods in the vineyard by 2.7 times, apples by 1.5-1.7 times, and apricots by 3-3.5 times;
- Saving of irrigation water for the vineyard by 2.2 times, for an apple orchard by 2.4-3.5 times, and apricot garden by 3-4 times;
- Payback period of capital investment in the construction of DIS from 2.6 to 5 years.

On the basis of generalization of the world experience and the results of pilot implementation of DIS in Kyrgyzstan by the KNIIIR Experts in 1988, it was developed the “Methodology of drip irrigation zoning.” This document has not lost its relevance even by now, as in the past years, DIS has changed only in terms of improving the structural elements, but not the key features of irrigation. To confirm this assumption, it suffices to mention that most of the provisions of the Methodology are laid as the basis of the “Action Plan of the Government of the Kyrgyz Republic for 2015 to strengthen the national economy”, where it is planned to implement DIS of agricultural crops by regions of the Republic:

- In Batken Oblast for gardens and in greenhouses;
- In Dzhalal-Abad Oblast in greenhouses and for vegetable crops;
- In Osh Oblast for orchards and vegetable crops;
- In Issyk-Kul Oblast for orchards and berry plantations;

- In Naryn Oblast in greenhouses and farms;
- In Talas Oblast for beans and gardens;
- In the Chui Oblast for gardens, sugar beet and vegetable crops.

Since this Action Plan does not contain more specific information about the location of introduction of the DIS, the volumes of allocated investments, etc., this document should be considered only as a guideline that sets the main directions of perspective development of irrigation technologies. Moreover, it should not be considered as a guideline for immediate and overall expansion of DIS throughout the Republic. In this respect, it is more appropriate to base on the pragmatic recommendations of KNIIIR Experts offering, along with a moderate development of the DIS, the parallel introduction of modern samples of sprinkler technology in the northern regions of Kyrgyzstan (Chuy, Naryn and Talas), as well as the use of upgraded technology and equipment for furrow irrigation based on proven methods in the Republic of furrow irrigation, short furrows, contour irrigation, "Sherbet suu" and others.

1.4. Recommended priorities for application of drip irrigation in Kyrgyzstan

The review of world practice has been done within this project shows that drip irrigation is the universal, but at the same time very costly irrigation technology. Therefore, on a background of a complex economic situation in Kyrgyzstan, causing lack of investment, the use of DIS primarily expedient in circumstances where this technology has indisputable advantages, compared with other methods of irrigation, including:

- In sub-regions and local areas of agriculture, experiencing an acute shortage of irrigation water;
- On the foothill areas with difficult terrain and slopes up to 30°, where the use of traditional methods of surface irrigation is possible only after a major land leveling;
- In areas with rocky, sandy and gravelly soils with high water permeability, where the use of surface irrigation methods cause excessive loss of water;
- In greenhouses throughout the country.

However, the use of DIS is undesirable in areas with saline soils and levels of fresh groundwater of less than 2 m from the surface or levels of mineralized groundwater at least 4m from the ground surface.

"In Kyrgyzstan, the development of drip irrigation will allow introduce into agriculture up to 500 thousand hectares of slope lands," - said Chynybay Tursunbekov, the Leader of Social Democratic Party of Kyrgyzstan, at the meeting of the parliamentary fraction.
According to him, the country does not use such lands, while in other countries the land is managed using modern technologies. "According to various estimates, with the use of DIS, it is possible to manage additional land area from 200 to 500 thousand hectares, but this requires support from the State. So far farmers are adopting this technique on their own initiative. It is necessary not only propaganda, methodical and technological assistance, but also economic incentives for introduction of the resource saving practices. Water savings, increase of productivity, improve the use of fertilizers - in all of these aspects the improvement can be achieved by tens of percent".
Information agency «24.kg», 22/05/15
http://www.24kg.org/parlament/12962/

Significant cost of equipment and operation of drip irrigation systems determines the appropriateness of their use, primarily for irrigation of high-yielding agricultural crops that are in high demand in the domestic and foreign markets at the level of wholesale and retail prices, which ensure profitability of their production. From this point of view, the most attractive can be fruit, berries and melons. Already available in the KR experience of drip irrigation of beans and some vegetables (especially early ripening) provides a basis for further development in this direction. However, the use of DIS for irrigation of grain and forage crops in Kyrgyzstan should be recognized as inappropriate.

All systems of drip irrigation work in a mode of excess pressure generated by the pumping units, self-pumping irrigation wells either due to natural fluctuations of geodetic marks in the area on foothill plots. Obviously, in the latter case it is possible to noticeably reduce the cost of electricity or diesel fuel. As a rule, construction of specialized pumping systems for DIS is associated with significant additional costs. This condition, in general, allows recommending priority implementation of DIS on irrigated lands where the main sources of water supply have already existing pumping stations or wells. However, it is necessary to consider the following important factors:

- Most of the existing pumping stations on the territory of the Kyrgyz Republic located within the Naryn Oblast and the north-western area of Dzhalal-Abad Oblast and serve for irrigation of land, mainly designated for grain and forage crops. Therefore, taking into account the above recommendations, the implementation of DIS in these zones must be accompanied by a radical change in the composition of cultivated crops;
- Use of self-pressure irrigation and / or drainage wells as a source of water supply for DIS also does not require the use of pumping equipment and provides a significant reduction in operating costs.

However, we must take into account that the underground fresh water deposits in Kyrgyzstan are strategically important water bodies designed primarily for drinking and household needs of population. Therefore, the use of groundwater resources for irrigated agriculture, in general, should be limited.

Of particular note is the effectiveness of long-term use of DIS on newly developed irrigated areas under orchards and vineyards in the southern regions of the Republic. Practice has shown that usually in a hot climate in the first year of development the percentage of survival of planting material is very low and amounts to an average of 15 - 25%. Therefore, farmers are often forced to repeat planting on the same land area for 3-4 times that involves considerable labor and material costs. At the same time watering of gardens and vineyards using the DIS provide guaranteed one hundred percent survival rate of seedlings, their intensive growth, development, and early fruiting.

The generalization of the world experience shows that for effective crop production on an industrial scale, the land area equipped by DIS shall be not less than 10 hectares. It should be added that many reputable foreign manufacturers of irrigation equipment prefer to supply complete sets of DIS equipment, calculated for the area of 40-50 hectares. However, these conditions do not exclude the application of drip irrigation systems for irrigation of small plots of 1-2 hectares, which is within typical size of land plots of Kyrgyz farms.

Currently, the majority of international projects from the list given in Table 1 are aimed at the dissemination of information and practical skills among rural producers on the issues of application of advanced irrigation technologies. To this end, throughout the territory of the Kyrgyz Republic the demonstration plots are establishing, training seminars and workshops are held, providing support for the purchase of irrigation equipment and others. At the current stage of the reform of agricultural production in the Republic, this activity seems extremely important. At the same time it is appropriate to assume that in the future an independent introduction of new technologies, in particular capital-intensive such as drip irrigation, will be carried out by irrigated agriculture entities on the basis of purely economic considerations, that is, from the point of view of obtaining the maximum profit. Separate implementation of economic calculations of the efficiency of agricultural production is now often causes difficulties not only for farmers, but also for representatives of large agricultural enterprises in Kyrgyzstan. With this in mind, a summary presented below may serve as a guide to further enhance the awareness of stakeholders on the designated problem.

II. Methods of assessment of economic viability of introduction of advanced irrigation technologies

2.1. Introductory information to make preliminary decisions

The maximum effect of the DIS use is usually achieved in the countries and regions suffering from acute water shortage. For example, according to FAO, the global average price of water is about $ 0.1 / m³, so the reduction of irrigation rates due to the use of drip irrigation in the average of 3-4 thousand m³/ ha per year provides the annual economic effect of about $300-400 / ha. But in Israel, where the cost of water for irrigation is about $ 1/m³, the same rate of reduction in irrigation rate allows for local farmers to provide a return on the cost of purchase and installation of drip equipment for only one year.

To assess similar opportunities for Kyrgyzstan as of mid-2015, you can use the following average statistical data:

a) The ratio of exchange currency pair USD / KGS KR – 68 : 1;
b) Specific cost of equipment for drip irrigation systems:
    - For watering vegetables, melons, berries, etc. – $1.5-2.0 thousand / ha, or 90-120 thousand Som / ha;
    - For watering gardens with row-spacing of 3.5 and 5 m - $1.3-1.5 thousand /ha, or 80-90 thousand Som/ha[3]
    -
c) Warranty operation life of DIS stationary equipment from different suppliers typically range from 5 to 15 years, if you select high quality equipment it is appropriate to take designed operation life of 10 years, with the estimated depreciation rate of irrigation equipment of 10% / year;

[3] *Note: If the conditions of implementation provide for additional costs for design of the system, application of automatized irrigation facilities, contract supervision involving manufacturer, training, agronomic and technical support of specialists during the first season of growing products and other, then the amount of initial investment in this project may increase to$ 3 thousand /ha.*

d) The average irrigation rate in the Kyrgyz Republic under the furrow irrigation is about 8,000 m^3 / ha;
e) Based on the generalization of previous experience in Kyrgyzstan and other Central Asian countries, in the case of substitution of furrow irrigation by drip irrigation technology it is possible to increase crop yields of at least by 1.5-2 times, while reducing specific water consumption by at least 2 times, that is reducing irrigation rates to an average of about 4,000 m^3 / ha;
f) The tariff rate for irrigation water supply services of - 0.03 Som / m^3, that is 200 times below the world average water prices.

On the basis of these data, it is easy to calculate that halving the consumption of irrigation water will help to reduce the unit costs for the agrarian sector entities of the Kyrgyz Republic for a very small amount - only about 120 Som/ ha per year. In this present level of water tariffs the water conservation factor in Kyrgyzstan is clearly insignificant. Therefore, the profitable crop production in the Republic based on DIS can be achieved primarily due to a significant increase in the yield of agricultural crops with high added value and improve the commercial quality of products. At the same time it should be noted that the introduction of DIS can only be effective when using intensive agricultural technologies: a more thorough treatment of the soil, the use of high-yielding varieties of plants, herbicides, pesticides, insecticides, intensive fertilizing of plants with high-quality mineral fertilizers, and others. But the use of these methods will inevitably entail additional costs.

Even with the favorable external conditions, the investments in DIS are profitable only after gaining enough experience of implementation of intensive agricultural technologies and marketing of increased production volumes. For example, according to the FAO, in countries with high levels of agriculture an average of 850 kg of nitrogen and 250 kg of phosphorus and potassium fertilizers are consumed per one hectare of irrigated arable land. With regard to the conditions of Russia, the experienced agronomists recommend to nourish annually per hectare of up to 2 tons fertilizer mass containing at least 20% of mineral fertilizer and up to 100-150 tons of organic fertilizer. For comparison - in Kyrgyzstan annually generally used no more than 200 kg / ha of ammonium nitrate and a limited quantity of organic fertilizer (manure). The need for such measures becomes apparent, if takes into account that at the production of 10 tons of vegetables, such as onions, from the topsoil are permanently removed about 44 kg of nitrogen compounds, 12 kg of phosphorus, 21 kg of potash, 7 kg of calcium, and 4 kg of magnesium compounds. It is clear, if these losses will not be timely compensated, then increasing the crop yield will be out of question.

When assessing conditions of payback of investments in DIS it should also be taken into account other considerations: if you plan to equip the land with DIS and plant seedlings of a high-yielding variety of fruit plants, the investment in this project will pay off not earlier than in 4-5 years.

2.2. Study of markets and cost of materials, resources and services for production of agricultural products

Feasibility Study of any business project is based on data from market study, establishing the current state and forecasts of changes in market prices for certain types of products. In the context of promotion of drip irrigation technology, these studies may have the following objectives:

- Identifying of promising market segment (updating the most advantageous composition of crops, which are supposed to be watered using DIS and further sold in the product markets);
- Selection of the most effective set of DIS equipment;
- Selection of the most profitable nomenclature of consumable materials and resources used in the process of crop production and operation of DIS.

In Kyrgyzstan, the choice of one crop or another often is made based on:

- Previous experience (tradition) of cultivation of specific crops;
- For reasons of minimizing production costs (it is linked to the predominance of grain and forage crops in the structure of crops in KR);
- Based on the maximum market prices for specific types of products in the previous year.

In the absence of mechanisms of centralized regulation of agricultural production in the Kyrgyz Republic, this practice often causes temporary overproduction, or, conversely, the lack of certain crop products. In both cases, farmers of KR may suffer losses either due to the inability to sell part of the crop yield, or because of the emergence on local markets of new outside suppliers-competitors, who successfully close deficient product line. These findings confirm the need for pre-marketing studies. It should be noted that at the present time in the Republic there are no reputable consulting organizations that provide paid services for such studies and carry out material and other liability for damages to customers due to incorrect conclusions and recommendations.

The study of market segments related to specific types of agricultural products, such as vegetables and fruits, involves the collection and analysis of, at a minimum, the following information:

- On the need for this type of products on local markets and in the neighboring regions, the possibility of exports of these products to other countries;
- On the average annual wholesale and retail prices for the products in local, neighboring and regional markets for the current year and previous years;
- On the wholesale and market prices of high-quality seeds, seedlings and / or plants;
- On the existence and real opportunities of local and foreign competitors in the areas of production and marketing;
- On average statistics for the previous years and projected (after the introduction of DIS and intensive agricultural technologies) yield of selected crops;
- On losses of crop production (in %) - as a whole and on the stages of collection, storage, transportation and marketing of commercial products;
- On the possibility of a deep industrial processing of grown crops to get high-quality new commodity with high added value;
- On the possibility of collaboration (cooperation) with other manufacturers of such crops;
- On the possibility of obtaining benefits and subsidies in the implementation of the DIS.

In the process of studying the markets of drip equipment it is necessary to collect and analyze the following information:

- On contact information and goodwill of potential suppliers of equipment;
- On the list of services provided by suppliers (design of DIS, delivery of equipment, contract supervision, repair, training, etc.);
- On the composition of the basic configuration of the equipment supplied;
- On warranty terms and conditions of delivery of the equipment;
- On warranty period of operation of the equipment;
- On the conditions of compensation for damages in case of breach of contractual terms of supply;
- On contract prices for the basic sets of equipment;
- On the prices of consumables / products, for example, annual drip tapes, and the conditions of their guaranteed annual supply;
- On contract prices for works and services related to the design, transportation and installation of the equipment;
- On the operating costs associated with the maintenance of the DIS equipment;
- On special conditions of agreements with suppliers relating to force majeure, currency fluctuations, replacement of defective components and others.

In the last analysis, the final choice of type of drip equipment and a particular supplier is carried out in the course of negotiations with potential partners, based on the comparison of the above factors and the real financial opportunities of customers. Other things being equal, more preference may be given to local organizations to ensure complete delivery and contract supervision of DIS equipment, as well as training of personnel on rules of operation. For example, currently in Kyrgyzstan, the most popular partners in this area are the Public Foundation “Training, Consulting and Innovation Center” (TCIC), the Association of land and forest users “Agrimatko”, SSK “Drop Plus” and SSK “AgroBazar”.

To determine the economic efficiency of investments in DIS for the selected composition of crops and the specific irrigated land it is necessary to collect information and to compare the amount of industrial and commercial costs for two options of watering: the traditional, such as furrow irrigation, and perspective, that is using drip equipment. If it is planned to place the DIS on newly developed irrigated land, it is enough to identify only an amount of the prospective costs. In any case, at first it is necessary to collect and analyze the following additional information:

- On the current and future costs, directly related to crop growing (cost, depreciation, repair and maintenance of agricultural machinery, tillage, planting, weed control, collection, transportation and storage of the crop yield, and others.);
- On the current and future needs and for the wholesale and market prices of all types of applicable fertilizers (nitrogen, potassium, phosphorus, organic and micronutrient fertilizers);
- On the current and future needs and on the wholesale and market prices for plant protection products (pesticides, herbicides, insecticides);
- On the future needs and on the wholesale and market prices of chemicals designed for control the level of salinity of irrigation water and removal the salt residues from the DIS;
- On the current and future needs and prices of petroleum products, separately for agronomic purposes and for diesel pumping station (if necessary);

- On the current and future electric power needs and tariff for the supply of electricity to pumping station (if necessary);
- On the actual and future number of employees engaged in:
  - Watering and maintenance of irrigation equipment; and
  - Other farming practices;
- On the labor costs of operation personnel, social insurance, social security tax, etc.;
- On current and future commercial costs associated with the marketing of the harvest;
- On actual and future costs associated with the payment of all taxes, under the national legislation;
- On actual and prospective overhead charges associated with the maintenance of non-operation personnel and others.
- On actual and future costs associated with the payment for water supply services.

2.3. Determination and analysis of costs for production of agricultural products at the alternative irrigation methods

Starting estimation of costs, it should be distinguished:

a) Operating costs - the total cost of equipment, works, services, material and other resources during the annual cycle of production, harvesting and storage of agricultural products;
b) Irrigation costs - part of operating costs associated only with the organization of irrigation of crops;
c) Commercial costs - the sum of operating costs plus the cost of the additional works, services and material resources associated with the sale (marketing) of produced crop yield.

Most of the known methods of economic calculations recommend assessing the costs and other indicators (yields, irrigation rates, etc.) in specific terms, per hectare of irrigated land. Subsequently, it is easy to calculate gross expenses by multiplying the specific values for the actual area of irrigated plot.

A significant proportion of irrigation costs account for the initial investments to purchase the DIS equipment. This category of costs also usually includes the amount of payment for design services, installation of equipment and training. To determine the value of annual specific investments in DIS, it should be based on the operation life of the fixed equipment, guaranteed by the supplier. For example, if the unit cost of a set of equipment with a guaranteed lifetime of 10 years (depreciation rate of 10%) is estimated at $2 thousand /ha, the cost of design - about $ 300 /ha, the cost of installation - $ 600 /ha, the cost of training - 100 $ /ha, then the total amount of investments in DIS will be $3 thousand /ha, and the annual unit cost of depreciation of fixed assets (initial investment) - $ 300 / ha.

If water supply for DIS will be implemented through an electrified or diesel pump units, the costs of power supply for DIS is calculated, depending on the installed capacity of the installation (kW), the estimated duration of work during the irrigation season (hour) and the tariff rate for the power supply (Som / kWh) or the cost of diesel fuel (KGS / liter). Typically, the cost of operating of diesel pump units is higher by at least 30% compared with electrified installations. Of course, this cost item should not be taken into account for self-pressure DIS.

The essential item of the annual irrigation costs include the cost of purchase, installation, dismantling and recycling of drip tapes / tubes and emitters with warranty service life from one to three years. The need for this replaceable equipment is calculated based on the individual design of DIS taking into account the type of crops and planting schemes. Prices for drip tapes depend on the design features and quality of the product and may vary by 2-5 times. For a rough estimate it is worth noting that the average price of drop tapes is about $50-100 /meter. With a total length of drip lines on 1 hectare of irrigated land planted with vegetables at least 15 km, the minimum cost for purchase of annual drip tapes will amount to $750-1,500/ha. Other costs associated with purchase of consumables and products, such as chemicals for flushing drip communications, replaceable disk filters as part of the filtration plant, spare parts, etc., are insignificant compared to the cost of drip tapes and can be easily defined depending on the estimated specific needs and market prices for each type of product.

Labor costs of personnel serving the DIS are defined on the basis of number of personnel, hours of work during the irrigation season (person/month) and the amount of contractual monthly wage (Som /month per person.), taking into account additional deductions for social insurance and social security tax. Recommended irrigation staff may include at least one motor mechanic/operator providing service for pumping and filtration units and one irrigator per every 5-10 hectares of area occupied by DIS. These specialists can carry out installation, dismantling and conservation / recycling of equipment before and after the irrigation period.

The amount of annual cost of payment for the supply of irrigation water is established based on actual irrigation rate (thousand m^3 / ha) and the effective amount of current tariff rate. If the owner of DIS is a member of the WUA, in the specific amount of irrigation costs it should be taken into account additional costs associated with payment of membership dues or payment for the water supply by increased tariff.

The amount of other direct costs for production of agricultural products (other than irrigation costs) is set by well-known methods, providing for the following standard items of expenditure:

- Cost of purchase of fixed assets taking into account their depreciation (buildings, structures, agricultural machinery and tools, vehicles, etc.);
- Cost of maintenance and repair of fixed assets;
- Cost of consumables (seeds, saplings, seedlings, fertilizers, pesticides);
- Cost of fuel and lubricants for agricultural machinery and vehicles;
- Electric power costs;
- Labor costs of permanent and temporary operating personnel;
- Other direct costs.[4]

Indirect costs include mandatory taxes, including taxes on land, property and transport, value added tax, social tax, and insurance payments. Indirect costs also include overhead costs for

[4] *Note: With the high level of organization of agricultural production on large agribusinesses, calculations of direct costs is made on the basis of technological maps of cultivation of each crop, providing decoding of all expenses in the performance of each technological operation (plowing, harrowing, cultivating, planting seeds, enriching the soil, weed control, etc., up to the collection and storage of the crop yield).*

maintenance of non-operating (management) staff, office costs, etc. Typically, the amount of indirect costs is 10-30% of the total direct operating costs.

The amount of commercial costs associated with the marketing (sales) of grown crop in general, can include several similar items of expenditure, such as labor costs of additional personnel (forwarders, merchants, drivers of vehicles), the cost of purchasing the containers, maintenance of warehouses and trading spaces etc. If the producer does not carry out the sales independently, using the service of commercial or intermediary companies, then commercial costs can be kept to a minimum, however, at the same time the revenue from sales of harvest be reduced in proportion to the difference between wholesale and retail prices for the products.

Similarly, using the actual data of the previous years, it is possible set the amount of irrigation and other operating and commercial costs for production of agricultural products using traditional irrigation methods such as furrow irrigation. For a comparative analysis of specific annual costs by using alternative methods of irrigation, the results of calculations can be systematized in a tabular format.

Information sources provided in this report contain many examples of a comparative cost analysis based, for example, on experimental data of implementation of DIS in Russia, Kazakhstan, Uzbekistan, Tajikistan, and Ukraine. The generalization of this experience allows confirming some obvious patterns:

- The cost of purchase, installation, depreciation and maintenance of drip equipment, as well as consumables are always significantly higher than for similar ones for surface irrigation methods;
- Reduction of the cost per unit for water supply in implementation of DIS, naturally, depends on the actual reduction of irrigation rates and the current level of tariffs for supply of irrigation water;
- At introduction of DIS on previously cultivated lands of pumping irrigation, it is marked reduction in energy costs and / or diesel fuel which is proportional to an actual reduction of irrigation rates. For example, on various experimental plots in Uzbekistan application of DIS allowed to reduce energy costs for $150-195 / ha, and for diesel fuel - $ 40 / ha. However, when replacing gravity furrow irrigation to the DIS with pumping units, the associated costs increase sharply;
- At introduction of DIS, amounts of fertilizers used are reduced by an average of 25-40%, which leads to reduction in unit costs about $ 70 / ha;
- It should be noted the inconsistency of a number of published data related to the actual operating costs and, in particular, labor costs of personnel serving DIS. For example, on the previously mentioned experimental plots in Uzbekistan they managed to reduce unit labor costs by an average of $ 75-80 / ha. However, other data, based on the experience of Russia and Kazakhstan, substantially differ - from reducing operating costs by 27%, compared with furrow irrigation, to increasing these costs by 40-45%. These contradictions can be explained by differences in the levels of remuneration of employees in different countries, as well as by differences in the needs of the number of DIS staff for various crops under gravity or machine water supply and other conditions;

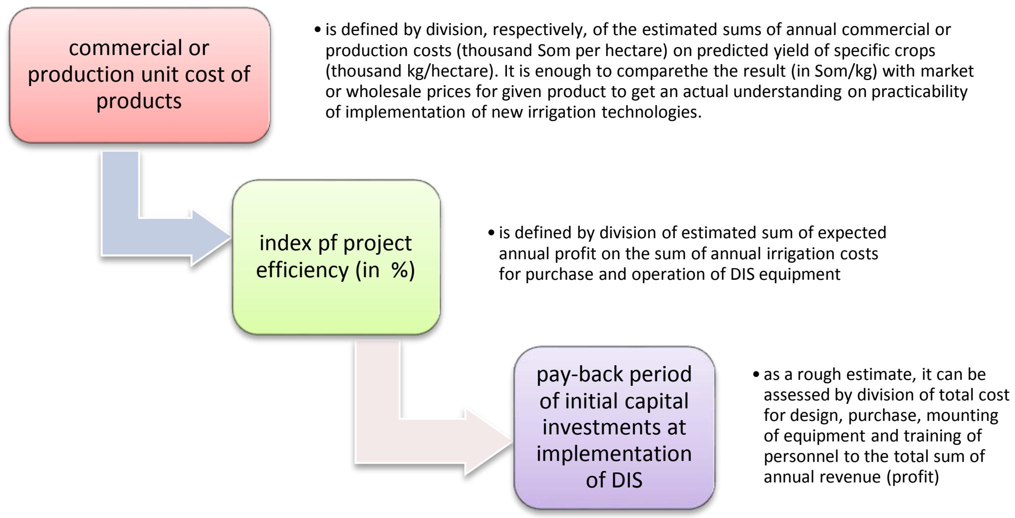
- Ultimately, as a result of introduction of DIS, the proportion of irrigation costs in total amount of annual operating costs may increase from 2-5% to more than 10%. It should be taken into account that, according to the review of international practices outlined in the report of the ADB project in the Kyrgyz Republic "Study of pricing system and cost-recovery mechanisms for irrigation" (Bishkek, 2006), irrigated agriculture can be profitable if the amount of irrigation costs is less than 20% of the item of expenditures of the farm budget.

2.4. Determination of key indicators of the Feasibility Study

In the world practice for the Feasibility Study of all investment projects in the area of production for calculation of basic indicators are used the standard methods: profitability of the project, payback period of capital investments, production costs per unit of output, and others. In general, performance indicators are established by comparing the benefits and costs in the production and sale of products. Depending on the expected method of marketing of products (wholesale or retail), two versions of calculation can be used based on the ratio of indicators either only for production revenues and costs, or general (commercial) revenues and costs.

As noted above, on the background of current macroeconomic conditions in Kyrgyzstan, the main source of revenue growth in implementation of DIS can be a significant increase in crop yields due to use of intensive agricultural technologies. Approximately, the value of expected income can be defined as the multiplication of a particular crop yield forecast (kg / ha) on the market price of this product (Som / kg). Refined calculation methodologies for the expected return also recommend taking into account commercial risks and the possible increase in market prices for these products as a result of improving its marketability. Commercial risks are taken into account by introduction the reducing risk factor into the estimated amount of income. For example, the factor of 0.9 would mean that it is expected to sell only 90% of the yield. In this regard, it is appropriate to mention that according to the national mass-media in Kyrgyzstan up to 40% of the harvest of some crops is often lost.

After verifying the value of the expected income, the efficiency index of agricultural production to be calculated for any method of irrigation. Diagram of this process is presented below.

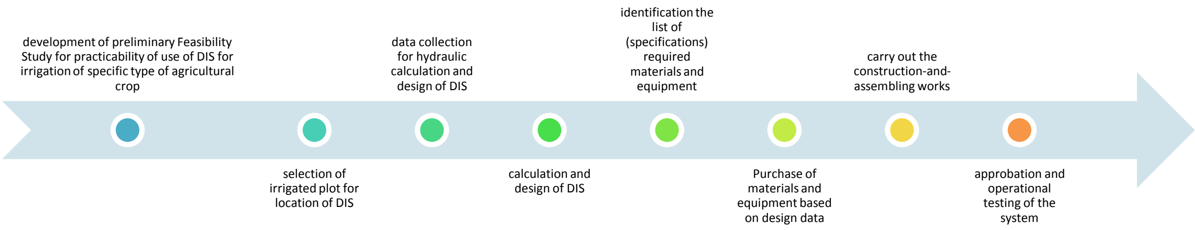


More complex calculation methodologies suggest the need to incorporate additional macroeconomic factors, caused by fluctuations in market prices, currency exchange rates, inflation processes, as well as uneven receipt of annual income in the course of development of intensive technologies of irrigated agriculture, and others. Together, these factors are taken into account by introduction of lowering discount rate into the estimated annual revenue. As a result, the amount of annual income is reduced by an average of 15-20% and the payback period of capital investments in the implementation of DIS may be about 5-6 years in the Kyrgyz Republic, according to optimistic estimates.

III. Recommended procedure in organization of introduction of drip irrigation systems

Currently, it is easy to find exhaustive information about the features of practical application of various designs and modifications of equipment for drip irrigation in public sources of information. The character of this information is extremely diverse: ranging from the technical and operational documentation of the largest enterprises manufacturing products, scientific publications and textbooks of agrarian universities, and up to critical assessments, useful advice and recommendations of direct consumers of these products, posted on the popular information portals and Internet sites. Obviously, the detailed systematization of these materials is very time-consuming task that goes beyond the scope of this project. Therefore, this section provides a brief set of useful information that summarizes the materials specified in the list of sources of information used, and allowing forming an objective vision of the typical composition, volume and stages of work, related to implementation of DIS in Kyrgyzstan. This also has taken into account that the other advanced irrigation technology – sprinkler irrigation has already received a certain distribution on the territory of the Kyrgyz Republic, and does not need further explanation.

In general, when planning the introduction of DIS it is necessary to provide for the following procedure:



3.1. Selection of irrigated plot and data collection for DIS design

When selecting the size of the plot it should be taken into account the world experience data showing that the maximum economic benefit is achieved by using standard sets of drip equipment from reputable manufacturers, designed for irrigation area of 40-50 hectares. In an area of less than 10 hectares and more than 100-200 hectares comparative efficiency of drip irrigation to some extent reduced. At the same time, publications on popular agrarian Internet forums show numerous cases of successful application of the simplest types of DIS equipment even in the areas of 0.1-1.0 ha, for example, in homestead and garden plots and small farms. However, the use of drip irrigation in the small areas generally seeks to meet the own needs of farms in vegetables, fruits and berries with a limited sale of surplus crops, rather than production of the marketable agricultural products.

When choosing a site for placing the DIS, at first it is necessary to consider the following conditions:

Location

- the topography, size and exact boundaries of the site within the irrigated land area, the direction of terrain slopes and planned direction of rows of plants

Water source

- the presence of (often under the conditions of KR - inter-farm channel), and the distance from the planned / existing water intake source to the irrigated plot

Other objects

- list and location of objects located in or near the selected area that can affect the design and construction of the system: canals, roads, residential and farm buildings, power lines, tree-planting bands and other.

For this purpose, it is necessary to use existing or new topographic map developed on the basis of geodetic survey.

At first, it is necessary to assess quality of the soil on a selected area on the basis of agrochemical analysis of soil samples (at least one sample per 1-2 ha). It is necessary, first, to confirm the allowable level of soil salinity, and secondly - to evaluate the level of soil fertility and the necessary amounts of mineral and organic fertilizers in the future.

A key step for introduction of DIS should be a selection of a particular crop or several crops that will be grown on this irrigated area, because configuration and cost of equipment mainly depends on this factor. With a single system it can be simultaneously watered multiple crops, but irrigation plot should be split into modular sectors, where each sector must be sowed with one culture. Division of plot into sectors is also expedient in cases where the estimated demand for water consumption in simultaneous watering of the entire area exceeds the limited capacity of selected water supply source (e.g., rate of flow of irrigation wells) or the established limit of water consumption from inter-farm channel and therefore it is necessary to provide alternate water supply to each sector. On the Figure 1 it is indicated by numbers:

1 – Irrigated modular sector 1 with agricultural crop - onions;
2 - Irrigated modular sector 2 with agricultural crop – tomatoes;
3 - Irrigated modular sector 3 with agricultural crop – cabbage;
4 - Irrigated modular sector 4 with agricultural crop – corn;

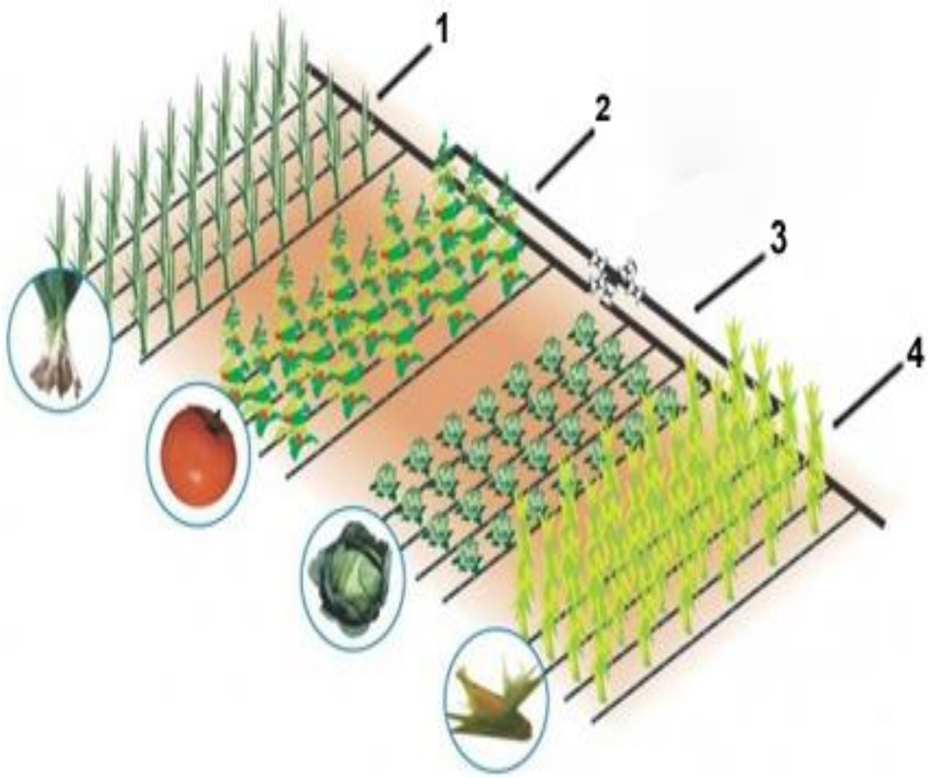


Figure 1. Scheme of irrigated plot divided into modular sectors

After the preliminary establishment of the composition of crops it is necessary, in consultation with qualified experts – agronomists, to determine the following indicators:

- Irrigation regimes of each crop adapted to specific regions of the Kyrgyz Republic and drip irrigation technology (daily moisture requirement of plants, depending on their grade and type, annual irrigation rate, number of watering, optimal timing, duration and irrigation rates for each watering);

- Methods of planting (seeds, seedlings or saplings), market prices for planting materials and labor costs associated with planting;
- Planting schemes (optimal row spacing and the distance between plants in each row)[5].

For DIS it is typical higher requirement to the quality of irrigation water. Therefore, to assess the suitability of selected water source (irrigation or drainage well, rivers, channels, lakes, springs, etc.), it is necessary to make the selection and analysis of water samples to establish, at a minimum, the following indicators:

- Concentration of suspended mechanical impurities (mg / l) and the maximum size of suspended particles (microns);
- Total mineralization of water (mg / l) and the content in water of iron oxide, manganese dioxide, calcium carbonate, sulphates, compounds of sodium, potassium, magnesium, sulfur (mg / eq. / l) etc., that may forming solid precipitates in the pipelines, drip tapes / tubes and droppers;
- Presence and concentration in water of aquatic organisms such as blue-green algae and bacteria capable of forming bacterial slime, blocking the droppers[6].

3.2. Calculation and design of Drip Irrigation System

For development of qualified DIS project documentation, qualified professionals should be involved, and additional unit costs of the customer for calculations and design may be about 10-15% of the estimated cost of equipment or, according to average current data for the CIS countries, no less than $ 200-300 / ha. But even before the conclusion of the contract with the project organization, the future owner of the system should have an objective idea about the composition and amount of future work. For this purpose, a brief summary of various publications on this topic presented below may be useful.

Basic set of DIS equipment (see Figure 2) typically includes:

- Water intake structure from surface or ground source, for example, pumping station;
- Filtration unit;
- Unit for feeding plants with fertilizers;
- Pressure regulator;
- Main pipeline;
- Distribution pipelines;
- Air valves;
- Drip lines with external and internal droppers;
- Connecting and locking fittings;

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[5] *Note: Distance between plants for onion, carrot, salad and other vegetables with small root crop usually is– 0.2-0.25m; for other vegetables – 0.3-0.4 м; for melons – 0.7-1 m; for shrub berries and vineyard – 0.50-1.50 m; for different orchard crops – 3.5-8m. Width of row spaces for most of vegetable crops is 0.5-0.7m, and for orchard crops – is equal to distance between trees in each row, that is about 3.5-8m.*

[6] *Note: contamination of water in the source by mechanical composition is not serious limiting factor, as the typical DIS equipment usually includes installation for cleaning from mechanical impurities. However, cleaning of water to allowable level of mineral composition and destruction of hydrobionts usually associated with additional sensible costs for purchase of chemicals and regular water treatment.*

* Additional fittings.

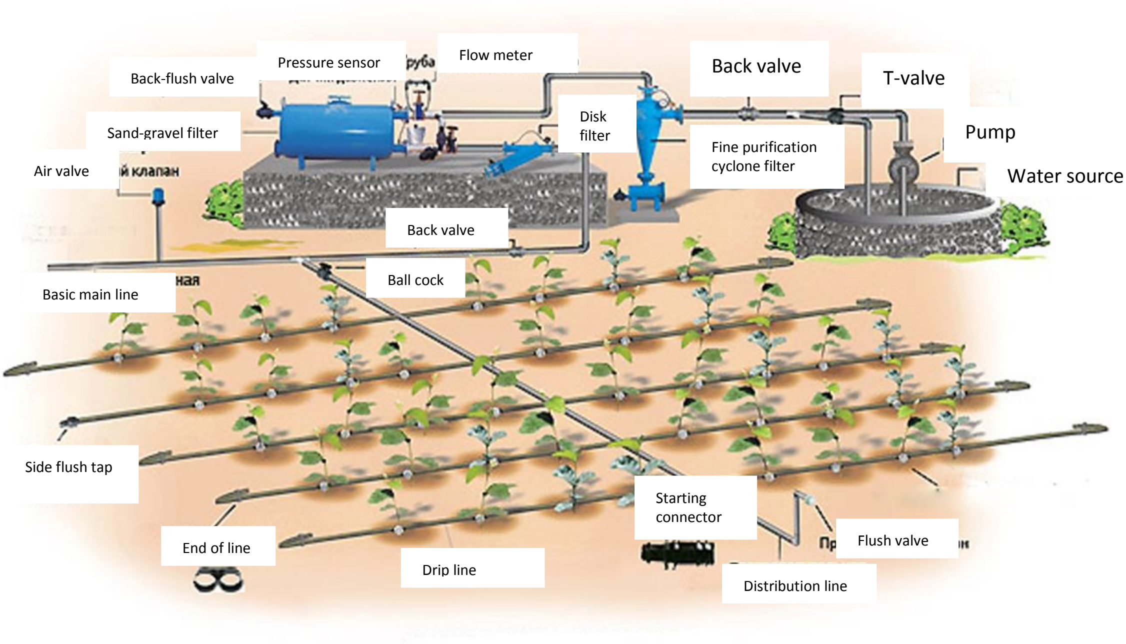


Figure 2. Structural layout of Drip Irrigation System

In addition to the diagram above, the brief additional information about the purpose and design features of the key elements of the DIS may be of interest.

Filtration unit – is the device for water purification from various impurities, which is always placed in front of the main pipelines. Depending on the degree of contamination of water in the source, type of dropper and size of irrigated area, various types of filters can be used. A key requirement to the filter is to detain and remove any particles larger than 0.1 of passage section of dropper. For pre-treatment of water are generally used sand-and-gravel, crushed stone or expanded clay filters; for final treatment and removal of organic pollutants to the level no greater than 140 microns - the filters of the second stage are used, for example, screen, disc (plate), filters with foamed polystyrene or hydro-cyclones. In case of using drinking water from wells, it can be limited by using a single disk or screen filters.

Unit for feeding plants with fertilizers – is intended for dosed application of fertilizers and / or plant protection products together with irrigation water. Usually it includes the reservoir for preparation of solution of fertilizers, injector to deliver the solution to the main pipeline and feeder (mixrait, agrorait) to regulate supply of the solution.

Pressure regulator – is the device of hydraulic and spring type, designed to reduce and maintain water pressure in the system at a certain level, to prevent excessive pressure and hydraulic shock.

Main and distribution pipelines – are respectively designed for the transport of water from the water intake to the distribution unit and further - to the drip lines. Usually are made of non-transparent plastic pipes which are resistant to corrosion and corrosive solutions. Most often for main pipelines are used pipes with a diameter of 40-160 mm made of high-density polyethylene, and for distributing pipelines – the same pipes or flexible reinforced hoses made of PVC.

Distribution unit – is a device in a form of an electromagnetic valve, ball valve, gate valve or shutter, and located at the intersection of the main and distribution pipelines, regulating the flow of water into each irrigation sector.

Air valves – are the devices for regulation of the air pressure in the pressurized system. When the system is not operating, all the pipelines and drip lines are usually filled with air. But when system is filled with water, there appears overpressure, which can cause hydraulic shock. If you turn off water supply the process is reversed, and in the system appears discharge of pressure (vacuum), which causes the system to suck air through emitters of drip lines. It may cause clogging of droppers, deformation of pipelines or depressurization of the system. To avoid this, air valves should be installed in the highest and / or end points of the main and distribution pipelines.

Drip lines – are the key elements of DIS system intended for dosed supply of water to each plant by the emitter - a device having a dosing canal and a micro-filter. Drip lines are usually tapped from distribution pipelines and are laid on irrigated plot in parallel to each other on the estimated distance. Most often drip lines for orchards and other perennial plants are represented by tubes / hoses meant for pressures up to 3 atmosphere, with length up to 750 m and a diameter of 16-32 mm, made of polyethylene of low density or high-density, with built-droppers (emitters). For vegetable crops are preferred drip tapes based on low pressure polyethylene meant for a pressure up to 0.8-1 atm. and fitted with solid droppers on a distance of 10-50 cm from each other. In conditions of KR, available market of drip equipment has a wide range of drip tapes – with flow rate of 0.5 to 2 l / h, according to the design - from the soft thin-walled, meant for an annual operation and to robust thick-walled, which can be used for several irrigation season (in average – for 5 years). For foothill areas with large slopes it is preferable to use relatively more expensive drip lines with pressure compensated emitters.

Connecting and locking fittings – it includes various parts (angles, T-bends, reducers, couplings, sleeves, valves, plugs, fittings, faucets, shutters, and others), used in the installation of the system and the regulation of water supply. For these purposes may be used both parts of general purpose made of corrosion resistant materials, and specialized devices such as start-connectors serving for tight connection of distributing pipelines with drip lines, drain plugs on the end portions of drip lines, ensuring their washing during irrigation and other.

Additional fittings – for example, control and measuring equipment (flow meters, water meters, pressure gauges), and various means of automated control, such as weather controller, tensiometers, evaporimeters to monitor soil moisture and determining irrigation norms, etc..

Clarifying the requirements of the number, sizes, designs and cost of each of the given elements of the DIS should be done at the design stage, on the basis of calculations and marketing research.

Calculation and design of DIS are usually performed by standardized methods set out in detail in the publications presented in the list of references. For efficient execution of these works with less costs it is advisable to involve design organizations or specialized units of suppliers of drip equipment, which have a computer software for automatized design of DIS. In general, design of DIS to be carried out in the following order:

1. At first, preliminary calculation of DIS water consumption is carried out (m^3/h or l /s) to assess the suitability of the water source, determine the power requirements of the pumping unit or well yield, as well as the necessary performance of filtration plant;
2. If on the irrigated plot it is provided for accommodation of several crops or capacity of water supply source / water intake does not allow simultaneous watering the entire area of irrigated land, then the area on the map to be divided into irrigation sectors (see Figure 1), with defined areas of each sector, covered with one crop and a maximum daily rate of irrigation;
3. After the establishment of layout and the number of irrigated areas and sectors, water consumption needs for each sector to be specified (m^3 / h);
4. Location of main and distribution pipelines are designed on the map of irrigated land (see Figure 3).

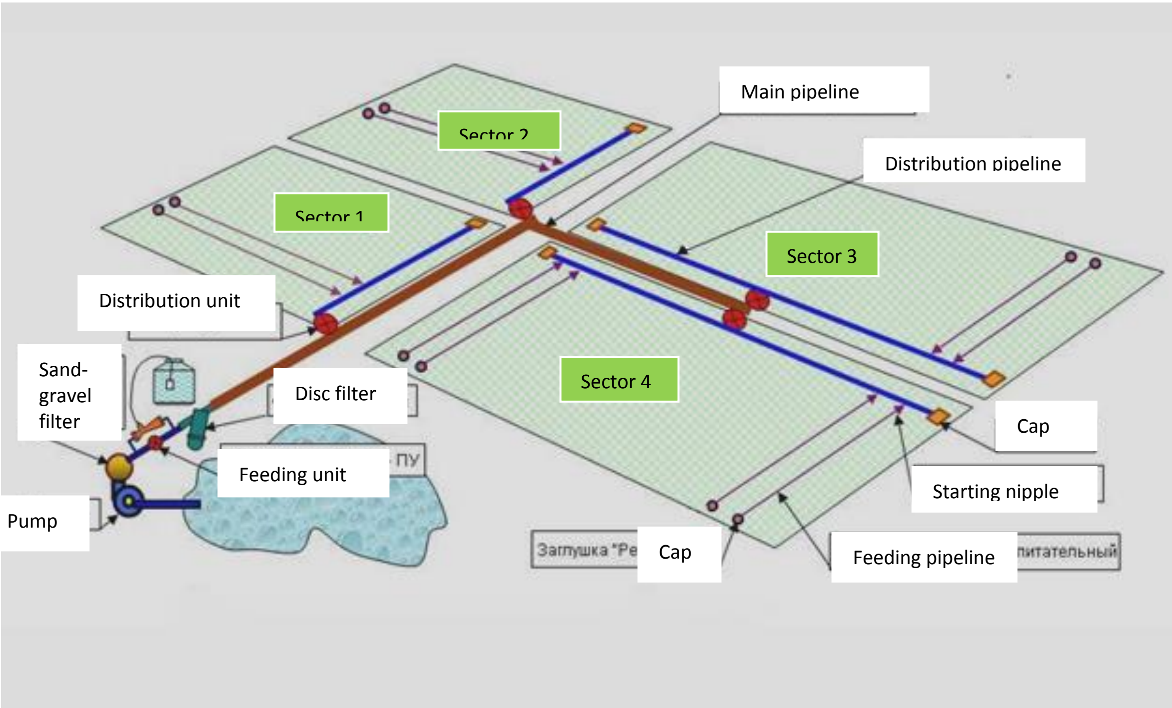


Figure 3. Mounting layout of main, distribution and drip lines

5. The main pipelines are usually placed in the middle or along the top border of the irrigated sector, while for distributing pipelines it is advantageous to place with tapped drip lines on both sides. Further it is necessary to clarify the number and length of each segment of main and distribution pipelines, taking into account rotations;
6. For each type of pipelines based on the value of calculated consumption and optimal flow rate of water current in the pipeline (approximately in the range of 0.8 to 1.9 m/s), the calculated hydraulic diameters of the main and distributing pipelines to be set based on the hydraulic formulas, which are then rounded up to the nearest large standard values. The actual speed of water in each pipeline to be defined for the final standard diameters of main and distributing pipelines;

7. Further water pressure loss to be defined for each pipeline, based on their length, diameter and resistivity values set for any type and size of pipe. By summing up the calculated head loss of water for the option of greatest length of the main and distribution pipelines, according to the chosen scheme, the value of the maximum pressure loss is determined, corresponding to the minimum permissible inlet pressure;
8. Based on the given schemes of planting of each crop (the width of row-spaces and distance between plants in each row), the location of drip irrigation lines for all sectors as well as the distance between droppers (emitters) to be designed and mapped. Based on these data the total need in drip lines and emitters of each sector and the DIS on the whole is specified;
9. In agreement with the project customer, the type of drip line (tape or tube), type, design and capacity of the droppers (emitters) are selected, depending on the capacity, conditions of water permeability of the soil and the needs of this crop plants in water;
10. Based on the capacity of water supply source, the established limit of water consumption and other conditions, the permanent irrigation scheme is established, including the number of simultaneously watered sectors, their total area and total demand of water flow. Based on the calculated value of the maximum water flow and data of water samples analysis in the water supply source, the estimated capacity of filtration plant (m^3 / h) is set, its type and structure are selected, and then the amount of additional loss of water pressure due to filtration is calculated;
11. Based on the data analysis of soil samples within the irrigated plot, the need for feeding of plants by dissolved mineral fertilizers is established. Feeding rate is usually from 3 to 15 kg / ha a day, where the concentration of fertilizer must not exceed 1-1.5 kg / m^3, and the duration of fertigation should be around of 30-100 minutes. In general, these figures vary depending on the phase of plant development and climatic conditions during irrigation season and must be justified by experts for each irrigated plot individually. On the basis of calculated data on the duration of fertigation and allowable concentration of the solution, the required volume of the mixing reservoir is set and the design of feeding unit is selected using an injector, dispenser, etc.;
12. Depending on the selected DIS scheme, types and sizes of connecting and locking fittings are established, as well as the required number of each product;
13. By summing of the estimated losses of water pressure along the length of main and distributing pipelines and drip lines, as well as local head losses in the fitting elements, the value of total head loss at the inlet of DIS is established for the variant of maximum water consumption;
14. The design and the type of water intake structure are set depending on the type of water source, based on the two estimated indicators - consumption and excess water pressure. In general, the operating excessive pressure generated by the pump unit (or by pressure antechamber / pool on the water intake from the surface source) should be at least 10-15% higher than the total pressure loss in the system. Operating pressure range for DIS on the area over 1 hectare are generally in the range of 0.07-0.3 MPa (0.7-3.0 atm). Based on the estimated value of the operating pressure, the designs of pressure regulator at the inlet of DIS are also selected. Because of the numerous standard design solutions for water intake structures, their individual design is carried out very rarely. Self-pressurized irrigation and drainage wells can also be used as the water intakes, which flow rates in Kyrgyzstan are typically of 20-50 l / s.

15. The fundamental issue on the final design stage of DIS design is the choice of system management mode (manual or automatic). With manual control regulation of water supply in the water intake, feeding and filtering units, in the main and distributing pipelines and drip lines is carried out by using taps / valves. For automatic control it is necessary the use of control board, flow sensors, water pressure and soil moisture sensors, electromagnetic valves, programmable timers, weather controllers, and other high-precision equipment, additional facilities, lines of communication and power supply. Obviously, the automatic control creates comfortable working conditions for staff serving the DIS, but it contributes to a sharp increase (up to 50%) of the cost of equipment. For example, the market value of the controller is about $100. In view of this, selection of control mode is usually carried out by the customer of the project and primarily is based on economic considerations.

Ultimately, a set of design documents, as a minimum, should contain:

- An explanatory note outlining the requirements of the customer and rationale of chosen design solutions;
- Plan (map) of irrigated land, divided into sectors with graphic design in accordance with the requirements of SNIP;
- Scheme of installation of all pipelines and drip lines;
- Summary table of the results of calculations of hydrodynamic and parametric characteristics of the DIS equipment;
- Working drawings for all types of equipment with reference to location;
- Scheme of installation of the elements of connecting and locking fittings;
- Specification of required materials and equipment;
- Recommended regimes of crop irrigation for all irrigation sectors;
- Project volumes and timing of water delivery for each distribution pipeline;
- Recommended fertilizing modes and regime of washes;
- Instructions on installation of the equipment;
- Operation manual for DIS.

3.3. Selection, purchase and mounting of DIS equipment

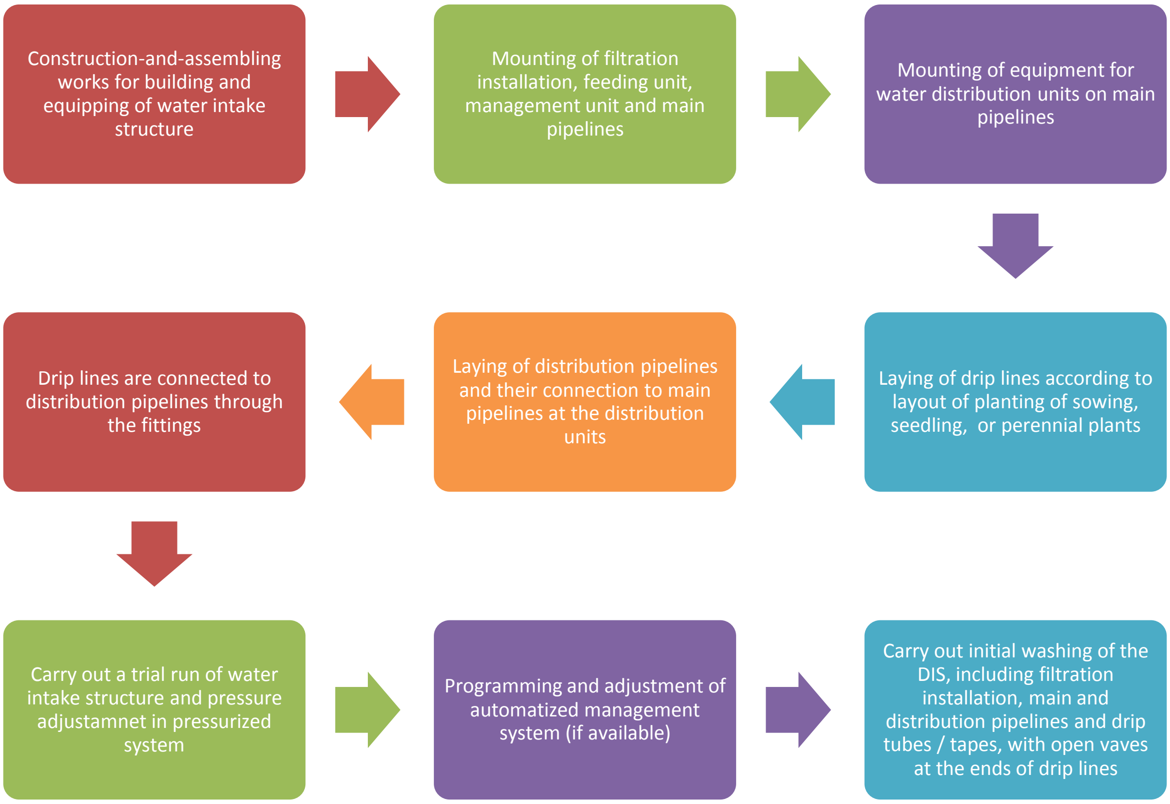
The basis for the selection of DIS components is the specification of materials and equipment included with project documentation. It contains a full list of equipment, indicating their purpose, types, sizes, and the necessary number. However, the final selection of components is often difficult, because the supply of irrigation equipment on the market contains dozens of items of the same type of products from different countries and manufacturers, where prices of similar products may vary by 2-3 times. In this case, the best choice is usually made based on the ratio of “price / quality”, taking into account the generalization of information about the reputation of specific manufacturers. For example, in consultations with the suppliers of equipment or the analysis of consumer reviews on the available Internet resources, it is easy to define that prices for the most common in Kyrgyzstan products for DIS of Chinese, Indian or Turkish origin, as a rule, are lower not less than 40% compared with Israel or Western European counterparts, but the average lifetime of cheap products wherein is less by about two times; respectively, there is an increase of the risk of unstable operation of DIS due to equipment breakdowns. In addition, at the choice of equipment it is necessary to consider the level of prices on the domestic market of the Kyrgyz Republic, taking into account the additional costs for delivery of bought-in products.

After the purchase of DIS equipment, construction and installation works are carried out in accordance with the instructions supplied with the project documentation. Typically, these works are carried out in two stages:

- Construction and installation of fixed equipment (water intake, filtration plant, feeding unit, control unit, main and distributing pipelines and others.) is usually carried out on large DIS in the non-vegetation period;
- Installation of drip lines, meant for an annual application is made, as a rule, every year, after seedbed preparation and application of soil herbicides, along with planting or just before planting of seedlings.

For construction and installation of stationary equipment, especially for installation of automated control systems, it is expedient to involve qualified professionals, but the installation costs can be up to 50-70% of the cost of the equipment. In case of the small DIS, sometimes it is provided for annual dismantling and storage of the entire set of equipment after the growing season, followed by re-installing in the next year.

Technologies of installation of DIS equipment may be slightly different in various project documentations, but, in general, they provide for the following sequence of activities:



Methods of installation of drip lines, in general, depend on the type and scheme of planting of particular crop, the type and design of emitters. For example, the drip tubes or perennial high density tapes can be laid on the soil surface. Annual thin-walled drip tapes are buried to a depth of 3-5 cm or laid on the ground surface. It is advisable to carry out laying drip lines over large areas by mechanized method using converted cultivator, sowing machine or vegetable planter, while in areas up to 1 ha the manual laying is appropriate. Flexible irrigation hoses or integrated perennial drip tubes for irrigation of gardens, vineyards and berries are placed on the soil surface or suspended from the trellis wire at the time of planting the seedlings where they can serve up to 12 years. Laying irrigation lines in the gardens usually made in rings, with mature fruit trees in the center, or in zigzag.

Main and distribution pipes normally are laid in the trenches of a depth of 0.3 to 1.0 m, followed by backfilling. Equipment of locking-regulation fittings on the main and distribution pipelines are placed in wooden or plastic boxes with lockable lids.

When installing distribution pipelines and drip lines, special attention should be given to alternative (subsoil or surface) laying methods, because both methods have specific disadvantages. In particular, at the surface laying, the tube or the tape are more susceptible to damage during mechanical treatment of the soil, due to exposure to harmful ultraviolet radiation, and also because of the birds and rodents. Besides, drip lines are easily displaced with respect to the project location in the heavy rains and strong winds. At the subsoil laying, often other problems appear - damage of drip lines by soil pests (wireworms, mole cricket, chafers) and blocking of droppers because of the penetration of plant roots.

3.4. Characteristic problems of DSI operation

A detailed description of the maintenance procedures, repair, conservation and other operating activities are usually contained in the accompanying documentation of manufacturers of DIS equipment and design organizations. Therefore, the following is only a brief overview of problematic situations that service personnel usually face in the initial period of operation of the DIS.

The vast majority of failures in the DIS work are due to mechanical damage or clogging of drip lines and droppers (emitters). In turn, the main causes of mechanical damages may be:

- Manufacturing defects in the manufacture of cheap drip tapes and emitters or damage during transportation;
- Laying of drip tapes or tubes without pre-planning and preparation of topsoil (the structure of the topsoil should be homogeneous and fine grain);
- Violation of the established mounting technology, most often - incorrect connection of the emitters to tapes or tubes;
- Mechanical damage of the drip equipment during cultivation of the soil, removing weeds and carrying out other agro-technical measures (to control weeds more preferable compared to mechanical removal methods, is the use of herbicides of selective or complex effect);
- Damage to the drip lines by rodents, birds, insects, soil pests, etc. (for the control of soil pests it is necessary to treat drip lines with insecticides at the beginning of the irrigation season, for example, Akhtar, Marshall, Treflan, Bazudin, Decis, Zolon, BI-58 etc., at the rate of 0.8-3 l / ha);
- Violation of elasticity and strength of drip lines due to exposure to ultraviolet radiation.

In any case, the defects of drip lines and emitters are easily detected visually by checking the system for leaks or blockages and are subject to immediate removal during repair or replacement of damaged parts. At operable system of irrigation, on the surface of beds wet areas appear around each dropper. Formation of puddles or micro-fountains is a sign of rupture or leaking joints. On the contrary, the absence of wet areas at one or more droppers is an evidence of their clogging. In the future, it is necessary constantly monitor the tightness of all the joints in the system.

The prevention and elimination of consequences of clogging of drip lines and emitters is the most difficult problem of DIS operation. It should be taken into account the probability of the three types of blockages - mechanical, chemical and biological. For prevention of blockage of drip lines and emitters by suspended material, the two-stage filtration plants are an integral part of most DIS. But for the stable operation of filtration plant it is necessary to carry out periodic washing of sand-and-gravel unit, disc and/or screen filters with clean water. After the end of irrigation season gravel-sand fraction must be removed and washed in running water on the grid / sieve, and then loaded into the unit. It is also necessary to wash all communications and drip lines with clean water at the beginning, at the end of the irrigation season and during the season at intervals not less once a month.

To prevent biological contamination of drip lines it is necessary to periodically flush the entire system through the feeding unit with solutions of hydrochloric, nitric or phosphoric acid with a concentration of 0.6-1.0%, and the sodium hydroxide solution at the rate of 15-20 grams per 100 liters of water. During the season, this operation should be performed at least once in 15-30 days, and at the end of the season washing is carried out before storage of equipment, using similar solutions of increased concentrations (2-4%).

The main causes of chemical clogging of drip lines and emitters may be increased salinity of water in the source of water supply or salt deposits of insoluble residues of fertilizers (mainly calcium compounds, phosphorus, magnesium, nitrate and ammonia nitrogen), supplied through a feeding unit. In addition, these compounds can be a breeding ground for various aquatic organisms. This explains the need for constant monitoring of the chemical composition of irrigation water, especially with frequent fertigation. To prevent chemical clogging of the DIS equipment it is sufficient to maintain the pH level of water within the range in from 5 to 7. Before entering the reagents into feeding unit, the entire system is filled with clean water up to the working pressure. Thereafter, during about 30 minutes, a staged supply of the acid solution in each irrigation sector is carried out, and then the whole system is flushed with clean water during the period at least of 30 minutes.

In case of application of intensive agro-techniques, different types of fertilizers are commonly used - basic (including nitrogen, potassium and phosphorus) and also additional - for example, agrochemicals for foliar fertilizing and accelerated absorption of nutrients by the plant root system, based on compounds of boron, magnesium and others.

When simultaneously mixing in a container of feeding unit the concentrates of different fertilizers, there may be unpredictable reactions with formation of new chemical compounds. Such mixtures may not only block the work of drop lines and emitters, but also cause burns to the root system of plants. Therefore, use of various kinds of fertilizer should be carried out one by one, with the obligatory intermediate washing of feeding unit, distribution and drip lines. It should also be borne in mind that among the most common and relatively cheap fertilizers, ammonium nitrate and urea have the best solubility. In DSI it is strongly prohibited the use of poorly soluble fertilizers such as nitroammophosk, etc. Often, manufacturers and suppliers of drip equipment recommend using instead of soluble fertilizers the certified liquid fertilizers manufactured in West Europe, for instance, “Terrafleks”, “Calcinite”, “Monopotassium phosphate”, “Kristalon” and other. However, the cost of such products is usually many times greater than prices for nitrogen and phosphate fertilizers familiar to farmers in Kyrgyzstan.

Dismantling and maintenance of DIS equipment for autumn-winter period are associated with significant costs of manual labor of skilled workers. At this, the principal question is - what part of the equipment will remain on the irrigated plot, and what should be dismantled and stored in enclosed spaces. Obviously, for fixed installations the paramount measures are protection from precipitations, corrosion, damage and irrelevant interference. These measures, especially with regard to the pump equipment, filtration plant, feeding unit and DIS automated control should be given in detail in the project documentation or special instruction of the manufacturer.

With regard to removable equipment the specified documentation should provide for:

- Disconnection from fixed equipment, removal of parts of connecting fittings and their washing, followed by drying, packaging and placing in enclosed spaces;
- Dismantling, washing, followed by drying, oiling with technical oil, packaging and warehousing of valves, ball cocks, and others parts prone to corrosion;
- Washing, drying, packaging and storage of the filter elements; washing of elements and all kinds of rubber seals, and their further storage in a heated room;
- Dismantling, chemical treatment with hydrochloric acid, washing and drying of the flexible hoses, drip tubes and / or drip tapes of long-term use. The ends of these lines to be covered by inter-seasonal caps, and the lines themselves, twisted into coils without bends and deformations, are transported for storage in enclosed space.

In conclusion, it should be noted one of the most difficult problems of DIS operation associated with dismantling and recycling of one-year drip lines. To assess the scale of the problem, it suffices to mention that in one hectare of irrigated land planted with vegetables, typically fit up to 15 km of drip tapes of total weight up to 600 kg of polymers, which cannot be decomposed in the soil for decades. Dismantling the drip lines using manual labor is an extremely time-consuming operation, while the specialized tractor-drawn attached implements for this purpose are not available in Kyrgyzstan. In this regard, the experience of farmers from neighboring countries may be useful, which use independently converted seeding machines, ridgers, harrows, cultivators and other mechanical devices to collect drip lines.

Conclusion

During the study it was confirmed that a large proportion of irrigation water is lost within the farm-level irrigation systems.

Current growth of these losses is due to the three main reasons:

- Unsatisfactory technical condition of farm-level irrigation system;
- Splitting up the irrigated areas into small plots of land. This significantly increased the length of distribution network, from the inter-farm water outlets and up to allotments to each farm. Due to this fact, water losses were increased through the filtration, evaporation, and transpiration by weeds;
- Lack of tangible incentives of water users in the agricultural sector to conserve irrigation water due to an extremely low level of tariffs for water supply services.

To ensure minimization of water losses in the fields is only possible with a comprehensive reorganization of conditions of industrial activity in the sector of crop production. The main directions of these reforms in the Republic suggest the following priority actions:

- Reform of land relations, stimulating consolidation of irrigated tracts of land;
- Creation of cooperative associations of water users and / or independent agricultural enterprises on the basis of small farms and peasant farms;
- To form effective motivations of the agricultural sector entities, contributing to a more rational use of water resources and introduction of water-saving irrigation technologies. To do so, the certain economic, legal and administrative levers of stimulation can be used, first of all - associated with a marked increase in tariff charges for irrigation water supply services;
- Fundamental changes of the existing structure of crop production by the pre-emptive use of more productive and profitable varieties of crops - fruit, berries, vegetables and the like, instead of the most common crops. It is necessary to achieve more ambitious goals to create steady sales on foreign food markets as brands for specific types of Kyrgyz agricultural production, for example, beans, fruits, berries, etc.
- Development of market infrastructure of the agricultural sector, ensuring sustainable procurement and maintenance supply, production, purchase, processing, transportation, and marketing (sales) of crop products.
- Development of capacities of the enterprises processing agricultural raw material in order to significantly increase the surplus value of crop production.

At the same time, sufficient attention should be paid to conservation of fertility of the soil, promotion of replacement of traditional crops by the high-yield and profitable ones, environmental aspects of land use, etc.

Implementation of all the proposed measures will only be possible over a long period. Therefore, **as priority objectives** it is appropriate to outline the intensification of efforts **to form agricultural cooperatives** and **organize mass training of rural residents** for more perfect, but at the same time affordable technologies of irrigated agriculture.

In the conditions of Kyrgyzstan, the following tree methods of irrigation are the most preferable:

- Improved furrow irrigation;
- Sprinkler irrigation;
- Watering by the drip irrigation method.

Inadequate dissemination of drip and sprinkler irrigation methods in the Kyrgyz Republic, as well as the mechanized technologies of furrow irrigation to a large extent is explained by the low awareness of a significant part of the irrigated agriculture entities on their advantages and features of application, compared to the primitive methods of irrigation. Therefore, the widespread information awareness campaigns and training activities can contribute to their wider application, taking into account the positive experience gained in the implementation of a number of international projects in Kyrgyzstan.

Information provided in this and previous reports demonstrate incomparable advantage of drip irrigation on a number of objective indicators compared with alternative methods. However, significant costs for the purchase and maintenance of drip equipment, as well as increased requirements for qualification of the maintenance staff will be the major constraints to large-scale implementation in Kyrgyzstan in coming years.

Certainly, in the early years of introduction of DIS it will be required a significant support of the State to the agricultural producers.

In particular, among the priority actions can be the following measures:

- improvement of preferential mechanizms for insurance of agro-business
- enhancement of the State subsidizing of agro-industrial activity
- improvement of tax policy
- regulation of prices for main agricultural products (meat, milk, egg, vegetables, fruit, etc.)
- support of building of market infrastructure
- economical and administrative-legal removal of excessive networks of mediators in the process of production of agricultural products, its processing and market sales
- support for mastering of production of drip irrigation equipment on national plants

List of used information sources

1. V.D. Alba, A.S. Kushnarev, G.I. Ivanov "Method of calculation and operation of drip irrigation systems". Published by "Chemistry Agronomy Service" No-No 47-50. Kiev 2013.
2. A.I. Kuznetsov, Technology of business planning. Tutorial of Bauman' MSTU, 2005
3. A. Zh. Atakanov, Technology and mode of drip irrigation of vineyards in the southern regions of Kyrgyzstan (on the example of Batken rayon). Bishkek, 2000.
4. N.Y. Kovalenko, Agricultural Economics with the basics of agricultural markets. Moscow, "EKMOS" Publisher, 2009.
5. Guidelines on accounting of expenses for production and calculation of the unit cost of goods (works, services) in the agricultural organizations. Moscow. Ministry of Agriculture of the Russian Federation. 2003.
6. V.A. Barinov. Business planning, Tutorial. M., "FORUM-INFRA" Publisher, 2009.
7. V.D. Alba, A.S. Kushnarev, G.I. Ivanov "Method of calculation and operation of drip irrigation systems". Publisher "Chemistry Agronomy Service". №№ 47-50. Kiev. 2013.
8. A.D. Akhmedov, E.A. Khodyakov, E.P. Borovoy, M.V. Mazepa "Technique and technology of cultivation of crops under drip and inter-soil irrigation" Volgograd. Ed. IPK FGOU, 2008.
9. VTR-11-28-81. "Guidelines for the design, construction and operation of drip irrigation systems". M., Minvodkhoz USSR, 1981.
10. V.T. Vodyannikov "Economic evaluation of the energy of AIC", M., "EKMOS" Publisher, 2002.
11. K.S. Ternovykh, A.S. Aleksenko, A.S. Annenko. Planning for the agribusiness company. M. "Kolos" Publisher, 2007.
12. K.P. Licko. Forecasting and planning of agro-industrial complex. M. "Gardariki" Publisher, 2006.
13. G.V. Savitskaya. Analysis of economic activity of agricultural enterprises. M., "INFARM" Publisher, 2006.
14. A.S. Narynbaeva. Foreign experience of state regulation of agro-industrial complex. Bishkek. "Bulletin KRSU". Volume 14. №4. 1914.
15. "The principle of work of drip irrigation systems". "Agrostimul" Publisher, Kiev, 2012.
16. D.A. Chernova, L.A. Vojvodina. Overview "Technical solutions for problems of drip irrigation and their development trends", Ed. FGBNU "RosNIIPM", M., 2013.
17. Safe systems and drip irrigation technologies. Scientific review FGNU RosNIIPM, Novocherkassk, 2010
18. A.J. Atakanov, A.O. Naloychenko. "Drip irrigation system for orchard and vineyard". The series "Support to farmers and WUA". Ed. 10. Bishkek. 2010.
19. P.M. Zhooshov, K.A. Abdraimov, R. Weber. Planning Manual of drip irrigation system. Bishkek. 2015.
20. I. Bakumenko. Southern region: starting point for drip irrigation. The newspaper "Agroinfo" Kazakhstan. 08.07.2015.
21. Drip irrigation of vegetables. Why it does not always work? Magazine "Grain", Kiev. №8, 2011.
22. Kulov K.M., Naloychenko A.O. Methods of regionalization of drip irrigation. Frunze, 1988.
23. http://agrobuy.ru// Agro-industrial Internet-portal "Agrobuy.ru". R.M. Kotov. "Comparative characteristics of the system of state regulation of agriculture in foreign countries".

24. http://old.review.uz/ru// V. Prokofieva “Chain Reaction in drip irrigation”. The magazine “Economic Review”, Tashkent.
25. L.S. Gil, V.I. Dyachenko, A.I. Paszkowski, L.T. Sulima. Modern industrial production of vegetables and potatoes using drip irrigation systems. Magazine “Ruta”, Ukraine, 2007.
26. http://www.pomeshhik.ru// S. Garayan. (Nagorno-Karabakh). “Shortcomings of drip irrigation for growing environmentally pure products”.
27. L.I. Makartsev. The economy of agricultural production. M.,“UNITY-DANA” Publisher, 2007.
28. I.A. Minakov. Agricultural Economics. M. Ed. “Kolos”, 2009.
29. V.B. Panov, Analysis of economic activity of agricultural enterprises. M. INFARM. 2010.
30. http://old.group-global.org/ru//. I. Sabirova. Method of calculation of economic efficiency of cultivation of agricultural crops under different irrigation methods and technologies.
31. http://l-userpic.livejournal.com// how does the drip irrigation works in Israel?
32. http://zarip-ovosch.ru// Method of calculation and operation of drip irrigation systems, drip irrigation in horticulture and greenhouses.
33. http://articlekz.com// Application of fertigation for efficient use of fertilizer (the experience of Israel).
34. G.V. Korenev. Intensive technologies of cultivation of agricultural crops. M. “Agropromizdat”, 2003.
35. http://www.fruit-inform.com/ru// M. Romashchenko., V. Koryunenko. Features of application and operation of drip irrigation systems.
36. http://russkoe-pole.com// Operation manual for drip irrigation. Ed. NPK “Russian field”, 2012.
37. http://water-salt.narod.ru// A. Pisarenko, “Drip Irrigation in the fields of Russia”, Journal “Topical agricultural systems”, 2011.
38. http://www.googleadservices.com// “The technology of growing tomatoes using drip irrigation”
39. http://agrodelo.com.ua// “Preparation of irrigation network for winter storage”.
40. http://agrorus.org// “Drip irrigation with your own hands”.
41. http://polivagro.su// . “Schemes and models of drip irrigation”
42. http://agro-market.ftes.info// Calculation of drip irrigation.
43. http://stroy-shkola.ru// “Drip irrigation systems with your own hands: instruction on installation”.
44. http://portal-energo.ru// saving water for irrigation of plants. Drip irrigation.
45. http://fermer.ru// “How developed countries protect their farmers?” Internet portal “Farmer.ru”.

Internet-sites of organizations and enterprises involved in production, delivery, design, and contract supervision of equipment for DIS

1. http://www.agrotop.co.il// «Agrotop Ltd» Company, Israel.
2. http://ibreedit.com// «Breedit Ltd» Company, Israel.
3. http://www.export.gov.il// «Derekh Erekh» Company, Israel.
4. http://www.eshet.co.il// «Eshet Eilon» Company, Israel.
5. http://www.genesisseeds.com// «Genesis Seeds Ltd» Company, Israel.
6. http://www.mad-agri.com// «M.A.D. Developing Agricultural Projects Ltd» Company, Israel.
7. http://ru.metzerplas.com// «Metzerplas» Company, Israel.
8. http://www.naandanjain.com// «Naandan Jain» Company, Israel.
9. http://www.export.gov.il// «The Israel Export & International Cooperation Institute» Company, Israel.
10. https://www.netafim.com// «NETAFIM» Israel, Israel.
11. http://alecon.co.il// «ALECON» Company, Israel.
12. http://www.greenprophet.com// «Drip Irrigation Systems» Company ("QUEEN GIL"). Israel.
13. http://rivulis.com//, http://www. tsystemsinternational.com// «T-Systems International. Inc» Company. USA, Canada, China.
14. https://www.newaginternational.com// «Chapin Watermatics Inc» Company. USA, UK, China.
15. http://bizorg.su content// img/logo.png. Production and delivery of drip irrigation systems «NEO-DRIP». China.
16. http://www.robertsirrigation.net// «Roberts irrigation» Company. USA.
17. http://ftes.info/users/ava// «SUN-FLOW INC» Company. USA.
18. http://ftes.info/users/ava// «JOHN DEERE Water S.A.S» Company. USA.
19. http://www.paginegialle.it// «TECNIR SRL» Company. Italy.
20. http://www.aasystems.eu/ / «Aqua-TraXX» and «AAS TECHNOLOGY» Companies. Italy.
21. http://www.guvenplastic.com// «Guven Plastic» Company. Turkey.
22. http://www.eurodripusa.com// "EURODRIP" Company. Greece.
23. http://ftes.info/users/ava// «SUZHOU SEAPEAK CO. LTD» Company. China.
24. http://agrimatco.by// International company AGRIMATCO (Agricultural Materials Co.). Brunch in Byelorussia.
25. http://www.zaoast.ru// Close corporation "Aqua service trade" Company. Delivery of drip equipment. Russia.
26. http://www.himal.ru// LLS Company "Chemical Alliance Movement". Delivery of mineral fertilizers. Russia.
27. http://www.6mil.ru// Company "Center of innovations Green River", Russia. Production of equipment for drip irrigation.
28. http://www.polivavto.ru// «PolivAvto» Company. Russia. Estimation and mounting of drip irrigation systems.
29. http://www.fito-system.ru// Scientific-industrial Company SIC "Fito". Russia. Delivery and mounting of drip irrigation systems on "turnkey" basis. Training of specialists.
30. http://www.landizain.ru// "Drain-M" Company. Russia. Design of automatic irrigation systems.

31. http://www.irrigate.ru// "Irrigate.ru" Compamny. Russia. Design, delivery and mounting of drip equipment.
32. http://sovelteh.ru// Company "Modern Electrical Technologies". Russia. Delivery, mounting and setting-up of pumping equipment.
33. http://poliv-master74.ru// Company "Poliv-Master". Russia. Delivery of drip equipment.
34. http://www.powerunit.ru// Group of "PSM" Companies on production of power and pumping equipment. Russia.
35. http://www.potatosystem.ru// LLS Company "Agro technologies". Russia.
36. http://www.asprus.ru// Association of producers of fruit, berries and planting stock "ASP-Rus". Russia.
37. http://prom-martel.ru// "Martel" Company. Russia.
38. http://www.irrikom.ru// LLS Company "IRRICOM", Russia.
39. http://agrohimcenter.com// Internet-shop "Agrochimcenter". Russia.
40. http://agromagistral.ru// LLS Trade Company "Agromagistral". Russia.
41. http://aikltd.com// Company "AIK LTD", Ukraine.
42. http://archiflora.com.ua// «ArchiFlora» Company, Ukraine. Design and mounting of drip irrigation systems.
43. http://aquaplus.su/index.php// Network of shops of water technics "Aqua Plus". Ukraine.
44. http://agrostimul.com.ua// Internet-shop for professional farmers and amateur gardeners "Agrostimul". Ukraine/Russia.
45. info@fakel.dn.ua. Plant "Fakel". Ukraine. Production of drip equipment.
46. http://evkalipt.com.ua// "Eucalyptus P" Company. Ukraine.
47. http://kandi.kz// "TOO Kandi-Almaty" Company. Kazakhstan. Delivery of drip equipment «SABTape».
48. http://www.teplica.kg/ / APEK Company. Kyrgyzstan. Delivery of drip equipment.

Information websites, portals, and forums of agrarian profile

1. http://drip-irrigator.ru// Information agronomic website “Drip-irrigator”. Russia
2. http://fermer.ru// Information portal “Farmer.ru”. Russia.
3. http://ab-centre.ru// Expert analytical Center of Agro Business. Russia.
4. http://glavpoliv.ru// Information website “Glavpoliv”. Russia.
5. http://portal-energo.ru// Information website “Portal-energo”. Russia.
6. http://www.apk-inform.com/ru// Information analytical agency “APK-Inform: fruit and vegetables”. Russia.
7. http://adwise.agency// forum of Internet marketing.
8. http://gejzer.ru// Information business portal.
9. http://agropraktik.ru// Internet portal “Agro practice”.
10. http://www.agroserver.ru// Russian agro-industrial server.
11. http://agro-market.ftes.info// Information agronomic website “Agro Market”. Ukraine.
12. http://agropoliv.uz/project // Information website «Agropoliv». Uzbekistan.
13. http://www.agroprom.kz// website of the Agro-industrial complex of Kazakhstan.
14. http://www.taic.kg// Agro forum of Kyrgyzstan
15. http://forum.agro.kg// Agro forum of Kyrgyzstan
16. http://www.pr.kg// Information-analytical portal «PR.kg». Kyrgyzstan.
17. http://www.taic.kg// Public Fund “Training, consultation and innovation center” (TCIC). Kyrgyzstan.