DEMONSTRATION PLOTS AS A TOOL TO ENSURE SUSTAINABILITY IN THE FERGANA VALLEY

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Abstract

This paper describes the use of demonstration plots as a tool to demonstrate use of modern agricultural and water management techniques to increase yield levels and ensure food security in a sustainable way which are taken in the three (Altiarik, Bagdad and Rishtan) districts of Fergana Valley of Uzbekistan comprising an area of approximately sixty eight thousand hectares. The project is elaborated within the framework of the Ferghana Valley Water Resources Management Project (Phase-I). Deep ripping, laser land leveling, application of appropriate amount of fertilizer, timely and correct application of agricultural practices and irrigation have resulted in wheat yields in pilot option was 8120 kg/ha, whereas it was 4800 kg/ha in the control plot.

DPs were used successfully in the World Bank funded Drainage, Irrigation and Wetlands Improvement Project (DIWIP) in South Karakalpakstan to deal with a range of problems similar to those present in the Fergana Valley. These DPs covered the full range of activities on both leasehold and dekhan farms. In the past similar research techniques that make use of DPs have been used successfully in other regions of Uzbekistan.

Demonstration Plots (DP) accompanied by Farmer Field Schools (FFS) have been successfully used in FWRMP in agricultural development to carry out research and as a practical training tool. They have been used not only to introduce new techniques to farmers but also remind the forgotten ones.

Fergana Valley Water Resources Management Project

In parallel to the above given measures, Government of Uzbekistan started implementing donor funded projects for solution of the above mentioned problems. The Fergana Valley Water Resources Management Project Phase-I (FWRMP), which is World Bank funded, has been devised to address constraints on agricultural productivity in parts of the Uzbekistan territory lying within the Fergana Valley (FV). In addition, it seeks to tackle chronic problems of waterlogging which are affecting infrastructure and buildings within this part of the FV.

The FV comprises parts of three Central Asian States: Uzbekistan, Tajikistan and the Kyrgyz Republic (**Figure 1**). The total area is approximately 2.6 million ha, and there is a total population of 14 million, of which 66% live in the rural areas. Compared to the other parts of these countries, population density in the Valley is high, and the amount of land available per person is small. Poverty is widespread.

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The main water-sources for the FV are the Naryn River, the Kara Darya, and the Syr Darya, which is formed by the confluence of the Naryn and Kara Darya. Numerous small rivers flow in from the north, east and south, including the Sokh and Isfara. The FV has appreciable groundwater that has developed over geological time. The subterranean waters associated with the rivers noted above, especially the Sokh and Isfara, form a main source of potable water supply for the population in the Valley.

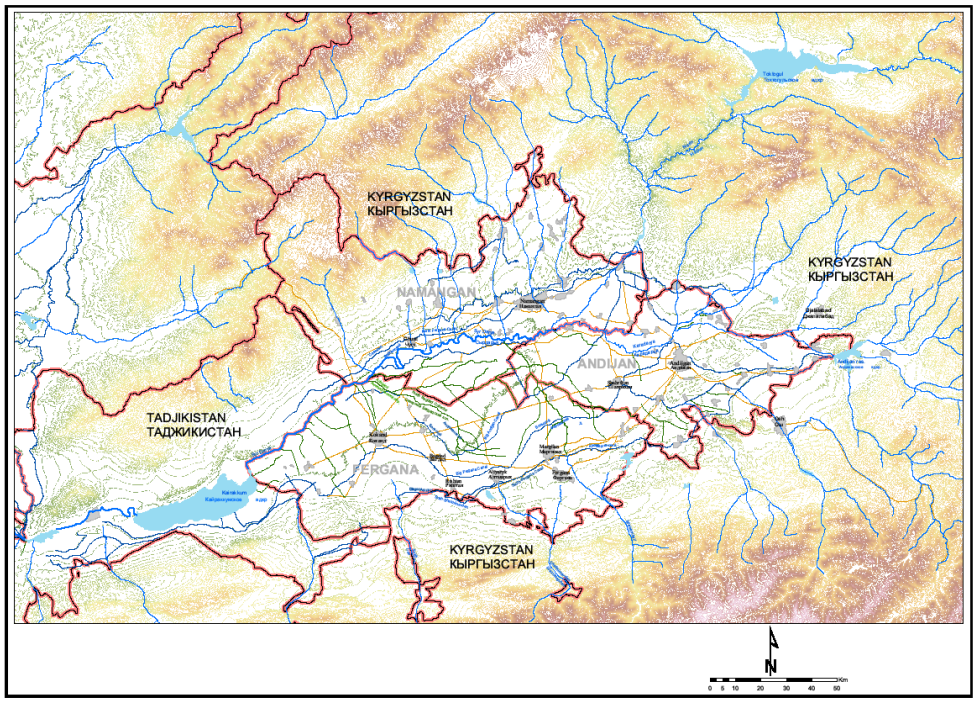

Figure 1 Fergana Valley Water Resources Management Project Area

A major problem in the FV is the high water table, especially in the lower and central parts of the FV. This widespread problem is particularly associated with the irrigated areas. It is generally believed that the high water table is due to the absence of an adequate drainage system; or a drainage system that is no longer properly functioning, because the necessary rehabilitation and maintenance has not been carried out during the past two decades; and because of poor water management practices. As a result, the area is suffering from substantial water logging and soil and water salinization. The high water table has mobilized salt in the soil which, with waterlogging, has resulted in destruction of buildings and residential houses located near the collector drains. For crops, it has resulted in lower yields and therefore lower incomes for the people living in the area.

The main objectives of the FWRMP are to: (i) Promote sustainable irrigated agriculture production, increase employment and generate farm incomes in the Uzbek part of the FV by improving drainage and irrigation systems and overall water resources management; (ii) Reduce damage to private and public infrastructure, and improve environmental and public health conditions by controlling water logging; (iii) Introduce participatory irrigation management through water users' associations and improved agricultural and irrigation practices, and income generating activities to enhance value of the products from the project area; and (iv) Strengthen water management, and irrigation and drainage institutions. These objectives will be achieved by the implementation of the following components:

Component A: Improvement of Irrigation and Drainage Systems

Component B: Groundwater Development

Component C: Community and Agricultural Development Support

- Development of effective WUAs, by means of technical assistance and training, to improve on-farm water management and operation and maintenance (O&M)
- Promotion of improved irrigation and agricultural practices by use of demonstration plots (DP) and farmer field schools (FFS)
- Income generating activities such as canning of fruits, sericulture and processing of agriculture and textile products to enhance the value of the commodities produced in the project area.

Component D: Project Management, Monitoring and Evaluation, Technical Assistance and Training

Problems in the Fergana Valley

Integrity of non-irrigation related infrastructure is impacted by high groundwater levels, impaired drainage and incidence of soil salinisation. Many of these physical problems originate in physical defects, or can be overcome by physical interventions. However, some of the problems are due to, or are exacerbated by institutional and capacity aspects; some of the physical solutions available will only be effective in a modified institutional setting.

In recent years state policy decisions have resulted in radical changes to the institutional framework under which irrigation and drainage (I&D) and agriculture is practised. Although the policy framework to move these activities from control and management by the state to a private sector orientation is now largely in place, converting the policy into reality is a long and difficult process, with many problems to be solved.

FWRMP will be able to contribute to some of the solutions at the local level of the study area, however, many potential solutions are outside its scope. In particular, whilst FWRMP can be a vehicle to trial new institutional arrangements, it is inappropriate for FWRMP to promote changes extending beyond the study area boundary. Whilst FWRMP may influence national policy, or its implementation, there are many stakeholders outside the study area with an interest in, and influence on, how policy develops.

Demonstration Plots in the Fergana Valley

Three demonstration plots for each project district (nine in total) have been proposed. In these DPs practices that will improve crop yields, such as better water management and field distribution of water, improved soil fertility and increased organic soil matter, are being demonstrated, as set out below:

The DPs can generally be divided into two categories: (i) cotton and wheat DPs; and (ii) “Dehkan” DPs

The six cotton and wheat demonstration plots are essentially the same; six are included to ensure coverage of the whole project area, and the two DPs in each district are at different stages in the cotton-wheat-secondary crop 2 years rotation cycle so at any one time each plot demonstrates a different stage.

The FWRMP demonstration programme concentrates on those practices which can reverse the negative influence on crop yield through better water management and in-field distribution of water and improved soil fertility and increased organic soil content.

The programme demonstrates deep ripping and land levelling / grading of fields, minimum tillage techniques, the introduction of vegetable and forage / green manure crops, irrigation of fields using constructed field head ditches, siphons, field drains, and furrow irrigation control.

In addition, the beneficial effects (both technically and financially) of using good quality seed, correctly balanced fertilizer applications, integrated pest management, and increased use of organic manure to increase general soil organic content and soil fertility are being demonstrated.

There are two main types of farmer in the FWRMP Project Area: commercial farmers, who hold farms of 70 – 100 ha, and mainly grow state order crops of cotton and wheat, and dehkan farmers, who typically hold small plots of around one hectare, and are involved in vegetable and fruit production.

Traditionally, the commercial farmers' fields were part of large collective farms run by technical specialists. One of the legacies of this system is that no one individual was given a good technical grasp of the whole scope of farming activities: irrigation would have been handled by specially trained irrigation professionals, soil fertility management would have been handled by soil specialists; mechanical operations handled by highly specialist mechanics. This means that no one farmer has a solid understanding of the complete range of activities necessary to run a successful farm. The farmer may have previously been a tractor repair mechanic, and not even have a basic understanding of irrigation or soil husbandry. Therefore, the target group is generally all farmers. As a result of this change in farming styles, DPs and Farmer Field Schools aim to: (i) educate people who have recently acquired land and do not know how to farm it; and (ii) re-introduce basic farming methods and techniques where these have been forgotten or ignored during a period of great change in the farming sector.

The ultimate indication of the success of the DPs and FFSs will be whether, over a number of years, the land increases in productivity, not only in yields for given crops but also in the number of crops that are harvested each year (or each multi-year cycle). The question of whether the conservation of the land will have improved will only be seen in the longer term, depending on whether increased crop yields prove sustainable, and continue to increase, over a number of years.

This requires the whole project interventions, and not simply DPs and FFSs, and, whilst the contribution of DPs and FFSs is considered necessary, it is not alone considered sufficient.

The success of demonstration plots can be measured using the following indicators: (i) the improvement of the condition of the soil (e.g. mineral and organic content); (ii) the volume of water used; (iii) the harvest; (iv) the range of crops grown; and (v) financial indicators (i.e. profit).

These will be benchmarked not only year by year, but also against other neighbouring fields not included in the demonstration.

The success of FFSs can be monitored by: (i) the number of farmers attending; (ii) the number of farmers attending for a second or third time; (iii) The number of booklets distributed; and (iv) the farmers' evaluation of the training.

The farmers' evaluations are being conducted immediately after each training session by the implementation consultants, but could also be usefully undertaken by the M&E consultants.

Further measures of success, which are harder to measure, are the extent to which techniques used at the DP are adopted by farmers in the area and those visiting the DPs for FFSs. This can only generally be gauged by chance observations, but is perhaps the clearest indicator of success. A further indicator would be the extent to which farmers contract out laser land levelling and minimum tillage operations.

Problems and Solution Prposals

Problems common to the cotton and wheat fields and their solution proposals which are being demonstrated in the DPs can be categorised as follows:

- Poor drainage: resolved predominantly by the physical works to be realized within the scope of the project, but also improved water management
- Poor land and soil management: resolved by focus on land management and tillage
- Poor water management: resolved by optimising crop irrigation and leaching
- Poor water and land protection: resolved by use of disease and pest control measures, primarily biological.

Improving and restoring the quality and productivity of the land require the following set of organisational, technical and land treatment processes:

Drainage

The rehabilitation and increase in capacity of the collector and drainage infrastructure to ensure that the level of the water table is lowered and that the optimum levels of water, air and salt in the root zone of soils are reached – which are being implemented under the project.

Land preparation and tillage

Technically precise land levelling to ensure irrigation water is used economically, including field moistening and preventing the appearance of salt patches.

Deep ripping to 70-80 cm carried out periodically (once every 4 years on heavy soils and once every 6 to 8 years on light soils) in order to break the “plough pan” and to improve the physical and water related properties of the soil.

The use of minimum tillage techniques.

The application of crop diversification and rotation, using grains, legumes and perennial grasses

The application of the right proportion of organic and mineral fertilizers based on the availability of soil nutrients and the existing soil fertility.

Optimum mode of crop irrigation and leaching

Water saving methods of irrigation and leaching saline soils during rehabilitation with the application of agro- and bio-technologies.

Observing recommended irrigation parameters to ensure the sensible use of irrigation water.

Strict observation of water and nature protection measures

Irrigation water quality monitoring and control, collector and drainage water management, etc.

If possible the use of biological means to protect plants from diseases and pests, etc.

In addition it is recommended planting two or three rows of shelter-belts to regulate the temperature and humidity of the irrigated fields. The trees provide biological drainage, which slows down salinity and water logging. Surveys have shown that shelter-belts decrease wind speed over irrigated fields by 20-70%, evaporation by 10-30% and increase crop yields by 10-15%.

The three dehkan DPs have been chosen to represent different aspects of small scale farming: one plot, an orchard, which will focus on improved water management and drip irrigation; the second, a vegetable plot, which will focus on improved soil management (use of manure), improved water management; the third, a vegetable plot with a focus on improved soil management (use of manure) and greenhouse technologies.

Wheat Demonstration Plots

A great portion of the agricultural lands in the Fergana Oblast are affected by different categories of salinity. To obtain higher levels of yield from such lands requires success of agrotechnical activities from many aspects.

Therefore it is required to clean the collectors around totally salinized fields, lower the groundwater levels and implement agrotechnical measures which will decrease the salt concentration of the soils to levels necessary for agricultural activities.

In order to achieve the above mentioned results 30 tonnes/ha of local manure have been spread over the fields of the demonstration which have been deep ripped 60 cm.

As a result of monoculture which continued for many years, layers with hard pans have occured. The ultimate aim is to increase the yield levels by improvement of physical, chemical and biological conditions of these layers through spreading of manure and deep ripping.

Characteristics of the demonstration plots are given in **Table 1**.

Table 1 Characteristics of Demonstration Plots

	Altiarik	**Bagdad**	**Rishtan**
WCA	Pavulgan Abduselam	Irrigator Bagdad	Zahidan Chasmasi
Farm	Sharofatkhan	Nurmuhammed Bagi	Mamadjan
Soil type	Fertile	Fertile	Fertile
Salinity	Medium	Medium	Medium
GW level	0.70-1.00 m	1.50-2.00 m	0.70-1.00 m
Wheat sort	Zamin-1	Krasnodar-99	Kroshka

Analysis of the information obtained from these plots demonstrates that spreading of local manure of 30 tonnes/hectare and deep ripping before ploughing have destroyed the hard pans which resulted in water and air circulation.

Local manure spread under the plough has become absorbable by the crop after decaying with the effect of microorganisms after irrigation. During the decaying process, harmful salts in the soil have been dissolved making the soil neutral.

Unit weight calender in the demonstration plots has given the indicators shown below.

In the Rishtan district unit weights of the medium salinized fertile soil in the layer of 0-30 cm have been measured as 1.37 g/cm^3 and 1.31 g/cm^3 relatively in the control plot where conventional techniques have been applied and in the deep ripped demonstration plot where manure has been spread.Whereas in the layer of 30-50 cm, the values measured are 1.40 g/cm^3 and 1.35 g/cm^3 respectively. Similar results obtained in the other demonstration plots can be seen from **Table 2**.

Soil moisture results in the layer of 0-30 cm have increased in the demonstration plots compared to the control plots by 1.7%, 1.8% and 1.4% in the Altiarik, Bagdad and Rishtan districts respectively. This indicator has also given higher results in the layer of 30-50 cm.

Table 2 Affect of organic manure, DR and green manure on the unit weight of soil

Layer (cm)	Option	Date	Altiarik	Bagdad	Rishtan
0-10	Control	15.05.2012	1.35	1.31	1.32
		21.09.2012	1.37	1.34	1.33
	DP	15.05.2012	1.30	1.29	1.28
		21.09.2012	1.32	1.33	1.30
10-20	Control	15.05.2012	1.38	1.36	1.37
		21.09.2012	1.38	1.36	1.37
	DP	15.05.2012	1.32	1.30	1.30
		21.09.2012	1.34	1.34	1.33
20-30	Control	15.05.2012	1.37	1.37	1.36
		21.09.2012	1.40	1.39	1.39
	DP	15.05.2012	1.34	1.33	1.32
		21.09.2012	1.36	1.36	1.34
30-40	Control	15.05.2012	1.40	1.39	1.40
		21.09.2012	1.42	1.41	1.41
	DP	15.05.2012	1.35	1.33	1.31
		21.09.2012	1.37	1.36	1.34
40-50	Control	15.05.2012	1.31	1.40	1.40
		21.09.2012	1.43	1.42	1.42
	DP	15.05.2012	1.36	1.34	1.33
		21.09.2012	1.38	1.37	1.35
50-60	Control	15.05.2012	1.42	1.40	1.41
		21.09.2012	1.46	1.44	1.44
	DP	15.05.2012	1.36	1.35	1.34
		21.09.2012	1.40	1.40	1.36
60-70	Control	15.05.2012	1.43	1.41	1.42
		21.09.2012	1.46	1.45	1.44
	DP	15.05.2012	1.35	1.36	1.34
		21.09.2012	1.42	1.42	1.36
0-70	Control	15.05.2012	1.39	1.37	1.38
		21.09.2012	1.41	1.40	1.40
	DP	15.05.2012	1.34	1.33	1.31
		21.09.2012	1.39	1.36	1.33

Deep ripping and local manure spread have positively effected growth and development of winter wheat. Review of **Table 3** shows that number of crops per m^2, collection and number of general stem, number of wheat in one spike, and average weight of 1000 wheat have increased in the demonstration plots compared to control plots.

As a result of the agrotechnical measures, wheat yield of 8120 kg/ha has been obtained in Rishtan which means a difference of 3620 kg/ha from the yield of the control plot (4500 kg/ha). In Bagdad the increase was 1650 kg/ha from 3950 to 5600. The releatively low yield increase in Bagdad can be explained by very late seeding of wheat on July 6th. In Altiarik there has been an increase of 2440 kg/ha from 2660 to 5100.

Differences in the yield levels between the demonstration plots in the three districts can be explained by the differences in the soil and climatic conditions of each environment.

Table 3 Affect of organic manure and DR on development and yield of wheat

			Altiarik	Bagdad	Rishtan
Soil unit weight during vegetation season (g/cm^3)	Control	0-30	1.38	1.36	1.37
		30-50	1.42	1.39	1.40
	DP	0-30	1.34	1.29	1.31
		30-50	1.37	1.34	1.35
Soil moisture during vegetation season (%)	Control	0-30	14.8	14.9	15.1
		30-50	16.1	16.8	16.5
	DP	0-30	16.5	16.7	16.5
		30-50	17.9	18.4	18.7
Collection	Control		3	2	3
	DP		4	4	6
Number of total stems (m^2)	Control		321	353	361
	DP		373	430	427
Crop height (cm)	Control		71.0	74.0	73.0
	DP		79.8	77.6	80.0
Number of wheat in one spike	Control		29.3	31.6	32.5
	DP		33.2	34.2	34.4
Weight of 1000 wheat grains (gr)	Control		30.0	32.0	35.0
	DP		36.0	35.0	40.0
Total yield (kg/ha)	Control		2660	3950	4500
	DP		5100	5600	8120
Yield increase compared to control plot (kg/ha)			2440	1650	3620

We can reach to the conclusion that increase in the yield levels in the demonstration plots compared to the control plots can be corrolated to deep ripping and application of organic manure.

In the demonstration plots there has been a saving of 1320-1465 m^3/ha in the irrigation water used and number of irrigation has also reduced 1-1.5 times in the average compared to the control plot.

Cotton Demonstration Plots

Previous researchs show that decrease of the organic material in the soil content as a result of monoculture applied in a field for long years changes physical, chemical and biological characteristics of the soil and eventually causes loss of soil fertility.

Similarly lack of cleaning works of onfarm drains and main collectors on time, and consequent increase of the ground water levels and mineralization result in accumulation of harmful salts in the culture zone leading losses in the soil fertility.

In the skirts of the mountains and piedmonts located in the southern part of the project area sierozem soils of light color and dark color, hard loam and sierozem soils have been developed. Upper parts of the Sokh Fan occupying a large section of the territory have been formed by stone-gravel layer whereas lower parts by cones and sinks.

As a result of irrigated agriculture for years plough layer of the soil has been filled with discharge coming from irrigation return flow. Development of mountain skirts and piedmonts for irrigated agriculture is one of the causes of swamp formation and salinization of the lower landscapes.

In order to solve the above mentioned problems, a number of agrotechnical measures as explained below have been implemented in the demonstration plots.

In Autumn 2011, organic manure of 30 tonnes/ha has been spread and ploughing has been done in 30-35 cm depth in the DPs. After that deep ripping of 60 cm has been implemented. After grading 180 kg/ha rye seed has been sown, and irrigated first growth have been ploughed and mixed with soil in the plough zone as green manure function in the early spring.

In these fields, after tillage in the spring, land levelling has been implemented, seeds have been spreadand seedlingds have been taken.

In the DPs, pheonological monitoring have been implemented based on the recommendations of Uzbek Cotton Scientific Research Institute.

Measurements of soil unit weight for different layers at control and demonstration plots are shown in **Table 4**. Unit weight of soil for all layers of the deep ripped plots where manure was spread were less than those for respective layers of the control plots.

Table 4 Affect of organic manure, DR and green manure on the moisture of soil

27.08.2012		Altiarik	Bagdad	Rishtan
Number of crop in one hectare (unit)	Control	117.5	97.0	75.6
	DP	120.6	103.2	81.2
Height of crop (cm)	Control	64.0	108.0	79.0
	DP	71.8	123.4	91.4
Number of flowers (unit)	Control	1.5	1.0	1.0
	DP	2.5	2.0	2.0
Number of blossom (unit)	Control	4.0	4.0	3.0
	DP	6.0	6.0	5.0
Number of ball (unit)	Control	5.2	8.1	9.1
	DP	7.1	10.4	15.4
Number of opened ball (unit)	Control	0.8	4.0	4.2
	DP	1.2	5.8	8.4
Yield (kg/ha)	Control	2520	3000	2690
	DP	2950	3290	4030
Yield increase compared to control plot (kg/ha)		-430	290	1340

In Rishtan during vegetation season the unit weight of the soil in the plough layer in the DP and in the control plot were1.28-1.32 g/cm^{3}and 1.33-1.38 g/cm^3 relatively, which means a decrease of 0.04-0.06 g/cm^3. Unit weight of soil in the DP after deep ripping and spread of manure has decreased by 0.08-0.09 g/cm^3 compared to the control plot.

In Bagdad, unit weight of the fertile medium salinized soil in in the plough layer in the DP has decreased by 0.04-0.08 g/cm^3 compared to the control plot, whereas 0.05-0.06 g/cm^3 in the sub-plough layer.

In Altiarik, unit weight of the dark colored sierozem soil in in the plough layer in the DP has decreased by 0.04-0.05 g/cm^3 compared to the control plot, whereas 0.05-0.08 g/cm^3 in the sub-plough layer. In these fields as cotton was sown in double rows passing of tractors many times before seeding have densified the soil.

In the end of the vegetation period unit weight has been measured for all the options. It has been observed that agrotechnical measures used, mainly deep ripping have shown their affects in the development of cotton and the yield increase.

Farmer Field Schools

The development of farmer field schools (FFSs) is divided into three components:

Phase 1–Development of training plan. During the seminar on the development of farmers' training in FFS the training programme has been prepared by the joint efforts of technical specialists, agriculture and water resources' specialists and experienced farmers. The content of the training modules approved covers all aspects of agronomy, farming and socio-economic issues.

Phase 2–Training of instructors (trainers). The future trainers of FFS trainees will be trained in the approved modules during the study seminar “Training for trainers”. Candidates are staff from the local region, who are employed by the Implementation Consultant. These are people who have both a good knowledge of and work experience in agriculture in the project area, as well as a higher education in some relevant field of irrigated agriculture. The first round of training of trainers was undertaken in June-July 2011. For the following topics, suitable national experts have already been identified and have been be used to train the trainers in the seminars held in May 2013: (i) Agricultural economics; (ii) Farm planning and management; (iii) Advanced surface irrigation techniques; (iv) IWRM; (v) Financial management; and (vi) Flow measurement

Phase 3–Training of farmers. The training process have been conducted according to the approved program and training modules, passed during the Seminar. The training was based on Demonstration Plots

Training of farmers in groups has an interactive character. Farmers talk to one another and their trainer engage in debate and share their opinions and experiences from their work on farms.

The main training method is to demonstrate by example. Organized Demonstration Plots (DP) serve as visual examples of best practices, methods and technologies. Field visits for groups of three to five farmers are effective for training. These training sessions take place in farmers’ fields.

So-called “open doors” days are organized to demonstrate certain techniques on the field, to model their accuracy, necessity and their implementation conditions

Showing the yield at harvest time is the most effective way of convincing farmers of the advantage of the methods they’ve seen applied on the DPs over the ordinary practices of farmers.

In FFS the aim is to reach more and more farmers by passing on information within a certain time period. In order to do so, there is a Farmer’s Information Support Desk (FISD) and project specialists publish bulletins, brochures, booklets and other printing materials, covering the main issues of crop cultivation (agro-techniques and irrigation).

Topical lectures on the main modules are supplemented by additional materials such as posters, schemes, maps, et al.

Conclusion

The project is elaborated within the framework of the Ferghana Valley Water Resources Management Project (Phase-I). Deep ripping, laser land leveling, application of appropriate amount of fertilizer, timely and correct application of agricultural practices and irrigation have resulted in wheat yields in pilot option was 8120 kg/ha, whereas it was 4800 kg/ha in the control plot.

DPs were used successfully in the World Bank funded Drainage, Irrigation and Wetlands Improvement Project (DIWIP) in South Karakalpakstan to deal with a range of problems similar to those present in the Fergana Valley. These DPs covered the full range of activities on both leasehold and dekhan farms. In the past similar research techniques that make use of DPs have been used successfully in other regions of Uzbekistan.

Demonstration Plots (DP) accompanied by Farmer Field Schools (FFS) have been successfully used in FWRMP in agricultural development to carry out research and as a practical training tool. They have been used not only to introduce new techniques to farmers but also remind the forgotten ones.