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Full Length Research Paper

A creative public-private joint venture for irrigation extension in Fergana valley of Central Asia

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A 'farmer-centric' innovative institutional mechanism, a public-private partnership, was created and strengthened, in the Fergana valley of Central Asia, for facilitating communication between farmers and researchers, and to disseminate knowledge on improved agronomic and irrigation management practices to improve water productivity at field level. As a result, yields of cotton from the twenty five demonstration sites in the three countries of Fergana valley - Kyrgyzstan, Tajikistan and Uzbekistan – were, on the average, 28% higher than the average yield of cotton in the valley, suggesting that the proposed institutional mechanism was very effective in dissemination of information to farmers. Yields from neighboring farmers of demonstration fields were 14% higher than the average yields. In addition, demonstration site farmers used, on the average, 20% less water than the non-project farmers. Two independent external reviewers stated that this innovative public-private mechanism was very effective in disseminating information on improving water productivity at plot level to farmers, and suggested that the focus in the future should be on devising effective policy and economic instruments for financial sustainability of the innovation cycle after the donor support is withdrawn.

Key words: Agricultural extension, irrigation extension, innovation cycle, public-private partnership, water productivity.

INTRODUCTION

Irrigation extension advisory services can play an important role in assisting farmers to adopt new techniques and technologies and to increase productivity, minimizing environmental risks and contributing to the sustainability of the agrarian sector (Smith and Munoz, 2002). Agricultural extension services have evolved over time, following patterns across the globe. The training and visit system stated 40 to 50 years ago, and the system experienced success in a number of countries, but later it was considered as a supply driven system and not a demand driven one. Agricultural extension evolved as pluralistic models and modes (Birner and Anderson, 2007; Neuchâtel Group, 2000). New thinking included delivery of extension services in the context of decentralization, aspects such as outsourcing, cost recovery and involvement of private sectors and NGOs.

Birner et al. (2006) argues that there is no single best method for providing need-specific, purpose-specific and target-specific extension advice. The right approach depends on the policy and infrastructural environment, capacity of potential service providers, characteristics of local communities, including their willingness to co-operate with agricultural extension agents. Raabe (2008) argues that to fit a particular situation, agricultural extension needs to be flexible and able to accommodate local needs.

Agriculture is at the forefront of development objectives of the three Central Asian Republics of Kyrgyzstan, Tajikistan and Uzbekistan. Since independence, these

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countries have undergone transition from centrally planned economies to market-oriented economy. The needs of the three Central Asian countries for improved agricultural extension are not yet similar. Over the years, there have been several sporadic attempts to revitalize agricultural extension, but with no sustainable effect. Hence, there is an urgent and clear need for establishing and strengthening agricultural extension services in Central Asia (Kazbekov and Qureshi, 2011). Also, after the Land Reform Acts of early 2000s, more than 30 to 40% of the farmers are new to irrigated agriculture, and are hungry for information on irrigated agriculture.

After independence from the former Soviet Union (in 1991), the State/Collective farms disintegrated, with nobody to claim the ownership of irrigation and drainage infrastructure. Land was distributed to local people, irrespective of their prior background in agriculture. In Kyrgyzstan, Kazakhstan and Tajikistan, farmers own their land, whereas in Turkmenistan and Uzbekistan farmers lease their land from the government for 50 years. Disintegration of large farms has increased the number of farmers the majority of whom have inadequate knowledge/skills of irrigated agriculture. There was insufficient on-farm irrigation infrastructure to distribute water to individual farmers. During the Soviet era, every State/Collective farm had professional agronomists and irrigation specialists for providing advisory services for irrigated agriculture. However, with the collapse of the system, some of this expertise has been lost. This has created a big 'vacuum' for knowledge dissemination to thousands of individual farmers in these countries specifically on irrigation water management from on-farm level to WUA level. It was difficult to government institutions such as Basin Water Management Organizations (Oblvodhoz) and Irrigation System Management Organizations (Rayvodhoz) to deliver water to thousands of farmers in Kyrgyzstan and Tajikistan, and hundreds of water users in Uzbekistan. Lands of farmers varied from 5 to 50 hectares in Uzbekistan and 0.1 to 2 ha in Kyrgyzstan and Tajikistan. In Kyrgyzstan and Tajikistan, the number of WUA members varies from 3000 to 5000 users and in Uzbekistan from 100 to 120 users. All the above mentioned issues have created issues on equitable water distribution among farmers and led to conflicts on water use between tail and head-end farmers.

As a consequence, crop yields have decreased, and a threat of food security is looms large in the region. To avert the potential threat of food security in the region, the Swiss Agency for Development and Cooperation (SDC) initiated a Water Productivity Improvement at Plot Level (WPI-PL) project. The objectives of the project were to design and evaluate an institutional mechanism for generation, synthesis and dissemination of knowledge related to improvement of water productivity; identify a set of agronomic and irrigation practices (interventions) to improve water productivity; and demonstrate increase in water productivity as a result of the proposed interventions. The institutions consist of public and private organizations. Public organizations such as research institutes receive financial support from the state, whereas private organizations such as information centers and disseminators are self-supporting. The proposed innovation cycle integrated the public and the private organizations in order to deliver knowledge to farmers to improve water productivity. Main aim of the innovation cycle was to channel knowledge on irrigation and agronomic practices based on needs of farmers.

This project was implemented over a three-year period (2009, 2010 and 2011) in the Fergana valley of Kyrgyzstan, Tajikistan and Uzbekistan. This paper describes the institutional mechanism developed and applied through the innovation cycle, and its effect on improving crop water productivity at plot level.

Description of the innovation cycle

The proposed innovation cycle was 'farmer-centric', that is, the knowledge generated, translated, and disseminated was based upon the identified needs of the farmers in the project area. These needs were identified through direct contact with the farmers and through simple survey forms. The proposed technologies or interventions included both agronomic as well as irrigation water management practices at the field level.

The cycle begins by identifying farmer's problems, by project disseminators, at field level, and conveying this information to the research centers through information centers (Figure 1). The A to H steps involved in the Innovation Cycle are explained as follows:

Step A: Information on the knowledge the farmers are seeking arrives at the research center. The research center searches for solutions in their database. If a solution already exists, the solution (a research report or a published paper, etc) is passed on to Step D. If not, it is sent to step B for adaptive research.

Step B: Adaptive research trials are conducted to provide a solution to farmers' problem.

Step C: Adaptive research results are analyzed, synthesized, and sent to information center.

Step D: Information received from either Step A or Step C is simplified into farmers' language, and readied for dissemination. This information is disseminated through brochures, monthly bulletins, newspaper articles, etc.

Step E: Information center prepares training materials to train disseminators.

Step F: Information center conducts training to disseminators.

Step G: Disseminators conduct training to farmers, and distribute dissemination materials in target areas. At the same time, they also gather information on the new information needs of the farmers.

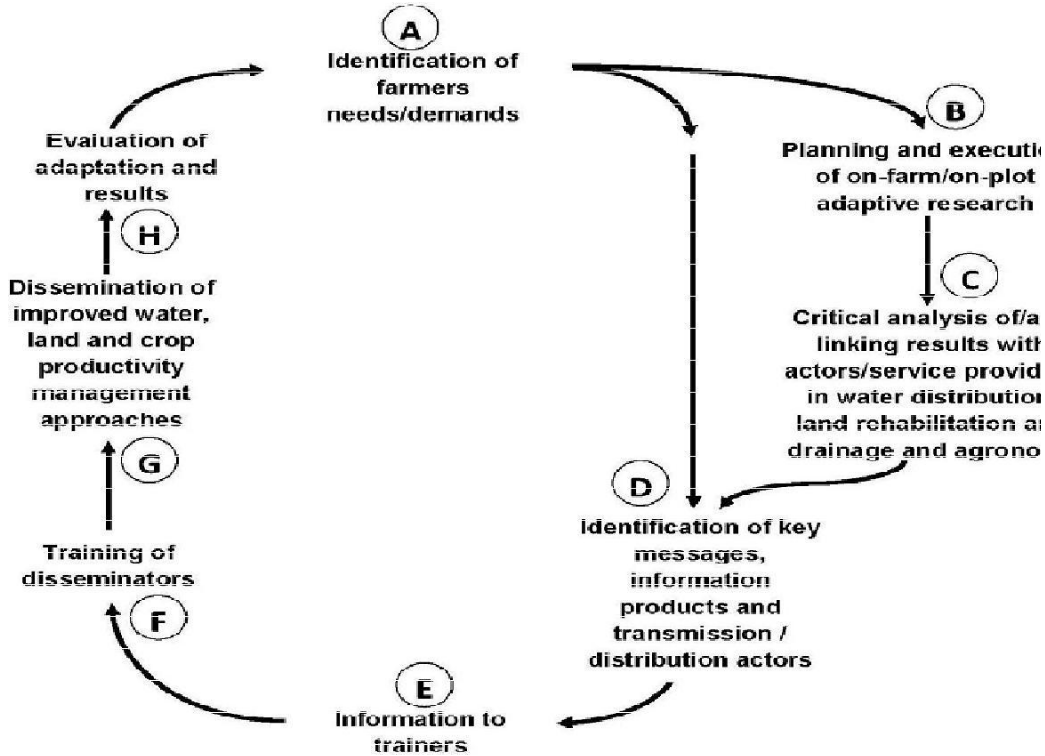

Figure 1. Innovation cycle.

Step H: Evaluate the effect of recommended interventions on crop yields and water savings, and document it for further analysis by researchers.

The above cyclical procedure continues, year-after-year. The same cycle is followed in all the three countries of the project. The institutional structure of the innovation cycle was the same for all the three countries, and is presented in Figure 2. The institutional members for each country are as follows:

1. Uzbekistan: It consisted of the Central Asian Scientific Research Institute for Irrigation (SANIIRI) as the research institute, the Naryn-Kara Darya Basin Irrigation System Authority (BISA) as the information center, and the Syr Darya-Sokh, the Naryn-Syr Darya and the Naryn-Kara Darya BISAs as disseminators. The project area in Uzbekistan covered three provinces of Andijan, Fergana and Namangan. Though there were three provinces to cover, only one BISA was selected to be the information center because farmers in all the three provinces speak the same language. In addition, the arrangement saved time and money in producing training and dissemination materials.

2. Tajikistan: The institutional structure here consisted of the Tajik Water Design Research Institute-Sogd Branch as the research institute, SOF as the information center, and ZarZamin and Irrigation Agrarian Consulting as disseminators of knowledge to farmers.

3. Kyrgyz Republic: The institutional arrangement consisted of the Kyrgyz Research Institute for Irrigation as a research institute, the Training Advisory and Innovation Center (ZOKI) as an information center, and the Osh Rural Advisory Service (Osh-RAS) and Osh WUA Support Unit as disseminators.

STUDY AREA AND METHODOLOGY

In order to assess the functioning of the innovation cycle and effectiveness of delivery of information, and finally its effect on improving water productivity at field level, 18 demonstration sites were selected in the Fergana valley of Central Asia. Fergana valley is located in the Southeastern part of Central Asia region and the Eastern part of Aral Sea basin, and its territory is shared by three countries - Kyrgyzstan, Tajikistan and Uzbekistan. Map of Fergana valley is given in Figure 3.

In Fergana valley, the annual precipitation varies from 109 to 502 mm, whereas the evaporation ranges from 1133 to 1294 mm throughout Fergana valley. Fergana valley is home for 11,342,000 people over an area of 124,200 km^2. In the framework of the project, recommendations and technologies proposed to farmers were tested in the demonstration sites. The agronomic and irrigation interventions proposed to the demonstration farmers, and the high level of implementation of these practices is shown in Table 1. For most of these interventions, brochures were prepared in the national languages of Kyrgyzstan, Tajikistan and Uzbekistan so that the farmers would follow it easily. In addition, trainings were conducted for farmers based on their needs. An impact assessment interview was conducted in the framework of the project in order to assess the performance of the partners involved in the innovation cycle (Figure 4). The interview mostly concentrated on how well the

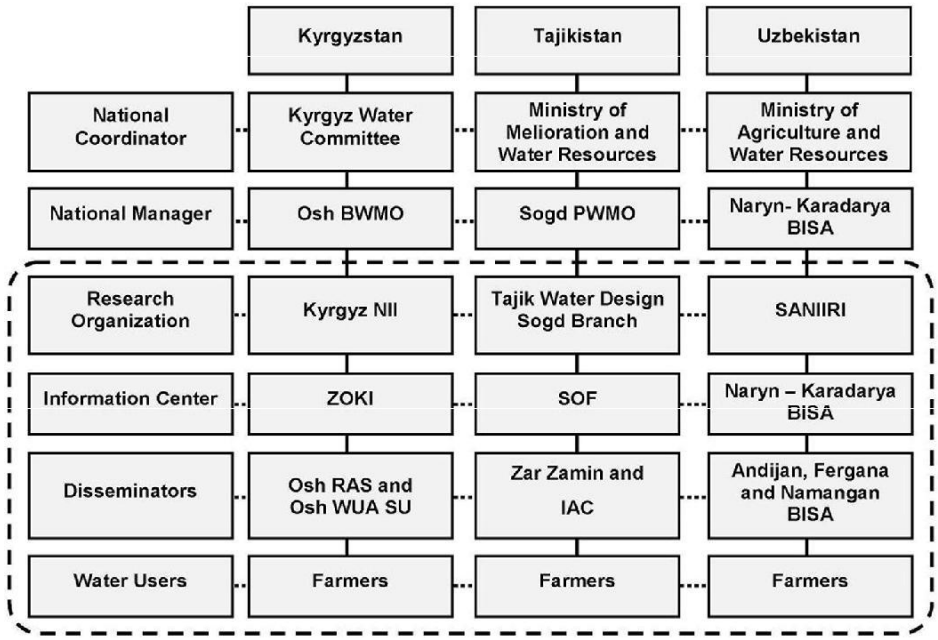

Figure 2. Institutional structure of innovation cycle.

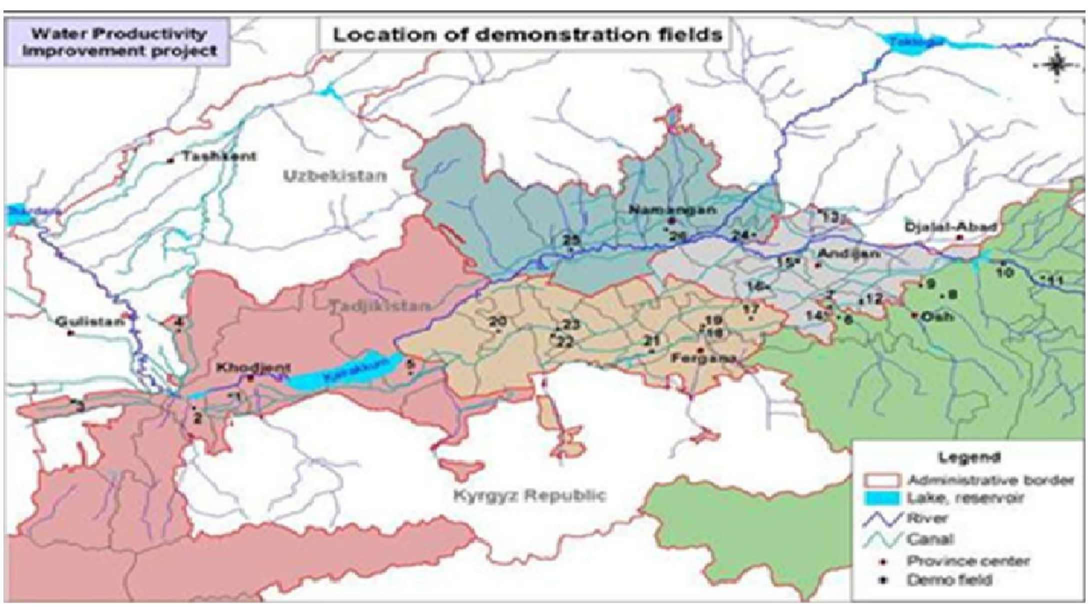

Figure 3. Location of demonstration sites.

institutions in innovation cycle performed in the three countries of Kyrgyzstan, Tajikistan and Uzbekistan. In addition, the interaction between researches institutes, information is shown in Figure 4. Components of impact assessment centers, and farmers were also assessed. Adoption of proposed technologies by farmers was also covered in the interview. Furthermore, the satisfaction of farmers with the knowledge and training provided by the institutions, and the overall contribution of the project in increasing farmers' incomes was assessed. Meetings were organized with research institutes, information centers, disseminators, and farmers both inside and outside of the project area. Semi-structured interviews were used to gather information. Interviews of this type are suited to working with small number of people and useful for studying specific situation (Institute National de Santé Publique, 2009). Before starting interviews with target groups, a topic guide was prepared tentatively for the discussion and short introduction was provided for respondents, and the objectives of interview were explained. Interview time was fixed for a maximum of one and half hours. The interview consisted of three main activities: interview among trained farmers, non-trained farmers, which are outside of project area and

Table 1. Recommendations and technologies

Site №	Leveling of irrigated land	Agro-ameliorative certification of farms	Selecting technological irrigation scheme	Application of mineral fertilizers (soil fertility improvement) forcottonandothercropsinconditionsofFerganaValley(toirrigatethroughpitsfilledwithorganicfertilizers)	Fertilizer irrigation through application of liquid mineral fertilizerswithirrigationwater(fertigation)	Crop pest control	Adoption of volumetric water delivery method	Irrigation scheduling	Mechanism of efficient irrigation water use in small farms (Sokolok)	Short furrows	Alternate furrow irrigation	Cutback furrow irrigation	Installation of plastic films at furrow heads	Use of plastic bottle heads and siphons	Re-use of runoff water from fields	Water rotation	Inter-row cultivation	Leaching of saline soils with different types of salinity
2009																		
1			1	1	1	1			1	1	1		1		1	1	1	
2			1	1	1	1					1		1			1	1	
3				1	1	1				1	1		1		1	1	1	
4			1	1	1	1					1		1			1	1	
5			1	1	1	1				1	1		1					
6	1			1		1				1	1		1		1		1	
7	1		1	1	1	1				1	1		1		1	1	1	
8			1	1		1									1			1
9	1	1		1	1	1		1		1	1		1		1	1	1	
10	1		1	1		1		1		1	1		1		1		1	
11				1		1				1	1		1		1	1	1	
12				1		1				1	1		1		1		1	
13				1	1	1				1	1		1		1			
14	1		1	1		1	1				1	1	1		1	1	1	
15	1		1	1		1	1				1	1	1		1	1	1	
16	1		1	1		1	1				1	1	1		1	1	1	
17	1		1	1		1	1				1	1	1		1	1	1	
18	1		1	1		1	1				1	1	1		1	1	1	
2010																		
1			1	1	1	1			1	1	1		1		1	1	1	
2			1	1	1	1				1	1		1			1		
3			1	1	1	1		1		1	1		1	1	1	1	1	
4			1	1	1	1					1		1			1	1	
5			1	1	1	1		1		1	1		1	1				
6	1			1		1				1	1		1		1		1	
7	1		1	1	1	1				1	1	1	1		1	1	1	
8	1		1	1	1	1				1			1		1			1
9	1	1		1	1	1		1		1	1		1		1	1	1	
10	1		1	1		1		1		1	1		1		1		1	
11	1	1		1	1	1					1		1		1		1	

Table 1. Contd**.**

12	1	1		1	1	1				1	1		1		1			
14	1		1	1		1	1				1	1	1		1	1	1	
15	1		1	1		1	1		1	1	1	1	1		1	1	1	
16	1		1	1		1	1		1	1	1	1	1		1	1	1	
17	1		1	1		1	1		1	1	1	1	1		1	1	1	
18	1		1	1		1	1		1	1	1	1	1		1	1	1	
2011																		
1			1	1	1	1			1	1	1		1		1	1	1	
2			1	1	1	1		1		1	1		1			1		
3			1	1	1	1		1		1	1		1	1	1	1	1	
5			1	1	1	1		1		1	1		1	1		1	1	
7	1		1	1	1	1				1	1	1	1		1	1	1	
8	1		1	1	1	1				1			1		1			1
9	1	1		1	1	1		1		1	1		1		1		1	
10	1		1	1		1		1		1	1		1		1		1	
11	1	1		1	1	1					1		1		1		1	
14	1		1	1		1	1	1	1	1	1	1	1		1	1	1	
15	1		1	1		1	1	1	1	1	1	1	1		1	1	1	
17	1		1	1		1	1	1	1	1	1	1	1		1	1	1	
18	1		1	1		1	1		1	1	1	1	1		1	1	1	

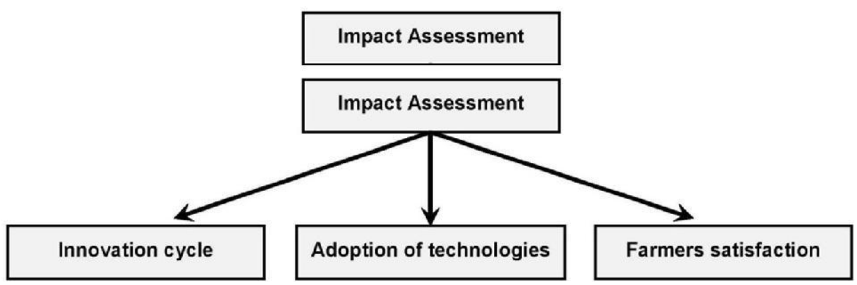

Figure 4. Components of impact assessment.

interviews with disseminators and discussion with representatives from the information centers and research institutes were also conducted. To conduct the interview between farmers and disseminators, a list of questions were prepared. Interview questionnaires comprised of the following main questions, and the main questions were usually followed by sub-questions:

1. Has the project established appropriate partnerships (innovation actors, research institutes, information centers and disseminators) that fit the agricultural innovation cycle?
2. Do all partners clearly understand their roles in the innovation cycle?
3. What is the number of technologies identified, disseminated and adopted by farmers in the project zone?
4. To what extent is the project contributing to reduce tensions, and facilitating current competing water use among farmers?
5. What is the satisfaction of farmers with the given knowledge and trainings?
6. To what extent improved technologies are disseminated among farmers and communities outside of the project area?
7. Are the farmers reporting economic benefits? Is there a noticeable saving in irrigation water use?

The topic guide and interviews had to assess the performance of institutions involved in the innovation cycle, the adoption of proposed technologies by farmers and the overall satisfaction of farmers. For the interviews, 6 trained farmers and 6 non-trained farmers from each country were selected randomly. In total, 36 farmers (18 trained and 18 non-trained) were involved. The monitoring covered 3 districts in Tajikistan, 6 districts in Uzbekistan and 2 districts in Kyrgyzstan. A total of 11 districts from the three countries were covered. Trained farmers for the interviews were chosen randomly from the lists provided by the disseminators. The non-trained farmers were chosen in the neighborhood of the trained farmers. The interviews were conducted during the spring (April, 2011) of the 3rd year of the project. Representatives of the disseminators accompanied the interviewers to identify the farmers. Interviews with disseminators, information centers and research institutes were conducted separately in the same form.

RESULTS AND DISCUSSION

During the interviews, all the 18 farmers that were trained

Table 2. How farmers know about water saving technologies.

Please indicate how do you know about efficient water use techniques?	Kyrgyzstan		Uzbekistan		Tajikistan	
	Trained	Non-trained	Trained	Non-trained	Trained	Non- trained
I saw installed water weirs	0	1	0	0	0	0
personal experience	2	5	0	1	0	1
From project trainers	4	1	6	1	6	1
From trained farmers	0	2	0	1	0	0
Other service providers	1	1	0	0	0	1

confirmed that their knowledge increased and they used the proposed recommendations and technologies. But while checking their detailed knowledge, it became clear that additional trainings were necessary. Trained farmers reported that appropriate partners were chosen for the innovation cycle in the three countries even though the partners were located far from each other they communicate and addressed the issues of farmers. Though the research institute in Kyrgyzstan (Kyrgyz SRII) is located in Bishkek, very far from the project area, it has good linkages with other institutes, which are in water and agricultural development sector. This research center provided recommendations and technologies that are related not only to water but also to agronomic issues. The information center in Kyrgyzstan is also located in Bishkek, allowing for good interaction between research institute and information center. The information center (ZOKI) has a branch office in the project area and has close contact with Osh Rural Advisory Services and Osh WUA Support Unit. In Kyrgyzstan the institutions involved in the innovation cycle clearly know their roles and responsibilities. Trained farmers reported that they know how much water to supply and pay for volume of water they use in their fields, whereas farmers that are outside of project area still follow hectare-based tariff. Partners in Kyrgyzstan reported that they disseminate knowledge and experience the project even though it is not in their mandate. Farmers that are outside of project area reported that they seek information from trained farmers.

In Uzbekistan, the research institute is located in Tashkent, quite far from the project area, but has a branch office in Fergana. This institute has highly qualified specialists in water and agronomy, and has good interaction with other project partners. The information center is located in the Basin Water Management Organization office in Andijan. This center worked closely with the Andijan Agricultural Institute to transform scientific materials to farmer-friendly language. The disseminator's role was played by three pilot WUAs in the three Provinces- Fergana, Andijan and Namangan- of the project. These disseminators worked through these pilot WUAs which had an irrigation engineer and an agronomist on their staff. Their roles were to disseminate the proposed recommendations and technologies to demonstration sites and to farmers within and outside of the WUA. All trained farmers in Uzbekistan confirmed that they are direct beneficiaries of the institutes involved in the innovation cycle. Farmers reported that after training they used less water and knew how to measure discharge with water flume meters. All trained farmers applied improved methods of irrigation such as short-furrow irrigation and measured the discharge of water received.

In Tajikistan, the research center, the information center, and the disseminators were located in Khujand city of Sogd province. Hence, there was plenty of interaction between the partners of the innovation cycle. Partners know their roles and responsibilities in innovation cycle. With respect to the research centers the farmers reported that:

1. It has very good archive of materials and good scientists, which provided recommendations for farmers based on local conditions.
2. Materials of research institutes were written in scientific language and it took too much time for information centers to simplify to farmer-friendly language;
3. Occasionally, advanced technologies were recommended, which did not consider farmers capacity and affordability.

Finally, the following observations were made regarding the disseminators:

1. Farmers had easy access to information and advice when the disseminators were located within the WUAs, as in Uzbekistan.
2. Provided irrigation advice to individual farmers which required a lot of time.

In Tajikistan and Kyrgyzstan, about 70% of all technologies proposed were linked to irrigation and 30% to agro-techniques. In Uzbekistan, 36% of the recommendations were related to irrigation and 64% to agricultural production issues. Tables 2 and 3 show the results of the survey on how farmers learnt about different types of water saving technologies. It is clear that the dissemination materials were reaching the far-mers within and outside the project area. Trained farmers reported yield increases: sixty six percent reported yield increases of 6 to 20%, twenty seven percent reported increases of 20 to 30%, and seven percent reported

Table 3. Technologies known to farmers.

Technologies	Kyrgyzstan		Uzbekistan		Tajikistan	
	Trained	Non- trained	Trained	Non- trained	Trained	Non-trained
Efficient furrow irrigation	8	7	7	5	10	3
Using of water weirs	5	3	3	0	6	0
Water harvesting	0	0	1	0	0	2
Drip and sprinkler irrigation	2	0	1	1	0	0
Other technologies	0	0	2	0	1	0

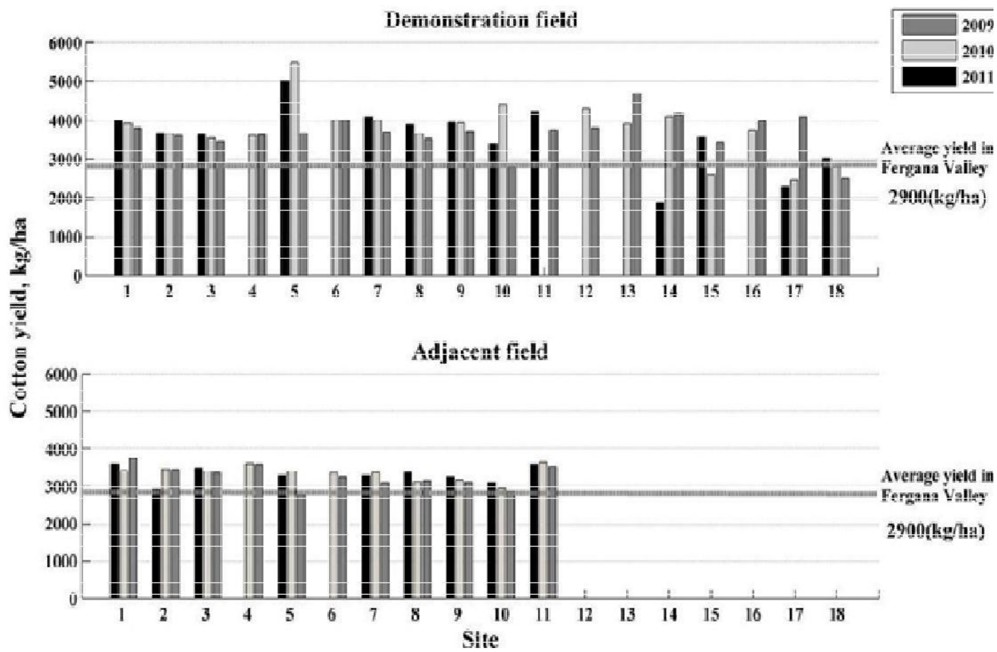

Figure 5. Cotton yields from demo fields and adjacent fields.

increases of more than 30%.

In addition to the interviews data on actual yields of cotton from the 18 demonstration sites (13 in Uzbekistan, and 5 in Tajikistan) were collected. During the 2010 and 2011 irrigation seasons, all the demonstration farmers did not grow cotton on their demonstration fields. Hence, the number of cotton fields was less than 18. Yields of cotton from the demonstration sites ranged from 2000 to 5500 kg/ha. This difference in yields was due to a combination of factors such as the quality and quantity of seed used, the availability and quality of inputs received or applied by farmers, crop variety, the irrigated cotton production knowledge-base of the farmers, etc. Two things are obvious from Figure 5. First, the average yield of cotton from the demonstration sites in Tajikistan was lower (less than 3000 kg/ha) than the average yield of cotton from demonstration sites in Uzbekistan (about 3500 kg/ha). This difference in yields may be partly explained by the availability of credit for purchasing agricultural inputs plus application of land use practices which are also supported and monitored by the provincial officials in Uzbekistan. In the case of Tajikistan, no such monitoring is done. Secondly, as mentioned elsewhere, 2009 and 2010 (more rainfall and more water was available for irrigation during the vegetation period) were considered as wet years whereas 2011 was a dry year (less rainfall and less amount of irrigation water was available during the vegetation period). Yet, on the average, there was no significant difference in the yield of cotton between the wet and dry years (Reddy et al., 2012).

Cotton yields from the adjacent fields are also shown in Figure 5. No data was available from the adjacent fields in Tajikistan. As expected, the average yields from the adjacent fields were lower (around 3300 kg/ha) than the average yields (3700 kg/ha) obtained from the demonstration sites in Uzbekistan. The demonstration field farmers implemented a variety of 'innovations' or improved agronomic and irrigation practices, as shown in Table 1, whereas the adjacent farmers were using one or more of the innovative practices implemented by the demonstration farmers. The average cotton yields in Fergana valley were about 2900 kg/ha, indicating that the average crop yields from the demonstration fields were 28% higher than the average crop yields in the area. It is evident that there is a substantial opportunity to increase crop yields in Fergana valley through a combination of agronomic and irrigation water management interventions (Table 1). Also, the yields of adjacent fields have already increased by 14% above the average for Fergana Valley suggesting that, with time, more farmers would adapt these interventions to raise the average yield of cotton in Fergana valley. The following observations about the innovation cycle were made by external reviewer (Christoplos, 2011).

1. The technologies being promoted have proven extremely relevant for the participating farmers and for more efficient water productivity in the Fergana valley more generally.
2. WPI-PL project has been very successful in developing and applying the innovation cycle among participating institutional partners and farmers.
3. The project has made good progress in a limited period of time in encouraging scaling up, but the current structure may not be appropriate for mobilizing broader technological adoption and adaptation.
4. Some success has been achieved in moving toward sustainability, but uncertainty regarding the WPI-PL project mandate in including WUAs in the innovation cycle and how to relate to government and other actors to explore avenues for collaboration, alternative financing and expanded diffusion are obstacles to moving further toward sustainability. The review mission suggested some avenues to explore to make the innovation cycle financially sustainable.

SUMMARY AND CONCLUSION

An innovative institutional mechanism, called a public-private partnership, was developed and strengthened for dissemination of information on improving water productivity at field level from research centers to farmers. This approach was 'farmer-centric' and promoted the interaction between researchers and farmers. This innovative institutional mechanism was called innovation cycle, and was implemented in the three countries of Fergana valley of Central Asia. The institutional structure was identical in each country, and consisted of research centers, information centers, and disseminators. In general, the research centers were public institutions, and the information centers and disseminators were private entities (NGOs) with several years of experience in advising farmers. The role of the research centers was to generate answers to farmers questions, whereas the role of information centers was to synthesize information from research centers into farmer-friendly language, and produce dissemination materials(brochures, bulletins, etc), and conduct training to information disseminators (training-of-trainers). Finally, the role of the disseminators was to provide training to farmers and disseminate materials produced by the information centers. Disseminators also worked with demonstration site (25 sites) farmers on implementing the improved agronomic and irrigation practices over a period of three years. On the average, crop (cotton) yields from the demonstration sites were 28% higher than the average yield of cotton in Fergana valley. In addition, the average application efficiency of the demonstration farms was at least 20% higher than the average application efficiency of fields in Fergana valley. The proposed innovation cycle was very effective in disseminating knowledge on improved agronomic and irrigation practices to farmers, and this innovation cycle must be further strengthened and streamlined for adoption by the respective governments.

Altogether, there were 15 different organizations in three countries, on the average 5 organizations in each country, worked as a team with excellent interaction, understanding and cooperation between the organizations. During the course of the WPI-PL project, all the organizations involved received financial support from the donor. However, since the donor support will cease sooner or later, strategies for making the innovation cycle self-sustaining financially should be investigated.

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