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World Bank-Assisted Community-Based Development Project for High-Value Crop Production: Failures and Successes

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Abstract

The government of Punjab has recently implemented a World-Bank-assisted community-based development project for the enhancement of farm productivity in water deficit areas of the Punjab province for 11 years. This paper describes a case study from the Faisalabad division, wherein drip irrigation in conjunction with tunnel technology has improved crop and water productivity of fruits, vegetables and cash crops, optimizing farm incomes. Not only crop yields were optimized, but also there were savings on water (30-45%) and other inputs, reduced incidence of pests and diseases (15-20%), early spring production by 35 days and higher quality of produce, which substantially increased farm incomes (19-41%) along with some environmental benefits. A conservative estimate showed a reduction in unemployment by 5% in project areas. Despite these impressive achievements, a post-project survey showed that 93% of beneficiary farmers abandoned drip irrigation systems, soon after project closure. It emphasized that in the Thal area, only a 4% system rolled back, suggesting the better suitability of the high-efficiency irrigation system for water conservation and productivity enhancement in sandy areas. Post-project farmer-participatory rural appraisal (PRA) shows that drip irrigation was rolled back due to multiple constraints. For example, unsuitable/inefficient design, clogging of drippers/drip lines, non-availability of spare parts, poor response of troubleshooters and top-down approach of the project, prompting better planning and implementation, in the future, for similar projects.

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Introduction

Water is becoming an alarming scarce source in Pakistan due to climate change and conflicts with India. Available water supplies in the Indus Basin Irrigation System (IBIS), at present, can meet requirements of less than 40% of the cultivable land [1]. The farmers in Pakistan traditionally irrigate crops by surface irrigation, called flood irrigation, which is a wasteful use of scarce water. Horticultural crops are, in general, heavy users of moisture and draw a large share of irrigation resources [2]; shortage of water has, therefore, reduced production of these crops. Farm incomes are consequently low. There is a clear need for the introduction of on-farm water-saving technologies and to economize fertilizer and other inputs to enhance crop productivity and income. Research studies in Pakistan and elsewhere show that drip irrigation technology increases water productivity by using every drop of applied water and saves other inputs [3-5]. It can conveniently improve farm productivity and profitability with intensive agriculture. The saved water can be used to expand agriculture to feed the burgeoned population. In this context, the Government of Punjab implemented a province-wide World Bank-assisted Punjab Irrigated Agriculture Productivity Improvement Project (PIPIP) (2011-12 to 2021-22), mainly aimed at addressing the water shortage and low farm-incomes problems for the farmers. Project interventions provided subsidized drip irrigation, solar energy, and tunnel farming systems, field demonstrations / adaptive research trails and farmers' training programs [6].

This paper presents a case study on this project from the Faisalabad Division (four districts, Faisalabad, Jhang, and Chiniot and Toba Tek Singh), a canal colony and populous area located at the edge of Central Punjab. These districts suffer from the shortage of canal water and brackish underground water. The goal was to study the extent of sustainable adoption of intervention technologies by the project farmers, the constraints they faced and the lessons learned by all stakeholders.

Methodology and Data Collection

The present case study was conducted in four districts, Faisalabad, Jhang, Chiniot and Toba Tek Singh, where a community-based, World Bank-assisted mega development project (PIPIP) was implemented (2011-21) in areas suffering from a shortage of canal water and brackish underground water. A semi-structured, open-ended survey was conducted through questionnaires and interviews with farmers, similar to the one used by Kulecho and Weatherhead [7]. The list of project farmers was obtained from the office of the Director, On-Farm Water Management, Faisalabad for the Faisalabad, Jhang, Chiniot and Toba Tek Singh districts. From each district, 40 respondents having drip irrigation coupled with solar systems were randomly selected for the study, so in total 160 respondents were selected. To conduct the comparative study, 40 beneficiary farmers were selected from the Thal area of Tehsil 18 Hazari, Punjab province. The farmers' response was quantified by assigning a percentage score based on the total. This approach is similar to that used by Kulecho and Weatherhead [7]. All data were statistically analyzed using SPSS (v. 25.0, Statistical Package for the Social Sciences) [8] for one-way ANOVA and multiple mean comparisons using the least significant difference (LSD) test (α = 0.05).

Results and Discussion

A “Farmer-participatory Rural Appraisal (PRA) was conducted before launching the project to later assess the project's impacts. PRA suggested that although farmers in Division Faisalabad are skilled and experienced in conventional agriculture, they are generally resource-poor and lack adequate information and access to modern agro-technologies. Hence, their farm profitability is very low. The dominant cropping pattern in the division was cotton-wheat and vegetables and fruit plants were also grown with injudicious use of inputs. Overall, farmers were not satisfied with the current low level of farm profitability. The main objective of the Punjab Irrigated Agriculture Productivity Improvement Project was to improve agriculture and water productivity to maximize farm incomes. The project is closed now and warrants evaluation to what extent the project objectives are realized.

Table 1 shows the total area covered under the high-efficiency irrigation and solar systems and the cost of their installation in Faisalabad, Toba Tek Singh. Chiniot and Jhang Districts. The drip irrigation systems were installed on 9755 acres of row crops, fruit and vegetables with a total cost of 6.48 million US$ with the farmer's contribution of 2.59 million US$. The solar system was coupled with a 3795-acre drip irrigation system at the cost of 227 million US$ with the farmer’s contribution of 0.96 million US$ [9]. A higher number of drip irrigation systems were installed in district Toba Tek Singh (402) followed by district Faisalabad (305), district Jhang (289) and

Table 1 Installation of high-efficiency irrigation (HEIS) and solar systems under the Punjab Irrigated Agriculture Productivity Improvement Project in the four districts of Faisalabad Division (2011-2021).

Districts	High-efficiency irrigation system					Solar system				
	Installed (area)		Cost (Million US$)			Installed (area)		Cost (Million US$)		
	Number of sites	Acres	WB	FS	Total	Number of sites	Acres	ADP	FS	Total
Faisalabad	305	2481	1.18	0.76	1.94	84	854	0.30	0.15	0.44
Jhang	289	3136	1.01	0.78	1.78	150	1629	0.62	0.57	1.18
Chiniot	102	1110	0.43	0.33	0.75	34	403	0.15	0.07	0.22
Toba Tek Singh	402	3029	1.28	0.74	2.02	91	910	0.27	0.18	0.44
Total	1098	9756	3.89	2.59	6.48	369	3796	1.33	0.96	2.27

WB = World Bank; FS = Farmer share; ADP = Asian Development Bank

Table 2 District-wise detail of beneficiary farmers that abundant high-efficiency irrigation system after the closure of the Punjab Irrigated Agriculture Productivity Improvement Project.

Project area	Sample size	System rolled back/nonfunctional			
		High-efficiency irrigation system		Solar system	
		Number of sites	Percentage	Number of sites	Percentage
Toba Tek Singh	40	35	88	5	12
Faisalabad	40	38	95	7	17
Jhang	40	37	93	4	10
Chiniot	40	39	97	7	17
Total	160	149	93	23	14
Thal Area 18	40	3	7	4	10

district Chiniot (102). The higher number of drip irrigation systems installed in districts Toba Tek Singh and Faisalabad might be due to the brackish underground water and scarcity of canal water that is unable to meet the crop water requirements and irrigate the available culture-able wasteland of these two districts. The shortage of irrigation water and salinity has seriously restricted the growth, development and optimization of agricultural potential in the Faisalabad division [10]. Achievements of the project were impressive in the Faisalabad division because of savings in main inputs (water 30-45%, fertilizers 22-30%, pesticides 15-20%) and improved quality of fruits, vegetables and cash crops [11]. The income of farmers increased from 19% to 41%, which is a considerable improvement in socioeconomic conditions in rural areas of these districts. Maximum economic return to the farmers came through vegetable farming, with drip irrigation in tunnels [12, 13]. Despite the benefits of drip irrigation, a vast majority of beneficiary farmers abandoned this technology. Its rollback soon after project closure is quite sad and alarming.

Table 2 shows the percentage of adopters from sampled respondents who rolled back their drip irrigation system. Almost 93% drip irrigation system was rolled back in the Faisalabad Division compared to a 7% rollback in the Thal area within 6 months of the closure of the project. The solar system is still in use, either for pumping groundwater or electrification of homes. The higher percentage of sustainability in the Thal area suggests that the site-specific need for technology has prime importance for the sustainability of drip irrigation programs or it was merely a proper selection of sites and motivated farmers. Results presented in Table 3 show that all respondents experienced technical difficulties with their systems that forced them to roll back. As per the perception of the farmers, high initial investment and high cost of spare parts ranked as the most important constraint in the sustainability of drip irrigation systems with the farmer's score of 84%. The results showed that 74% (a high majority) of farmers had adopted the technology only for solar systems. Other factors for roll-back of drip irrigation systems include more maintenance problems (78%) with drip irrigation than surface irrigation, non-availability of spare parts at the proper time at reasonable rates (97%) and clogging of drippers and high cost of replacement of lateral (86%). Other important reasons for the abandonment of drip irrigation after the adoption include non-availability of in-time technical guidance (29%), poor quality recycled high-efficiency irrigation systems (HEIS) equipment (28%), intercultural problems or difficulty with other farming operations (24%), insufficient water for adequate crop growth by drip irrigation (21%) and poor after-sale services (98%). The present findings

Table 3 Details of obstacles forced the farmers to abandon the drip irrigation system after adoption under the Punjab Irrigated Agriculture Productivity Improvement Project.

Obstacles for rolling back drip irrigation system	Respondents	
	Number of farmers	Percentage
1. System installed only for the purpose of solar system.	119c	74%
2. High initial cost due to over design/high cost of spare parts.	135b	84%
3. High maintenance cost.	125c	78%
4. Non-availability of spare parts at proper time.	156a	97%
5. Unsatisfactory after sales service.	158a	98%
6. Dripper/lateral clogging and high cost for lateral replacement.	137b	86%
7. Non-availability of technical guidance in time.	48e	29%
8. Poor quality recycled high-efficiency irrigation system equipment.	65d	28%
9. Difficulty in inter-culturing and farming operations.	39f	24%
10. Improper design fails to meet the crop water requirement.	35f	21%
11. High cost of liquid fertilizers.	21g	13%
12. Failure of high-density orchards.	20g	12%
13. No need of high-cost drip set as sufficient water is available.	19g	12%
LSD	5.07	-

are in agreement with other reports [14, 15]. In short, the clogging of drippers due to salt deposition and other impurities, the essentiality of technical knowledge and the complexity of the system were the main technical constraints [16, 17]. It was realized that the acid treatment does not help to completely mitigate the salt deposition problem. The benefits of technology are derived only when it is efficiently used by the farmers in their local situation. However, many of them could not do so after the closure of the project because of multiple constraints coming up in the way.

A perusal of project PC-1 [6] revealed that HEIS will be introduced in the project area for the promotion of high-value crops based on site-specific requirements after conducting soil and water analyses. Instead of studying soil and water conditions at each HEIS site and formulating site-specific irrigation and fertigation schedules at every new HEIS site, Service and supply companies (SSC) staff just picked a random sheet from the archive and put the name of the farmer they came across and handed over to him the fake recommendations which at best may not be even called good guesswork. These malpractices resulted in inaccurate fertilizer and irrigation schedules, unlikely to be compatible with individual HEIS sites. Most drip irrigation systems were thus, wrongly designed, not meeting crop water requirements, resulting in over or under-irrigating crops, leading to failure of crops in many cases and wastage of precious resources. No wonder, it caused a lot of problems for farmers and ultimately resulted in rollbacks at the HEIS sites. SSC is charging money for its agreed services, but in reality, they are cheating the farmers [18]. To earn quick profit from the subsidy programs, some SSCs used local equipment, especially pumps/motors and claimed as imported [19]. Often the sub-standard components affected the working conditions of the system creating enormous doubts in the farmers' minds about the functioning of the system; ultimately, they rolled back. Similarly, 86% of respondents complained about the high cost of replacement of laterals, a major cause of the rollback of the systems. Drip lines/lateral are used to deliver water from the drip system to the plants. The lateral tube has a long life and may last for 2-5 crop seasons but is very costly (0.23US$/m). In contrast, drip tape is much cheaper (0.03US$/m) and can conveniently be used in place of an integrated drip line for conveying water to the plants. It has been observed that drip line/lateral starts clogging/ damaging within a year and drip tape which is biodegradable and environmentally friendly can work up to 2 years and even for the third year through minor repairs [20]. Furthermore, drip tape is easy to install, can help reduce initial investment and is affordable for small farmers. Permission to use drip tape was not granted as drip lateral provides the highest margin.

A big majority of respondents (84%) reported initial high cost due to over-designing of the drip irrigation system. It has been observed that in government-sponsored subsidized schemes in Pakistan, mostly SSCs over-designed the HEIS system for their business interest based on available inventory in their stock. They install the drip system by adding heavy unnecessary filters, fertigation tanks, water meters, sensors, and automizers, etc., which make the system costly [21]. Unfortunately, the high initial cost of the drip system is not within the easy

Table 4 Farmers' suggestions for the future sustainability of high-efficiency irrigation systems.

Suggestions for sustainability of drip irrigation	Respondents	
	Number of farmers	Percentage
1. Drip system should be indigenized and manufactured locally and farmers should be allowed to purchase it directly from the open market.	150	93
2. Spare parts of the drip system should be available locally at a reasonable rate.	145	91
3. Drip system should be made cheaper and simplified for easier use.	140	87
4. Operation and maintenance skill development to use the system efficiently.	125	78
5. Control over service and supply companies should be shifted to the division level.	124	77
6. Five-year warranty instead of two years against high-efficiency irrigation system sets should be provided by service and supply companies.	120	75
7. Free after-sale service and early troubleshooting.	80	50
8. Drip tape should be allowed.	69	43
9. Drip system should be designed for farmers with 1-3 acres on gravity flow.	25	15

reach of small and marginal farmers. A small number of respondents (12%) were averse to drip irrigation due to its high initial cost and because they had easy access to sweet water zone and considered the traditional method of furrow irrigation quite suitable for them. Another small group of respondents (13%) reported that since only liquid fertilizers can be used with drip irrigation, they are costly for them. Some farmers reported failures with installed drip irrigation for high-density orchards and had to uproot the plants and roll back the irrigation system. These results are quite in line with the findings of earlier reports [22-24]. We also found some specific difficulties to be rectified to predict a successful future for drip irrigation. If a drip system is made available at a low cost, the area under drip irrigation can be promoted at a faster rate than now. A low-cost/economical drip irrigation system is possible by eliminating unwanted parts, purchasing the parts from local vendors and installing them locally with a total cost of 218-655 US$. It emphasized that a drip irrigation system for 1-3 acres can be designed on gravity flow by constructing a water tank at a reasonable height on the farm.

To overcome the obstacles in the long-term sustainability of drip irrigation systems, suggestions from the respondents are presented in Table 4, which shows a thumping majority of the drip adopters (93 %) opined that the drip irrigation system should be indigenized, manufactured locally and a subsidy scheme must allow the farmers to purchase HEIS system directly from the open market. Again, a thumping majority of the drip adopters (91%) stressed that the spare parts of the system should be available locally and timely, rather than made available at farmers' door steps at reasonable rates. Our results are quite in line with Rouzaneh et al. [25]. A large number of respondents (78%) asserted regular guidance on the maintenance of the system and 77% suggested that control over services and supply companies should be shifted to the division level for the provision of efficient service and early troubleshooting, rather than keeping under provincial control. A large number of respondents (75%) also wished at least a five-year warranty on DIS sets provided to them. Similar suggestions were also reported by others [26, 27]. Among all high-efficiency irrigation systems, drip irrigation (also called trickle/micro irrigation) is the most efficient technology that ensures highly effective use of water, fertilizers, and nutrients. However, under this project, most of the other districts in Punjab provided highly subsidized, fixed-impact sprinklers to farmers, along with solar panels. Since farmers are interested only in solar panels instead of complete HEIS as a whole, a higher rate of subsidy with sprinkler-based HEIS has lured them to opt for this system; they don't want to install drip irrigation-based HEIS anymore. However, since farmers' interest is only in solar panels, which they use to electrify their houses, they abandon the sprinklers too.

Conclusions and recommendations

The approach of this study and its findings enlighten us on what could be done to maximize the benefits of the heavy investment of government for realizing the role of high-efficiency irrigation systems in the enhancement of water use efficiency and crop yields. Among high-efficiency irrigation systems, a drip irrigation system offers significant benefits, including water saving, reduced soil erosion and targeted watering at the root zone. The drip irrigation system can help use scarce water more efficiently. Drip irrigation is more suitable for horticultural crops like strawberries, grapes, peaches, etc. than for agronomic crops. As cropping pattern decides the adoption and suitability of drip irrigation, widespread adoption of drip irrigation could be promoted in the regions where there is a shift towards horticultural crops. Other potential areas of drip irrigation systems are water-scarce areas like the Thal desert, where high-value crops may be grown. For increased adoption on a sustainable basis, there is a clear need to reduce the cost of drip irrigation systems by eliminating unnecessary system components so that small farmers can benefit from this technology. It is to be emphasized that this project was implemented with a big expenditure. The government obtained a loan of 157.21 million [6] from the World Bank. It is a pity for a developing country that the results of the project were so hopeless only because of poor planning and faulty decisions. There is a clear need to learn the lessons for relevant departments in developing countries. The following recommendations are made for the adoption of a drip irrigation system on a sustainable basis: (1) proper selection of areas has a potential for drip irrigation; (2) reduce cost by redesigning and eliminating the heavy filtration system (*i.e.*, hydrocyclon, sand media, disc filters), pressure gauges, water meters, and introducing drip tapes instead of costly laterals; (3) purchasing the drip system from local vendors/markets may also reduce the cost of the system, especially with indigenous production; (4) most activities and resources should be managed and coordinated at the district level instead of the head office level; (5) sales services company must provide a five-year guarantee against drip irrigation systems; (6) capacity building of farmers regarding drip irrigation systems must be continued by investing in their education, focused on installations, operation, maintenance and repairs for the success and sustainability of high-efficiency irrigation systems; and (7) irrigation advisory services can play an important role in assisting users in the sustained adoption of drip irrigation systems and water-efficient technologies. There is not only a clear need for rectification of the above constraints, but the project technologies need to be introduced on a landscape level, effecting a social change at the country level.

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Conflict of interest

The authors claim no conflicts of interest.

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