The Pakistan Development Review
39 : 2 (Summer 2000) pp. 131–152

Impacts of Irrigation and Drainage Development Projects in Pakistan: Farmers' Perceptions

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Using well-designed sample, anecdotal evidence from farmers of a recently completed irrigation and drainage project in Bhawalnagar Pakistan, valuable impact indicators could be assessed. The case study suggests that although this simple and quick method is not a substitute for the detailed scientific survey, yet it can be handy, sufficient, and could be usefully used at a nominal cost as a supplementary method. The parameters approached were the depth to water-table, crop yields, cropping pattern, abandoned lands, water distribution, and seepage reduction, etc. The results showed that some of these, including the depth to water-table, seepage reduction, and cropping pattern compared well with previous technical studies, while some others did not. The physical interventions of the project under quick evaluation comprised concrete lining of about 170 kms of the distributary canals and 352 kms of surface drains. The paper concludes that the farmers' perceptions, when carefully designed and analysed, offer substantial feedback for remedial actions and for planning future projects.

The paper describes the post-project results of farmers' perceptions on the impact of irrigation and drainage development projects. The survey was carried out during February 2000 in the Fordwah Eastern Sadiqia (South) (FESS) Irrigation and Drainage Project that commands 259,350 acres. It covered the three main components of the project; canal lining, surface drains, and farmers' organisations (FOs). To document the impact of canal lining and surface drains, a sample of 69 farmers located close to the lined distributaries and surface drains of the project area was taken. To document the impacts of FOs, the IWMI's country reports on the processes of FO's pilot tests were used. The paper first describes the objectives laid by the feasibility of canal lining, surface drains, and FOs. It then gives results of

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Author's Note: The author owes thanks to the project staff of PIDA and MMI, especially to Muhammad Abdul Majeed Bhatti, Executive Engineer, FESS Irrigation and Drainage Project, for providing logistics support during the field survey; to Nasar Iqbal Dodhy and Usman Qamar, Consultant and Senior Irrigation Specialist of World Bank respectively, for their thorough review and useful comments on the paper; to Dr M. Aslam and Sofya Saeed, Senior Irrigation Engineer and Editor, IWMI, respectively, for their comments; and to Ramya de Silva, Documentalist, IWMI, for providing access to literature.

how farmers perceive the impact of project interventions on the depth to water-table (DWT), crop yield, cropping pattern, migration, abandoned lands, water distribution, and seepage reduction, both positive and negative.

One revealing feature of the study is that farmers' perceptions, when compared with the technical data from previous technical studies of some selected parameters such as the DWT, were found to be reliable. The results of farmers' perceptions on the impacts of I&D development projects are therefore limited, but these offer an opportunity to assess the benefits of development projects from the farmers' point of view. The paper discusses farmers' views.

It is argued that using a well-designed sample profile, farmers' perception surveys are a quick, efficient, and cost-effective method to know the performance and assess the impact of and provide supplementary information for planning new projects. But farmers' perceptions may not be exclusively sufficient for refining the technical aspects of new projects. Finally, the paper provides suggestions on how the long-term sustainability of the development projects and FOs can be achieved.

There are some controversies on the technical and economic feasibility of these interventions in this project. These are not to be reflected in the farmers' perceptions, but may yet remain a subject of debate in Pakistan in the coming years.

1. INTRODUCTION

Impact assessment of irrigation and drainage (I&D) development projects such as canal lining, surface drains, and farmers' organisations (FOs) is a subject of much interest to donors, design consultants, planners, policy-makers, academic researchers, practitioners and communities so that they can see the results of their investment [Abernethy (1993)]. In the FESS project, the lining of canals, the construction of surface drains, and FOs were the three main components and were completed in June 1999, March 2000, and April 1997, respectively. This paper documents the farmers' perceptions of the impacts of these three components. The results of impact assessment studies are critical to the future investment on I&D development projects. Before describing the farmers' perceptions on the impacts, briefly, the question of feasibility of the canal lining, surface drains, and FO needs to be addressed.

There is a vast body of literature on the benefits and non-feasibility of canal lining [Murrey-Rust and Velde (1993); Swamee *et al.* (2000); Junejo (1993); Zaidi (1993); Habib and Garaces-Restrepo (1993); Shahid *et al.* (1993); Mashhadi (1993); Chancellor (1993); Ahmad *et al.* (1993)]. Lining of main canals and distributaries gives a rate of return of about 30 percent [Chancellor (1993)]. The feasibility of canal lining in Pakistan, however, is still a question. The most recent scholarship on the cost-effectiveness of canal lining in Pakistan, released by the EGC [Engineers General Consultants (2000)], however, does not favour canal lining. The EGC's study recommends that canal lining is more economical in the saline groundwater areas where seepage is permanently lost or where the seepage is 12 to 13 cusecs/million square feet.

Surface drains have also been considered as an effective way of lowering the water-table in the severely waterlogged areas. Surface drains in Pakistan are technically more feasible because their construction and maintenance is designed with locally available equipment. Another advantage is that surface drains can carry adequate flow in the case of storm run-off. The drainage investment is highly viable, giving a rate of return of about 20 percent [Faruqee (1997)].

The rising confidence in the capacity of farmers to take over management [Vermillion (1995)] is one of the main reasons of forming FOs for irrigation management. There is enough evidence to show that the performance of the government-managed system is not as good as that of the farmer-managed [Merrey (1995)]. In its seminal 1994 report 'Pakistan Irrigation and Drainage: Issues and Options', the World Bank recommends the transfer of greater control of the irrigation system to farmers' organisations (FOs) to overcome the government financial constraints and to provide an alternative O&M financial strategy. The international experiences show that farmer-managed systems are better managed systems than government-managed systems [Sagardoy (1995)]. Economic feasibility shows that there is great benefit to the community in investing in farmers' organisations, FOs [Tapa and Banskota (1993)].

This survey of farmers' perceptions was designed keeping in view the goals and objectives related to three main components of the project as mentioned in the preceding paragraph. At its inception, the project objectives [World Bank (1992); PC-1, WAPDA (1992)] were to: (1) raise agricultural production, employment and income; (2) reduce the need for expensive subsurface drainage and environmentally harmful effects of such drainage; (3) improve the equity of water distribution; (4) develop models for integrated agricultural management involving a "demand-based" system and enhanced farmer participation; and (5) improve the capabilities of the implementing agencies for preparing, implementing, operating, and maintaining irrigated agricultural projects. Objective (4), which is research-oriented, was modified during implementation into a pilot project for establishing distributary-level FOs. These objectives are needed to be translated into certain impacts, which can provide the basis to assess farmers' perceptions. The World Bank [Staff Appraisal Report (1992)] notes that the first three objectives will be achieved through: (1) increased water supply; (2) slowing down the deterioration of land due to waterlogging and salinity through reduction of seepage losses; and (3) improving agricultural inputs and services. In other words, these were the perceived improvements and impacts at the start of the project. The perception survey was design with the hypothesis that farmers perceive the same impacts as were perceived by project implementers. The second hypothesis was that when perceptions were integrated with the technical data of selected parameters of DWT and seepage reduction, those proved equally reliable.

Sections from 4.1 to 4.8 cover farmers' detailed views on the impacts of lining of canals and surface drains. The author personally conducted the perception survey on canal lining and surface drains in February, 2000. A larger and detailed country research report with in-depth farmers' views and anecdotal evidence will also be prepared [Waheed-uz-Zaman (forthcoming)].

Section 5 presents the impacts of FOs based on the review of IWMI's process documentation research related to pilot project area. Sections 6 and 7 discuss the policy implications, recommendations and conclusions.

2. DESCRIPTION OF THE FESS IRRIGATION AND DRAINAGE PROJECT

FESS was one of the areas worst affected by waterlogging and salinity (Figure 1). The project area is the part of Eastern Sadiqia Canal System, which offtakes from the Sulemanke Headworks across the Sutlej River. It serves a gross command area (GCA) of 300,000 acres and a culturable command area of 259,350 acres in Bhawalnagar district of Pakistan. Pre-project analysis of groundwater data of four years (1994–98) of the FESS project shows a rising trend in WT. In 1987, the area under waterlogging was 57 percent, whereas in 1998, it was 66 percent. This implies one percent arial encroachment of the root zone due to waterlogging, destroying 2600 acres per year in the project area. Estimates have been made variously showing that about 98,800 acres are abandoned annually due to brackish water in the Indus Basin and about an equal land area is extended during the same period, thus keeping the balance [Prathapar and Qureshi (1999)].

The annual rainfall in the area is 224 mm, with more than sixty percent of the amount occurring in the months of July through September [Ejaz and Ahmad (1999)]. World Bank Staff Appraisal Report (1992) notes that 85 percent of the farmers of FESS had landholdings less than 25 acres, i.e., 54 percent small farmers had less than 12.5 acres, and 31 percent medium farmers had less than 25 acres.

To address the environmental and socio-economic issues of the FESS linked to degradation of land, the Government of Pakistan initiated in 1993 the FESS Irrigation and Drainage project with the financial assistance of the World Bank, co-financed by the Punjab Irrigation and Drainage Authority (PIDA). The total cost of the project was Rs 3488.161 million ($ 73 million). The project envisioned sustained reclamation of 300,000 acres of land by lowering the water-table through the lining of 173 kms of distributaries, by controlling seepage, construction of 331 kms of surface drains to drain away storm run-off efficiently [Bhatti and Chaudry (2000)], and creation of sustainable FOs to participate in O & M.

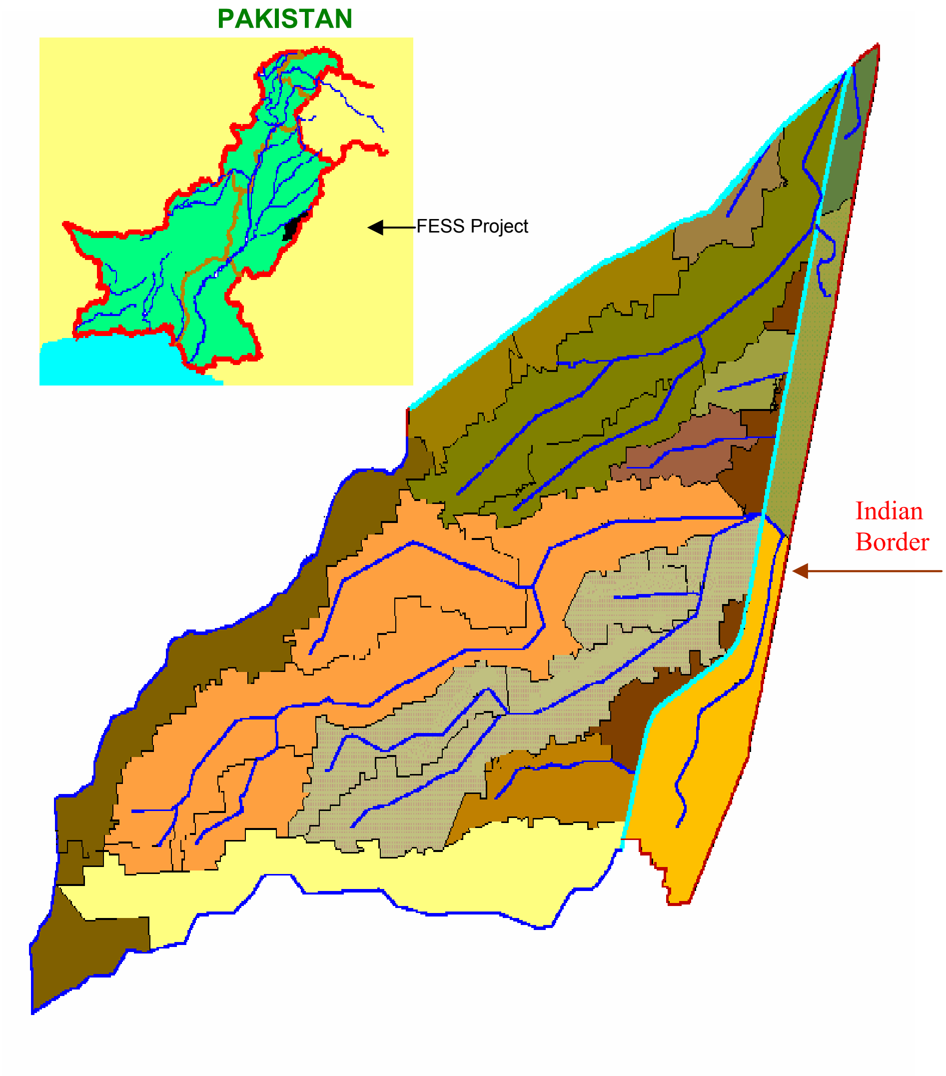

Fig. 1. Location Map of Fordwah Eastern Sadiqia South (FESS) Irrigation and Drainage Project in Southern Punjab.

3. RESEARCH APPROACH AND OBJECTIVES

A sample of 69 farmers along more than 300 kms of 11 lined distributaries of the FESS was selected for the farmers' perception survey. The distributaries fall in the network of surface drains. The selection of the sample was done purposely considering the proximity of farmer's fields to lined canals and surface drains. These fields are located from 200 to 1600 feet away from the lined canal and the drains. The proximity was an important consideration in the sample because one of the main focuses of the study was to see the impact along the corridors made by the lined canals and drains. The survey was undertaken in the month of February, 2000. The sample was selected from all three categories of landholding. The major constraint in the field surveys was the limited time and manpower resources used; one person carried out fieldwork for four days. The author travelled along the distributary and selected the farmers that were in easy access and closer to the canals and drains. A checklist of the main areas of investigation was prepared for interviewing the sample farmers. The farmers' perceptions were compared with the technical data collected by different national and international organisations working in the project area. The investigation compares the situation two years before the completion of the project and the impacts immediately after its completion (in February, 2000).

The principal objectives of the survey were to:

- gauge how farmers perceive the extent to which the project has succeeded in lowering the DWT, and to identify the farmer indicators to measure the DWT fluctuation;
- record the farmers' perceptions on the impacts of the FESS interventions on crop yields, cropping patterns, migration, abandoned lands, water distribution, reduction in seepage losses, and other uses of water;
- compare farmers' perceptions with technical data to see the level of accuracy of farmer perception; and
- document the impacts of farmer organisations.

For a comparison of farmers' perceptions with the DWT, the data of SCARP Monitoring Organisation (SMO) for 125 nodal points have been used. Evaluations from previous technical studies are compared to exhibit how reliable the farmers' perceptions are.

4. IMPACTS OF CANAL LINING AND SURFACE DRAINS

4.1. Depth to Water-table (DWT)

Farmers perceive that the project has successfully achieved the objective of lowering the water-table. When asked, whether the DWT changed after 2 years of project interventions, ninety percent of the respondents stated that over the period of two years, the WT had markedly (2 to 3.5 feet net drop) gone down. The reported range of net WT drop, however, varies from 1 to 25 feet between different locations of the FESS. Pre-project technical estimates also show that proposed canal lining should lower the WT to a depth of 6-feet/per year over the entire region [Aslam (1999)]. The impact on WT drop has been confirmed by the technical data collected in the project area by SCARP Monitoring Organisation (SMO) of WAPDA. The SMO's data show, on average, a drop of 3.25 feet in DWT in two years (from 1998 to 2000). The farmers discerned three main causes of the drop in DWT: (1) the lining of canals, (2) construction of surface drains, and (3) limited rain for the last two years. Other reported reasons were: (1) pumpage through private tubewells, (2) re-sizing of outlets resulting in reduced discharge and lowered WT in the watercourse command areas, and (3) the frequency of irrigation (only at micro level).

The impact of lowered WT on soil conditions can be gauged from the statement by a farmer of the Sirajwah Distributary, Haji Ilim Din, whose fields are close to the Haroonabad Drain: "For the last many years I have been constructing the pit for sugar-cane furnace above the soil surface due to higher water-table. After the construction of the drain, I have constructed it below the natural surface level".

The farmers gave many useful indicators by which they measure the extent (increase or decrease) of the WT drop: (1) frequency of irrigation, (2) bore depth of tubewells and hand-pumps, (3) variation in the discharge of tubewells, (4) water levels in the open-wells, (5) depletion rate in the drinking- and live-stock ponds, (6) ability of crops to withstand wind and rains, and ease in cultivation, and (7) condition of trees, i.e., when trees started re-sprouting due to the lowered WT.

Another important finding of the study is that the lining does not have a significant impact on the drop in DWT along those distributaries that are smaller and that run parallel to or adjacent to the main channels. This is the case of Bhukhu Shah and Bhukan distributaries, where main Hakra Branch and Malik Branch canals, respectively, are still recharging the belts adjoining these two lined distributaries. The recharge from the main channels outweighs the reduction in seepage from the lined distributaries, due to the proximity factor. Only 10 percent respondents perceived "No change" in the WT after lining. This minority of respondents belongs to these two smaller distributaries.

4.2. Crop Yield

The project envisioned an increase in agriculture production, employment, and income [World Bank (1992)]. Many studies show that poverty is influenced by agricultural performance and that agriculture is the most important factor of poverty alleviation. [Pradhan and Saluja (1998)]. The impacts of the project were gauged from the increased yield brought about by improved soil and water conditions. Research reported by [Skogerboe *et al.* (1999)] in the FESS area shows that wheat is the only crop which indicated a consistent increase in the yield. The wheat yield was 1669, 1773, and 1801 kgs/ha in the years 1988-89, 1993-94, and 1994-95, respectively. The years 1995-96 and 1996-97 showed a stabilised pattern in terms of the increase in wheat yield, which was 1819 kgs/ha. The average wheat yield in the region is only 61 percent of the potential yield (3600 kgs/ha). The overwhelming majority (88 percent) of farmers reported that they expected more than a 33 percent increase in wheat yield due to improved soil conditions. The reported range of yield, however, varies between 20 percent and 900 percent. The farmers attributed this increase to two project components, i.e., lining and surface drains. The following is a typical farmer statement:

> Before the lining of the canal my fields were waterlogged and I was getting 3 to 4 maunds (120 to 160 kgs) per acre yield of wheat. In the past, I never brought agricultural produce home because it had always been so inadequate. This year, I expect a wheat yield up to 35 maunds (1400 kgs) per acre, i.e., an increase of 875 percent.

Nearly, 900 percent expected increase in the yield reported by this farmer may not be an exaggeration. I construe this increase as follows. The area where the WT is at the surface (disastrous area), the wheat crop will not germinate. However, if the WT drops just to a depth ranging from 3 to 6 feet, the conditions for wheat crop become excellent because the root zone of the wheat crop varies from 3.25 to 5 feet in the spring and winter wheat crops respectively [Musick and Porter (1990)], and under very favourable rooting conditions, it goes up to 10 feet. Lowered WT leading to improved soil condition will not only provide a favourable environment for the growth of wheat, but the crop will also get supplemental irrigation from the sub-soil. Thus, the expected increase in the yield reported by the farmers is possible.

Increase in agriculture production was the main objective of the FESS project [World Bank (1992); WAPDA PC-1 (1992)]. In many ways, as mentioned by Chambers (1987), increased yield and agriculture production can help eradicate poverty of the farming community both at the macro and micro levels: it provides an alternative for imports and generates employment directly through farming and indirectly through related activities at national and household levels. Considering the size of the FESS area, the project interventions, it is hoped, will have an impact on both the levels. Agriculture production helps increase national growth. It raises the income of the poor by about as much as it benefits others. The growth has linkages with non-farm activities that help reduce poverty. The correlation between poverty alleviation and growth links, however, is better at state level. [Abu Abdullah (1998); *The Economist* (April 2000), (May 2000)].

4.3. Cropping Pattern

It was envisioned that after the implementation of different project components, marked changes would occur in the cropping pattern and cropping intensity. Skogerboe *et al.* (1999a) notes that one of the expectations is that the improved water supplies and equity conditions will help replace low-delta crops with high-delta crops. The impact on cropping pattern reveals that no major change has been noticed in the cropping pattern. There are, however, some locations where some farmers reported a slight shift in the cropping pattern. Moreover, contrary to the popular belief of shifting from low-delta crops to high-delta crops, farmers are shifting from higher-delta to lower-delta crops because lower-delta crops such as pulses and cotton are more profitable. A farmer from the 1-L Distributary stated that "in future, I shall grow cotton instead of rice because after lining of the distributary, when we apply irrigation, my fields now dry up after every 2-3 days as compared to earlier depletion time of 8 to 10 days".

The above statement is important in terms of achieving project objectives of increased income and employment, because the selection of crop in irrigated area is an important influencing factor in generating employment opportunities for the rural poor. A crop such as cotton requires relatively more man-days as compared to sugar-cane per unit of cultivation [Chitale (1994)].

Some farmers from the Bahadarwah Minor and 1-L Distributary stated that their lands were good for pulses when there was no Waterlogging and Salinity (WLAS) a few decades ago. Afterwards, their lands were affected by Waterlogging and Salinity (WLAS) and pulses were replaced by wheat. Now they said they would again like to experiment with pulses in some of their fields because their soils had improved. However, the shift from rice to cotton seems more probable in the years to come due to improved equity conditions, which have been achieved by bringing the oversized outlets to their original size. Improved equity conditions have discouraged the wasteful use of water. Abdul Ghafoor, a farmer from the 3-L command, who cultivates 36 acres adjacent to the Haroonabad Drain, at RD 120, stated: "Earlier, after irrigation my fields never dried up. Now they require irrigation after every week because the water is drained off to drains. This indicates that drainage in my lands has improved. In future, I shall not grow rice but sow cotton in my fields".

These statements show that the project has been successful in lowering the WT. The survey results suggest that farmers are adjusting their crops according to the changed soil and water availability conditions. It also indicates that irrigation and drainage system improvement projects are demonstrably effective in raising and sustaining water use efficiency. Farmers' statements help to understand that after project interventions, farmers will go for less water-intensive but high-value and profitable crops to maximise their returns. Increased income is the best measure to combat rural poverty.

4.4. Migration

The project's impact on migration was also investigated. The dominant majority (80 percent) reported that some farmers migrated as a result of abandonment of their land. The extent of the migration, however, was not large. The remaining 20 percent did not know any instance of migration close to their area after it deteriorated with WLAS, during the last decade. Had there been no project interventions, the local community would have continued to migrate:

> Had the surface drains not been constructed and the canal not lined, my lands would have been destroyed completely by waterlogging and this would have been my last year here and I would have migrated from my lands.

This is the statement of Khadam Hussian which indicates that project interventions have helped stop migration of the community. Groundwater data collected by the SMO [WAPDA (2000)] shows that two-thirds of the FESS land had a very high WT. This situation had rendered a lot of land barren and out of cultivation. The improved soil conditions after the construction of drains and lining have two positive impacts on migration: first, preventing "out-migration" and, second, attracting "in-migration". Abdul Ghafoor, from the 3-L command, stated. "Earlier I was buried under debt (bankrupt) and I was thinking of leave farming and migrating. Now my lands have improved and I shall be now better off. I am happy that I gave 5 acres land to provide the route to the surface drain".

The above statement of the farmer clearly indicates that the project interventions have helped prevent further "out-migration" of the poor community. Similarly, the following statement indicates that improved land conditions also helped attract "in-migration". The sons of Ismaeel from Donga Bonga town, who work in cities for their livelihood, reported: "Earlier our lands were converted into water ponds. After the construction of the drain, the water has been drained off. We shall again return and cultivate/reclaim our parcel of land by growing rice. We have benefited a lot from the construction of this drain".

4.5. Abandoned Lands

Waterlogging in the region rendered many parcels of land barren and out of cultivation. After the lining of distributaries and the construction of drains, these lands have been brought under cultivation; 100 percent of the farmers reported that project interventions had helped rehabilitate the decades-old abandoned lands. There are many instances where crops are grown for the first time after 12–15 years on abandoned segments. Some fields have been cultivated for the first time after 50 years. The farmers are extremely happy on the restoration of their lands and the impacts on ground are even more profound. For example, M. Ismaeel and Hanif, who own land in the vicinity of Donga Bonga pond, have cultivated mustard in their fields for the first time after 12 years.

4.6. Water Distribution

One of the main objectives of the FESS project was to achieve equity in water distribution [WAPDA PC-1 (2000)]. One of the indicators of the equity in water distribution is that tails must get their proportional share of water [Waheed-uz-Zaman (forthcoming)]. Nearly all (95 percent) respondents stated that after the lining of the canals, the condition of water supply at the tail-ends had improved, and was more equitable and reliable. National and international experiences of canal lining show that equity conditions at tail, for example in Pakistan, have considerably improved as a result of the lining of canals [Khan (1993)]. In Egypt, before lining, head-reach farmers were getting more water; after lining all the parts of the channels were getting equal water [Aziz (1993)]. In the FESS area, in the words of a farmer from the watercourse Number 19 of Bahadarwah Minor, "Whatever share of water we are getting is reliable. Before the lining of the minor, the upstream influentials were making cuts frequently and downstream farmers were not sure about getting their share of water".

Unreliability of water supplies can lead to poor crop yield, less income, and increased poverty of the farming community. Reliable water deliveries, on the other hand, provide strong support against crop failure and impoverishment. The equitable water supplies gained through the lining of the canal significantly raise agricultural production and economic well-being of the farmers [Zaidi (1993)].

Some earlier surveys also confirm this finding to some extent. In the survey conducted by Starklaoff and Waheed-uz-Zaman (1999), nearly 50 percent of the interviewees at the Hakra 4-R Distributary perceive that the reliability of water distribution has actually improved. But, the focus of the investigation in that survey was the impact of FO and not the lining. Nevertheless, the conditions of unreliability and inequity can not be improved by technology alone; farmers' organisations are very essential [Skogerboe *et al.* (1999)].

4.7. Seepage Losses and Other Usage

All the respondents perceive that reduction in seepage from the lined canal is 100 percent. The project staff, who implemented the lining component, also perceive that the material (geo-membrane) used in the FESS lining completely seals the seepage from the canals. The technical results of field tests on seepage losses conducted by the International Waterlogging and Salinity Institute (IWASRI), however, do not confirm these perceptions [Bhutta (2000)]. Results indicate that, on average, the seepage reduction from the lined canal is 70 percent. Bhutta however, reports that the reduction varies between 45 and 98 percent between different reaches of the lined channels. According to the numerical modelling by Wachyan and Rushton (1987) referred to by Jones and Davey (1993), the seepage losses from a 99 percent perfect lining will be 71 percent of the earthen canal. The results presented by IWASRI [Bhutta (2000)] are possible if the field situation implies that (1) the joints of geo-membrane are not properly sealed to prevent 100 percent seepage; (2) geo-membrane material gets damaged during the construction operation, which allows seepage through the geo-membrane sheets. Much field evidence shows that failure of joints and cracking can occur within a relatively short period of time and make the lining ineffective, especially in smaller channels [Skutsch (1993)]. Studies from developing countries confirm such impacts due to poor lining. For example, a study from Indian Punjab shows that seepage rate in the lined channels reached up to the unlined value within a few years following construction [Weller and McAteer (1993)]. Results reported by Jones and Davey (1993) show that if 0.01 percent of the area of lining is damaged, the seepage rate from the lined channels is equivalent to the earthen channels. There are even many instances where low-quality and faulty lining have actually increased the seepage rate from the canals [Laycock (1993)]. Thus, the farmer perceptions on this parameter may be considered accurate if the ideal field conditions persist. Since the ideal conditions in the field can not be achieved, therefore the farmers' perceptions for this parameter are not as accurate as technical measurements. Research institutes, however, can further strengthen their results by investigating causes of less reduction in seepage.

4.8. Implication and Impact on Other Uses

The project envisioned increases in production by improving land and water conditions and by reducing seepage from the canals. The entire FESS area has brackish groundwater unfit for both drinking and irrigation purposes. The farmers, however, use the shallow aquifer both for drinking and supplemental irrigation. The FESS Irrigation and Drainage project area is generally underlaid with an impervious layer around 20 feet, which is the shallowest depth to an impervious layer. However, localised clay layers were observed to a depth of 4 to 6 feet [Reichert (1999)]. The quality of groundwater above this shallow layer is relatively sweet. [WAPDA PC-1 (1992)]. This shallow aquifer gets recharge from the canals.

Perceptions of the farmers, the project staff, and the scientific studies show a tremendous decrease in the seepage after lining. The extent of reduction of the seepage rate shows that the project has achieved its objectives, but, based on field evidence, it has other implications, which are described below.

60 percent of the survey farmers observed no change in water quality. The remaining (40 percent) sample farmers feel that the groundwater quality has deteriorated after lining. At some locations, however, severe problems of deterioration of water quality were observed. During the survey, at two different locations, farmers reported that the groundwater quality of their tubewells has further deteriorated. A farmer from the watercourse of 11-L of the Hakra 3-R Distributary revealed that his neighbouring farmer has already abandoned the tubewell because the water quality had worsened in his fields after the lining of the channels. In case farmers do not abandon such tubewells, and continue to use this poor-quality water, it may further deteriorate their soils because they will be pumping from the deeper depths, which are more saline.

Another farmer from the watercourse number 20-R of Bahadarwah Minor stated that after the lining, the groundwater quality of his tubewell was gradually deteriorating. Asked whether he would continue to use the water of this tubewell, he replied: "If the quality of water gets worse, I shall abandon it".

Surveys conducted by Waheed-uz-Zaman *et al.* (1996) on the non-agricultural usage of the surface water showed that nearly 90 percent of the population uses surface water for domestic purposes. The major quantum of this water comes from the B-S Link Canal that receives a large amount of industrial, biological waste [Skogerboe *et al.* (1999)], and even sewage water. Furthermore, the maintenance of drinking *digis* (water tanks) in the region is very poor. The filtration tanks of most of the drinking schemes are lying abandoned.

Besides quality, the quantity of *digi* water is also an issue. With the increase of population the demand of domestic water has increased and *digi* water is proving insufficient. In this situation, the dependence of community on shallow groundwater is increasing. The recent survey conducted by Chaudhry and Tirmazi (2000) in two villages of Hakra 4-R Distributary showed that 33 and 19 percent of the people, respectively, rely on fresh groundwater in villages 54/4R Tibba and 64/4R. This shows a clear increased dependence on fresh groundwater. For drinking purposes, farmers installed electrically driven motors and hand-pumps to tap the fresh layer.

Furthermore, the multi-strainer-fractional-skimming tubewells have also been providing 'relatively safer' water supplies for both irrigation and drinking and other domestic uses in many locations of the area. After lining there is significant reduction in seepage from the distributaries, which suggests that the need for expensive sub-surface drainage in the FESS area has been eliminated which was another main objective of the project [World Bank (1992)]. This situation, however, has three implications: *first*, it deprives the community the use of fresh shallow aquifer for domestic use. Such negative concerns have been shown in earlier studies on the Chashma Right Bank Canal Stage-1 [Habib and Garaces-Restrepo (1993)]. *Second*, reduced availability of fresh water aquifer has serious health impacts, if community continues to use the tubewell water for domestic purpose. As a consequence, deteriorated health of household members contributes to the non-availability of family labour power [Starkloff (1998)]. *Third*, tubewells installed to supplement the irrigation may further deteriorate the soil conditions.

5. IMPACT OF FARMERS' ORGANISATIONS (FOs)

Creating functional FOs was another main objective of the FESS. Three pilot FOs were created in the project area; two by On-Farm Water Management (OFWM) and one by International Water Management Institute (IWMI). The FOs of the project area were formed in March 1997. Until March 2000, these FOs were not legally recognised. The management responsibilities were, however, transferred to the FOs on April 10, 2000. The FOs in their pre-takeover period undertook many management activities, which have significant impacts at the policy and operational levels. The following part of the paper covers the pre-transfer impacts of these FOs. [Waheed-uz-Zaman (1998); Ralf and Waheed-uz-Zaman (1999); Waheed-uz-Zaman *et al*. (1998); Waheed-uz-Zaman *et al.* (1998a); Waheed-uz-Zaman (1998b)].

At the policy level, to promote the transfer of responsibilities, the FOs participated in the review of the legal framework for FOs in the province of Punjab. The FOs negotiated on the modalities of major responsibilities and successfully settled all the issues of joint management schemes with the Provincial Irrigation and Drainage Authority (PIDA). One of the hotly debated issues, of the apportionment of *abiana* (irrigation service fee), was also settled amicably. The fee will be apportioned at the ratio of 60:40 i.e. 60 percent. It will go to the government and the FOs will retain 40 percent to meet the costs of operations, maintenance, and administration. The government-FO interface helped develop the negotiation capacity of the FOs. The FOs and the PIDA together drafted a Joint Management Scheme settling all the points at issue. The second positive impact associated with these interactions is the increased commitment to participatory reforms observed at higher levels of the PIDA. The FOs of the FESS project are now being referred to as model FOs by higher-level policy-makers. The pilot projects have helped to understand the social relations and dynamics of the pilot area communities. These experiences have been documented. The documentation has led to the identification of legal requirements and the institutional process required for effective realisation of reform objectives. The FO pilot test has yielded a viable FO mobilisation strategy [Bandaragoda *et al*. (1997); Bandaragoda (2000); Waheed-uz-Zaman (1998); Waheed-uz-Zaman (1998b)] based on which subsequent projects can be developed.

At the operational level, the impacts are even more significant. The equity of water has been assured by forming FO committees that correct faulty outlets and perform several joint inspections of channels with PIDA. FO leaders decided to refrain from installing seasonal pipes to improve the supplies at the tail-ends. Farmers' demands for water supplies since the formation of the FO have started reaching the PIDA quickly, and the PIDA now considers the farmers' irrigation demands as part of the distributary operation. The farmers were involved in all processes of assessment of maintenance needs. The FO, for example, of Hakra 4-R Distributary, undertook a 5-day maintenance campaign by mobilising 800 farmers and 120 tractors in the annual canal closure of 1997-98. The financial analysis shows that maintenance undertaken by FO was three times cheaper than that done by the PIDA. The total cost of resources mobilised by FO was US$ 2,800. The work done was equivalent to US$ 9,032 [Waheed-uz-Zaman (1998)]. Moreover, the maintenance undertaken by the FOs is efficient and based on needs. The general belief is that downstream farmers do not cooperate with upstream farmers in maintenance activities. At Hakra 4-R Distributary, participation of the downstream farmers to repair the initial section is also a visible evidence of the impact. At the operational level, as a result of farmer-agency interface, the informal payments to agency field staff for additional supplies have reduced significantly. A total of 20 disputes were submitted to FOs for arbitration. The disputes are diffused swiftly at the FO level. For example, an unsettled dispute for the last one year in the court of the Executive Engineer, Bahawalnagar Circle, was referred to the FO and was resolved within one week [Waheed-uz-Zaman (1998b)]. Members referring disputes to the FOs is in itself a big impact. The improved interaction of the FOs with the private sector has resulted in timely and efficient access to agriculture inputs and in community development projects. The community has access to new technology and improved agronomic practices through exposure trips within and outside the country. Over 300 FO leaders and grassroots members participated in 10 different training programmes related to flow measurement and organisational development. Some leaders now act as resource persons for farmers' training, which shows farmers' potential to acquire technical knowledge. These FOs have sustained themselves for three years without any formal support or legal recognition, and in spite of resistance from the PIDA field staff. The FO leadership participated as facilitators in the formalisation process of 124 watercourse-level water-users associations (WUAs) in 1998 [Waheed-uz-Zaman (1998a). In this process, grassroots WUAs were established according to legal criteria. In January 2000, the FOs showed a significant impact on organisational development when, under the PIDA legal framework, they successfully re-elected the office-bearers for distributary-level FOs. Under Irrigation Management Transfer (IMT), FO of Hakra 4-R has a remarkable impact on the equity of water distribution by re-sizing the faulty outlets, as demonstrated by IWMI field research.

6. CONCLUSION AND RECOMMENDATIONS

Findings of the farmers' perception survey would lead to several conclusions and recommendations for the Irrigation and Drainage projects. Some obvious ones are given below. Such surveys carried out periodically can provide quick feedback if the project could be sustained as planned, and these can also identify areas of critical importance to the communities.

- **Surveys have adequate output.** Both the positive and the negative impacts of the project interventions are reasonably identified by the perception surveys. The reported areas of impacts and the extent of satisfaction expressed by the farmers shows the success of the project and demonstrates that the project has achieved its objectives. These objectives have been achieved by improving soil, drainage, irrigation, and socio-economic condition of the region. How these impacts and changes will influence the long-term sustainability of the project is not decided yet. Periodic well-designed surveys could provide the feedback at a nominal cost, and provide the information on the sustainability.
- **Perception surveys are not a substitute but a complimentary exercise for the conventional scientific surveys.** While such surveys are beneficial, they also have limitations warranting caution. It is clear from this study that for some technical parameters, farmers' perceptions are as accurate as technical measurements. For example, in the assessment of DWT. But, for some parameters, farmers' guesses are not close to the technical measurements, such as those in the estimation of seepage reduction. Thus, perception surveys cannot substitute for all types of technical measurements. If carefully designed, however, they can provide a fairly accurate estimation for selected parameters. Thus farmer perception may be used to refine the technical monitoring. They are not for scientific assertion, but should be used for feedback only.
- **Farmers have better judgement about what to grow.** After the project, the farmers see the need to change to crops needing less water-intensive irrigation which are more profitable, while the project had envisioned that as a result of the water saved due to project interventions the farmers would go for more water-intensive crops.
- **Condition of conjunctive use of groundwater in the canal and drain belts.** As a result of an immediate drop of 3 to 4 feet in the depth of water-table provided along the channels and the drains, favourable conditions for the conjunctive use of groundwater have resulted in much higher crop yields in the following years.
- **Customary statistical analysis may mask some important social issue.** Provide corrective measures and make cost provisions in the project planning where potable water would be affected by project interventions. Among the solutions may include the introduction of the skimming tubewell technology in the area to prevent further deterioration by indiscriminate exploitation in future. Evidence shows that the quality of

groundwater in the vicinity of lined channels has deteriorated, affecting those using groundwater as drinking-water, and will have health impacts on the communities.

- **Identify the need for subsidies.** Social factors and traditions may require initiating subsidies. FESS, for example, needs reclamation of moderately sodic saline soil requiring gypsum application, which is prohibitive for the very poor community. (Hamid (1999), for example, has calculated Rs 17,653,600 as the cost of gypsum application for reclaiming 3396 has of moderately saline sodic soils of the entire FESS area, which is 23 percent of the total area.)
- **Devise steps for reduction in poverty.** The perception survey would help in identifying the need and the potential of various measures to alleviate poverty accurately at the root level.
- **Location of the distributary canal will influence the effect of canal lining.** Those in the vicinity of larger channels did not show land reclamation, as apparently the seepage effect on the shallow water-table was larger than the reduction caused by the lining of the smaller channel.
- **Cultivate the culture of drainage cess.** There is an urgent need to initiate adequate drainage cess if the drainage facilities are to be maintained to provide continued benefits. While these admit the benefit, the need to contribute towards maintenance funds should be advised.
- **Institution management transfer model (IMT Model).** Perception surveys, when designed appropriately, could provide appropriate, quick, and easy follow-up technique for the Farmers' Organisations as an IMT model on the maintenance of small channels.
- **Down-to-earth farmers' indicators.** The survey has identified several *farmers' indicators* to measure the DWT fluctuations. The use of the indicators by farmers shows their ability to comprehend the changed hydrological and agronomic conditions after project interventions. These indicators also show the spatial variability in hydrological and environmental impact of project interventions. The reported indictors are: (1) frequency of irrigation, (2) bore depth of tubewells and hand-pumps, (3) variation in the discharge of tubewells, (4) water levels in the open wells, (5) depletion rate in the drinking- and livestock-ponds, (6) ability of crops to withstand wind and rains, and ease in cultivation, and (7) condition of trees, i.e., when the trees have started re-sprouting due to lowered WT.

The usefulness of these indicators to the impact evaluations is immense because they relate to the real-life situation and are not imaginary. From the farmers' perspective, these indicators, however, need to be carefully defined to make them more practicable in the field.

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