

Emerging Issues in the Implementation of Irrigation and Drainage Sector Reforms in Sindh, Pakistan

JUNAID ALAM MEMON and USMAN MUSTAFA

1. INTRODUCTION

Ever increasing demand for food, electricity and domestic water use due to rapid growth in population has remained a key challenge for Pakistan since the 1950s. The country has invested heavily in water engineering projects to establish the world's largest gravity-driven irrigation network on the Indus [Bandaragoda (2006); Bengali (2009)]. Besides fulfilling a significant proportion of the country's energy demand from hydropower installations, the system irrigates about 14 million hectares of farmlands and supports agriculture sector to contribute about 21 percent of the GDP, 60 percent of the exports and 45 percent of the labour force [Bhutta (2006); Pakistan (2012)]. Amidst its development, the elaborated irrigation facility has impressed a deep footprint on productivity and environment of the basin itself in the form of rising levels of water-logging, salinity and the degradation of deltaic ecology [Briscoe and Qamar (2009); Memon and Thapa (2011)]. By the 1960s, every year about 40,000 ha of fertile farmlands were turning into wastelands because of water-logging and salinity [Bhutta (2006); Mulk (2009); Qureshi, *et al.* (2008)]. Therefore, the country had no option but to develop a remedial drainage network of thousands of kilometers of drains and numerous tube wells parallel to the existing irrigation infrastructure.

Investment in the irrigation infrastructure had been rationalised based on the assumption that it will pave a path for social change in Pakistan [Haines (2011)]. However, once the major phase irrigation development completed, the policy-makers and The World Bank (with its crucial role in the Indus Water Treaty 1960, and subsequent development of the basin) sensed the political economy of the agrarian society within which the irrigation infrastructure was unable to recover even a small fraction of its operation and maintenance (O&M) costs. The politically dominant feudal, who possessed the major share of farmlands, were not only interfering in everyday affairs of irrigation management [Mustafa (2002a)], but could also influence the legislature and enjoy water

Junaid Alam Memon <memon@pide.org.pk, memon@gmx.us> is Head, Department of Environmental Economics, Pakistan Institute of Development Economics, Islamabad. Usman Mustafa <usman@pide.org.pk> is Chief, Training Programme, Pakistan Institute of Development Economics, Islamabad.

Authors' Note: The Higher Education Commission of Pakistan generously funded the research for this paper. The authors are also indebted to Mr Nazeer Ahmed Esani and Dr Fateh Muhammad Mari for sharing of their invaluable resources and knowledge for the study.

subsidies in the name of small landholders [Faisal (2009); Nabi, *et al.* (1986)]. Add-ins were the ethos and colonial legacies of the hydraulic bureaucracy that kept itself isolated from the general public and therefore had no option but to connive with the feudal lords and operate the system at their will [Mustafa (2002a)]. Numerous policy and operational problems, such as unjustified irrigation subsidies, low crop assessment and cost recovery, inequitable irrigation distribution and widespread corruption in all tier of water management, emerged and caused the gradual deterioration of system infrastructure and efficiency [Bengali (2009); Faisal (2009); Memon (2006); Prathapar, *et al.* (2001)].

Concerning the situation, the World Bank stopped financing the engineering solutions and explored the possibility of institutional reforms. The idea was to transform a very bureaucratic setup into participatory and farmer-managed irrigation and drainage (I&D) system. Obviously, this transformation was easier said than done. Years of action research and policy dialogue finally yielded the Provincial Irrigation and Drainage Authorities Act in 1997 [Bandaragoda (2006); Dinar, *et al.* (2004)]. The act facilitated the formation of autonomous institutions at the different levels of irrigation management. Under the umbrella of provincial authorities, Area Water Boards (AWBs) were to be established to manage the secondary level channels or canals. Below this, farmers were to be organised into Water User Associations (WUA) and Drainage Beneficiary Groups (DBGs) to form Farmer Organisations (FOs) and manage the distributary/minor or tertiary level I&D affairs [Memon (2006); Prathapar, *et al.* (2001)].

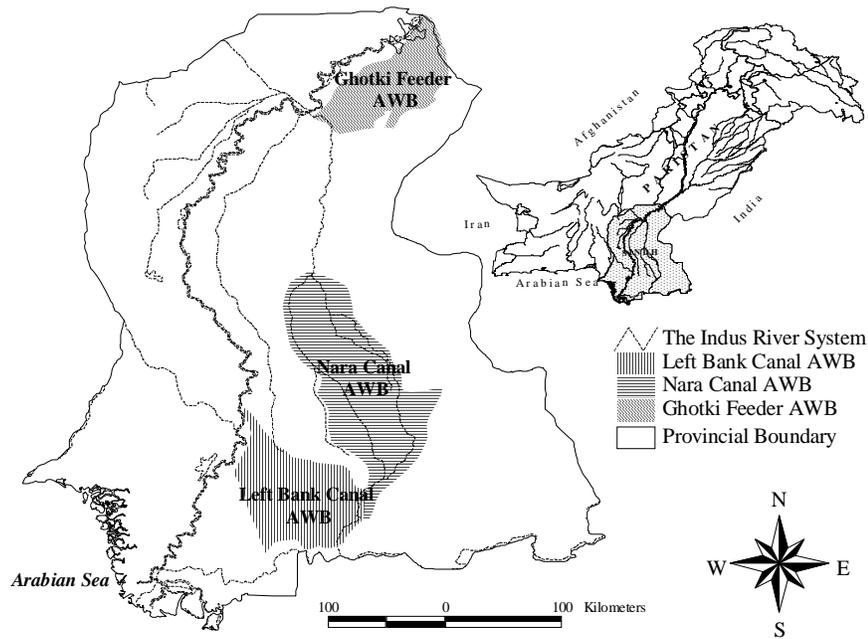
Sindh Province of Pakistan has been one of the major beneficiaries of irrigation development on the Indus River. The provincial irrigation facility itself stands as one the largest contiguous irrigation networks in the world (Fig. 1). The provincial system irrigates about five million hectare of farmlands through 14 canals, 1,446 distributaries/minors and 45,000 water courses [Memon (2006)]. Besides, the system features about 3,690 kilometers of drains. Since the last 15 years, the province has been implementing irrigation and drainage sector reforms. The provincial cabinet approved the Sindh Irrigation and Drainage Act in 1997 and replaced it with the Sindh Water Management Ordinance 2002 in order to accelerate the reforms [Sindh Governor House (2002)]. This study evaluates the extent to which the reforms could be implemented so far and highlights some of the emerging issues in this process. The next section describes the data sources and methods and is followed the result section highlighting the major achievements towards the reforms. The final section discusses key findings in the broader theoretical and policy context to draw the conclusions and make policy recommendations.

2. METHODOLOGY

2.1. Study Approach

At first, the broad indicators of progress in the implementation of reforms were qualitatively analysed. Subsequently, we focused on three AWBs namely NC-AWB, GC-AWB and LBC-AWB motivated by the fact that so far the implementation of reforms in Sindh Province has been limited to those areas. Emerging trends in the implementation were highlighted through the descriptive statistical analysis of the information extracted from FO profiles. The reasons for those trends were inquired through in-depth interviews conducted with the purposively selected respondents which included SIDA and AWB officials and Management Committee member of FOs.

Fig. 1. Irrigation Network of Sindh Province of Pakistan



2.2. Data Sources

SIDA is primarily responsible for the implementation of proposed institutional reforms in the I&D sector of Sindh Province. In 2009, the agency published a one-page profile of 354 FOs in Sindh province. Since then, the profile has never been updated as there has been hardly any progress in FO formation. Data on key variables was extracted from those profiles and was processed for descriptive analysis. Face to face and telephonic interviews were conducted with SIDA, AWB and Water Sector Improvement Project (WISP) officials in order to explore the reasons behind the emerging trends in the implementation of reforms. Besides, formal and informal discussions with some of the Management Committee members of FOs were also insightful in understanding the underlying factors responsible for the overall state of reform implementation.

3. RESULTS

3.1. Overall Implementation of Institutional Reforms

Despite years of action research by the International Water Management Institute (IWMI) and subsequent implementation by SIDA, the I&D reforms in Sindh Province are still immature (Table 1). As a precondition for the takeover of reforms, SIDA has been established and made operational since 1998. It was pursuing its mission to decentralise the irrigation and drainage management at the canal and distributary/minor levels. SIDA was also functioning as the ‘Regulatory Authority,’ as the establishment of such institution has been pending since the promulgation of

Sindh Water Management Ordinance 2002 [SWMO (2002)]. So far only three AWBs, namely, the Nara Canal, the Ghotki Feeder Canal and the Left Bank Canal (Fig. 1), could be established against the plan of establishing 14 AWBs on all canals throughout the Province by 2008. On account of FO formation, progress was conditional to the establishment of AWBs. On the provincial level, only one fourth of the total targets of FOs formations could be achieved while the progress in terms of actual Irrigation and Management Transfer to FOs was less than one fifth of the target (Table 1). Most of the progress has been observed in the above-mentioned three AWBs. The NC-AWB was the only subsystem where the targets of management transfer were almost complete. It worth mentioning that the Nara Canal had been the pilot AWB in Sindh province where the action research carried out by IWMI found that the farmer-managed irrigation system was a viable option for reforming the I&D sector of Sindh Province.

Table 1

Overview of the Implementation of Institutional Reforms in the Sindh Province

Progress indicator	Target and Achievements	Achievements
Formulation of Provincial Irrigation & Drainage Authority	- Sindh Irrigation and Drainage Authority have already been formed at the provincial level.	Completed
Formulation of Regulatory Authority (RA)	- Appropriate formation is still awaited. Currently, SIDA is functioning as RA.	Incomplete. RA is operational through ad hoc arrangement
Formulation of AWBs	- Out of 13 AWBs, only three (Fig. 1) could be formed as of 2009. No progress has been made thereafter.	23 % complete
Formulation of FOs in AWBs	- Out of about 1,400 FOs, about 338 have been formed in three AWBs namely: NC-AWB, GC-AWB and LBC-AWB. Beside some 16 FOs has also been formed in the canal commands where irrigation reforms are yet to be implemented and AWBs are to be established.	25 % complete
Irrigation & Drainage Management Transfer (IDMT) to FOs	- Out of 359, about 259 FOs have been transferred irrigation and drainage management responsibility. About 94% FOs of NC-AWB, 38% FOs of GC-AWB and 60% FOs of LBC-AWB had been transferred the irrigation management responsibility of their respective minors and distributaries.	For three AWBs, the target is 73 % complete. At the provincial level, only 18 % complete

Notes: Calculations are based on FO Profile 2009. There is no substantial progress in FO formation thereafter.

Most of the FOs of NC-AWB were formed during 2000-2003 and were handed over the management responsibility during 2001-2004 and in 2008 (Table 2). In GC-AWB and LBC-AWB, most of the FOs were formed during 2005-2008. However, the FOs in GC-AWB and LBC-AWB were bestowed with the responsibility of managing their channels during 2007-2008 and 2006-2008, respectively (Table 2). Besides these three AWBs, some FOs were also formed haphazardly in the command areas of other canals (secondary level channels) which were still not handed over to the SIDA for the establishment of AWBs and FOs. In total, about 16 such FOs were formed outside the jurisdictions of the three AWBs of which only one could be transferred the management responsibility till the time this study completed (Table 2).

Table 2

AWB Wise Details of FO Formation and Irrigation and Drainage Management Transfer (IDMT)

Year	FOs in NC-AWB		FOs in GC-AWB		FOs in LBC-AWB		FOs in other AWBs	
	Formed	IDMT	Formed	IDMT	Formed	IDMT	Formed	IDMT
1998	2	–	–	–	–	–	–	–
1999	5	–	–	–	–	–	–	–
2000	17	–	–	–	–	–	3	–
2001	12	24	–	–	1	–	4	–
2002	94	54	5	–	5	–	2	–
2003	25	48	6	–	7	11	–	–
2004	5	16	–	11	–	2	–	–
2005	–	–	3	–	7	–	–	–
2006	–	–	18	–	27	14	1	–
2007	1	–	46	5	38	19	5	–
2008	–	18	6	12	4	15	1	1
2009	–	–	–	–	3	–	–	–
Total	161+1 ^a	160	84	28	92	61	16	1

Notes: ^aValue for one case is missing. – Figures in the table are the numbers of FOs.

The achievements in FO formation were mostly the outcome of various projects implemented by SIDA and voluntary contributions of various government and non-government organisations (Table 3). The credit for FO formation till 2000 goes to IWMI under the World Bank financed Left Bank Outfall Drain Project (LBOD) and the Directorate of OFWM (Agriculture Department, Government of Sindh) for their voluntary contributions. However, most of the FO formation is attributed to SIDA and OFWM under the National Drainage Program (NDP) during 2002-2007, also sponsored by the World Bank. Meanwhile, the World Bank also sponsored another project called the Sindh On-farm Water Management Project. This project also had a component on FO formation that too was implemented by the OFWM. Besides those formal and sponsored attempts, some local and international NGOs, such as OXFAM and SWAFCO, have also formed FOs in the NC-AWB and outside the command areas of the three AWBs (Table 3).

Table 3

Different Agencies Involved in FO Formation During the Years 1998–2009

FO Forming Agency	NC-AWB	GC-AWB	LBC-WB	Other AWBs	Total
SIDA	47	48	44	8	147
On-farm Water Management (OFWM)	79	36	48	5	168
SIDA and OFWM Jointly	23	–	–	–	23
International Water Management Institute	11	–	–	1	12
Other NGOs such as OXFAM, SWAFCO	1	–	–	2	3
Total	161	84	92	16	353+1 ^a

Notes:

^a Missing values.

– Figures in the table are the number of FOs.

3.2. Composition of Farmer Organisations

Since irrigation right in Pakistan is a proxy to farmland ownership, all those who have possessed or leased any farmland in the command area of a channel were by default the members of its FO. Thus the membership size of a FO or its constituting WUAs was the function of the command area that its respective irrigation channel was designed to serve. On average, a FO of NC-AWB had 280 farmers/members out of which about 24 were women farmers. In GC-AWB and LBC-AWB, although the average number of farmers/members was substantially higher than that of the NC-AWB, but the number of woman farmers/members was considerably less or even negligible. The average landholding per farmer in a FO of three AWB ranged between nine and 13 hectares but the distribution of land was quite skewed towards the privileged small number of farmers. The average landholding of the smallest farmer in any of the FO was not more than five hectares while the average landholding of the largest landholder could be as high as 100 hectares in NC-AWB, 85 hectares in GC-AWB and about 175 hectares in LBC-AWB.

Table 4

Characteristics of FO Membership in Three AWBs of Sindh Province

Salient features of FOs' Membership	NC-AWB			GC-AWB			LBC-AWB		
	\bar{x}	SD	n*	\bar{x}	SD	n*	\bar{x}	SD	n*
Farmers/Members (Person)	280	231	161	347	400	72	347	383	78
Women Farmers/Members (Person)	24	36	100	5	5	20	9	11	26
Land Holding per Farmer (ha)	13.0	10.7	159	9.4	7.5	70	11.9	7.4	77
Land of the Smallest Land Holder (ha)	2.8	2.5	160	2.5	2.7	84	4.7	22	91
Land of the Largest Land Holder (ha)	97.8	84.5	160	84.3	106	84	176	230	91

Notes:

* The number of cases valid in the calculation of \bar{x} (s); ' \bar{x} ' is the arithmetic mean and 'SD' is standard deviation while 'n' is the number of cases valid for the calculation of \bar{x} .

– Calculations are based on FO Profile 2009. There is no substantial progress in FO formation after 2009.

3.3. Institutional Attributes of Farmer Organisations

A complete transformation from the state- to a farmer-managed irrigation system could only be observed in the case of NC-AWB (Table 5). The majority of the FOs in NC-AWB was near to complete the second tenure of their MCs while a few of the FOs

had already started the third tenure. In GC-AWB and LBC-AWB, the majority of the FOs was still going through the first tenure of their MCs (Table 5) mostly because FOs in these AWBs were formed relatively recently (Table 2). However, while comparing the FOs of GC-AWB and LBC-AWB which were formed during the same time (Table 2), the percentage of FOs in their second tenure was much higher for the GC-AWB than the LBC-AWB. This defect appears to be a function of unknown status of MC tenures of 14 percent FOs of the LBC-AWB (Table 5). When specifically inquired about the exact reason behind the unknown status of the MC tenure of some FOs, it was revealed that their reelection was pending due to severe conflict among farmer groups. Unfortunately, neither SIDA nor the respective AWBs could play any successful role in resolution of the conflicts over the reelections.

Table 5

Organisational Feature of FOs in three AWBs in Sindh Province

Organisational Details	NC-AWB (n=162)	GC-AWB (n=84)	LBC-AWB (n=92)
FOs signed IDMT Agreement	98.8	45.2	65.2
Tenure of FO Management Committees			
- 1 st tenure	–	79.8	75.0
- 2 nd tenure	92.6	19.0	10.9
- 3 rd tenure	0.6	–	–
- Status unknown	6.8	1.2	14.1
The Largest Landholder of a FO in MC	39.8	35.7	32.6
The Smallest Landholder of a FO in MC	17.4	20.2	20.7
Women Farmers in MC	1.8	1.2	–

Notes:

- Figures in the table are percentages.
- Calculations are based on FO Profile 2009. There is no substantial progress in FO formation after 2009.

From the information given in the FO Profiles 2009, the participation of three farmer groups, namely, woman farmers, the smallest farmers and the largest farmers, in the FO management committees can be analysed. It could be observed that two fifth of the largest landlords of the FOs in NC-AWB, one third of the largest landlords in the FOs of GC-AWB and LBC-AWB were MC members of their respective FOs (Table 5). Most of the largest farmers in FOs across all AWBs, who were members of MCs, were either Chairman or other important office bearers and only a few of them were just the members (Table 6). Compared to the largest landholders, the participation of the smallest landholder in the MCs of FOs was in much lesser numbers. In all three AWBs, only about 20 FO management committees had the participation of the smallest landholder (Table 5). Most of the smallest landholders, who were on the MC of their FOs, were just members while only a few of them could be found holding the offices of chairman, vice chairman, secretary and treasurers (Table 6). It can be further observed that the composition of FO management committees was quite masculine in nature. Compared to the percentage of women landholders in FO general bodies across all AWBs (Table 4), their participation in the MCs was negligible or completely missing. Only four women could be found bearing an office, three of whom were in the NC-AWB while only one in

the GC-AWB. None of the office bearers was found to be a chairwoman (Table 6). In NC-AWB, three women were designated each as Vice Chairwoman, General Secretary and Treasurer; while the only woman in GC-AWB was just a member (Table 6).

Table 6

Farmer Groups	Not Participating	Positions in FO management committees				
		Chair	V. Chair	G. Sec	Treasurer	Members
NC-AWB (n=161)						
- Women farmer	98.2	–	0.6	0.6	0.6	–
- Smallest farmer	79.5	0.6	3.7	3.1	3.1	9.9
- Largest farmer	57.8	23.0	8.1	4.3	3.1	3.7
GC-AWB (n=84)						
- Women	98.8	–	–	–	–	1.2
- Smallest farmer	78.6	3.6	2.4	3.6	1.2	10.7
- Largest farmer	64.3	22.6	6.0	1.2	1.2	4.8
LBC-AWB (n=92)						
- Women farmers	–	–	–	–	–	–
- Smallest farmer	79.3%	1.1	4.3	3.3	2.2	9.8
- Largest farmer	65.2	14.1	1.1	5.4	4.3	9.8

Notes:

- Figures in the table are percentages.
- Calculations are based on FO Profile 2009. There is no substantial progress in FO formation thereafter.

4. DISCUSSION AND POLICY IMPLICATIONS

Although the need for water sector reforms has been uniform across various countries, the underlying causes, the cost of implementation and degree of success in achieving the stated objectives varied across different socio-political and geographical contexts [Dinar, *et al.* (2004)]. In the case of Pakistan, improper O&M of irrigation infrastructure, low crop assessment and revenue collection, inequitable water distribution and corruption in water bureaucracy were the compelling reasons behind the I&D sector reforms [Memon (2006)]. Nevertheless, like other South Asian countries, the design of reforms and push for their persuasion mainly came from the World Bank having a major role in the post-independence irrigation development in the country [Bandaragoda (2006)]. Given the fact that the demand for reforms was not internally generated by users and managers of irrigation facilities [Bandaragoda (2006)], the findings of this study revealed that the prescriptions were implemented halfheartedly. The establishment of SIDA was a cosmetic step that partially transformed the Provincial Irrigation Department and created a parallel institution made responsible for the implementation of the farmer-managed irrigation system. After the initial hike, not much progress has been made. So far, the farmer-managed irrigation system is confined to NC-AWB, GC-AWB and LBC AWBs and could not encompass the remaining 11 canals in the province. By the year 2000, the Government of Sindh had already notified five canals to be brought under the farmer-managed irrigation system. Nevertheless, the Irrigation Department continues to operate the Begari Sindh and the Western Sindh canals and never transferred these two to SIDA for the establishment of AWBs and the introduction of the farmer-managed irrigation model.

Even in the AWBs, where the SIDA was able to implement reforms, the process had been quite slow, and currently grinding to halt as no major achievement has been made since 2009. Over the last 15 years, SIDA could not establish any mechanism to ensure the democratic selection of the members of AWB on any of the three canals. The operations of these AWBs were in the hands of politically installed feudal without having any representation of the farmers at large. Besides, the FO formation and management transfer was still incomplete in GC-AWB and LBC-AWB and will require decades to complete for the remaining canals at the current pace of implementation. Surprisingly, despite knowing that reforms were supply-driven [Bandaragoda (2006)] and a lengthy process, SIDA had not established any program level staff for social mobilisation, FO formation or post transfer management support to new FOs. So far, most of the FO formation was project-based, done either through project staffs of SIDA or outsourcing. Evidences suggest the large landholders, who were one of the reasons for the failure of state-managed irrigation, had already captured the management committees of FOs by implanting either themselves or their proxies on the key positions. Although such a tendency on the part of large landholders could have its roots in the skewed power distribution in rural Sindh, another reason, as narrated by some of the Social Mobilisers, could be the project-based approach of FO formation persuaded by the SIDA and AWBs. Their supervisors compelled them to meet the targets of FO formation by implicitly compromising over the quality of social mobilisation, capacity building and farmer participation. Upon the condition of anonymity, many of the social organisers confessed that they opted for shortcuts to meet close deadlines for FO formation by asking the influential landlords and politicians to select the MCs of FOs at their will.

Another major concern that has been misplaced somewhere in the debate on institutional reforms was the wholesale ignorance of drainage affairs during the implementation of reforms. Such an observation was particularly valid for the low-lying topography of the NC-AWB and LBC-AWB, where the farmers highly acknowledged the importance of the drainage network in maintaining the fertility of their farmlands. It was gathered that almost half of the FOs in both of NC-AWB and GC-AWBs had some form of drainage structures such as surface and tube well and tile drains. However, virtually none of those FOs had formed any DBG for managing their drainage structures. The FOs were reluctant to take over the responsibility of drainage management in purview of the payment of drainage levy [Official Correspondent *Daily Dawn* (2004)]. Since the government was not generating any revenue from the drainage facility, it ignored O&M of these structures until absolutely inevitable. As a result, the state of drainage structures was indeed miserable characterised by choked drains and nonfunctional tube-wells. It was virtually in a state what the major theorist of Commons Pool Resources have explained as an open access resource [Berkes and Farvar (1989); Schlager and Ostrom (1992)] or an unmanaged common [Hardin (1968, 1994, 1998)—where everybody was a beneficiary but nobody was bearing the management responsibility.

To a neutral observer, the existing state of the implementation of institutional reforms in Sindh Province was not much surprising. Surprising, however, was the fact that policymakers ignored or perhaps concealed some of the major findings of the action research carried out by IWMI under the LBOD Project. For example, Murray-Rust, *et al.* (2001) found that FO formation was possible, but the sustainability of such institutions

was unclear since none of the FOs were handed over the responsibility of O&M till the project ended. Besides warnings that the well-established hydraulic bureaucracy could impede the success PIM, Murray-Rust, *et al.* (2001) and Bandaragoda, *et al.* (1997) found it unrealistic to assume that the large farmers, for whom control over irrigation was the key to remain advantageous in the local power structure, could relinquish it in favour of marginalised farmers. Similarly, other initial studies conducted by IWMI research team [Bandaragoda and Memon (1997); Bandaragoda, *et al.* (1997)] and others [Mustafa (2002a); Mustafa (2002b)] also identified various caveats such as rivalries of line hydraulic bureaucrats against institutional reforms, the possibility of feudal capture and chances of corruption among FO leaders. Nevertheless, perhaps the donor push was strong enough to compel the policymakers to ignore the abovementioned caveats and pick only those conclusions which suggested the viability of the PIM within the socio-political context of Sindh Province.

One of the SIDA officials who had been a very instrumental advocate of reforms expressed his frustration as: “the inception of reforms shook the roots of a century-old water bureaucracy in Sindh; however, it is the fact of today that over the time the water bureaucracy has sustained those shocks and has reemerged as a major threat to the reforms.” It is perhaps the peak time for the policymakers to revisit the design of reforms before continuing the failed path of reform implementation. Despite the unsatisfactory pace of reform implementation, the lessons learned could serve as the guiding principles for setting the future directions of water management policies. Undoubtedly, it requires more research, particularly in evaluating the performance of FOs against the stated objectives of equitable irrigation distribution, maintenance of channels and cost recovery. Besides, it is also necessary to reevaluate the prospect of PIM in the context of local power structure, factors determining the willingness of water bureaucracy in supporting the institutional reforms and the capacity and willingness of farmers to manage the system. Understanding of such dimensions will provide new insights and policy input for the redesign of reforms and address some of the key obstacles in their implementation.

REFERENCES

- Bandaragoda, D. J. (2006) Limits to Donor-driven Water Sector Reforms: Insight and Evidence from Pakistan and Sri Lanka. *Water Policy* 8, 51–67.
- Bandaragoda, D. J. and Y. Memon (1997) Moving Towards Participatory Irrigation Management—Phase II report of pilot project for farmer-managed irrigated agriculture under the Left Bank Outfall Drain (LBOD) Stage I Project, Pakistan. International Irrigation Management Institute, Lahore.
- Bandaragoda, D. J., G. V. Skogerboe, and Y. Memon (1997) Prospect of Farmer-managed Irrigated Agriculture in the Sindh Province of Pakistan. Pakistan National Programme, International Irrigation Management Institute, Lahore, p. 147.
- Bengali, K. (2009) Water Management under Constraints: The Need for a Paradigm Shift. In M. Kugelman, and R. M. Hathaway (eds.) *Running on Empty: Pakistan's Water Crisis*. Washington, DC: Woodrow Wilson International Center for Scholars.
- Berkes, F. and M. T. Farvar (1989) Introduction and Overview. In F. Berkes (ed.) *Common Property Resources: Ecology and Community-based Sustainable Development*. London: Balhaven Press. pp. 1–17.

- Bhutta, M. N. (2006) *Bringing Drainage Towards Integrated Water Resources Management in the Indus Basin, The World Water Day*. Lahore: Pakistan Engineering Council. pp. 41–52.
- Briscoe, J. and U. Qamar (2009) *Pakistan's Water Economy Running Dry*. Oxford Uni. Press.
- Dinar, A., T. K. Balakrishnan, and J. Wambia (2004) Politics of Institutional Reforms in the Water and Drainage Sector of Pakistan. *Environment and Development Economics* 9, 409-445. doi: 10.1017/S1355770X0300127X.
- Faisal, K. (2009) Water, Governance, and Corruption in Pakistan. In M. Kugelman and R. M. Hathaway (eds.) *Running on Empty: Pakistan's Water Crisis*. Washington, DC: Woodrow Wilson International Center for Scholars.
- Haines, T. D. (2011) *Building the Empire, Building the Nation: Water, Land, and the Politics of River-development in Sindh, 1898-1969*. Royal Holloway College. University of London. p. 292.
- Hardin, G. (1968) The Tragedy of the Commons. *Science* 162, 1243-1248.
- Hardin, G. (1994) The Tragedy of the Unmanaged Commons. *Trends in Ecology and Evolution* 9, 199–199.
- Hardin, G. (1998) Extensions of “The Tragedy of the Commons”. *Science* (Washington) 280, 682–683.
- Memon, J. and G. Thapa (2011) The Indus Irrigation System, Natural Resources, and Community Occupational Quality in the Delta Region of Pakistan. *Environmental Management* 47, 173–187.
- Memon, N. A. (2006) Participatory Irrigation Management and Institutionalising Irrigation Service in Sindh. In I. Hussain, Z. A. Gill, Z. Naseer, and S. Sarwar (eds.) *INPIM's 9th International Seminar Participatory Irrigation Management*. Lahore: INPIM. pp. 78–93.
- Mulk, S. U. (2009) Pakistan's Water Economy, the Indus River System and Its Development Infrastructure, and the Relentless Struggle for Sustainability. In R. M. Hathaway and M. Kugelman (eds.) *Running on Empty: Pakistan's Water Crisis*. Washington, DC: Woodrow Wilson International Centre for Scholars. pp. 64–81.
- Murray-Rust, H., Y. Memon, and M. Talpur (2001) *Empowerment of Farmer Organisations—Case Study of Farmer Managed Irrigated Agriculture Project, Sindh*. Lahore: International Water Management Institute. 24 pp.
- Mustafa, D. (2002a) Theory Versus Practice: The Bureaucratic Ethos of Water Resource Management and Administration in Pakistan. *Contemporary South Asia* 11, 39–56.
- Mustafa, D. (2002b) To Each According to His Power? Participation, Access, and Vulnerability in Irrigation and Flood Management in Pakistan. *Environment and Planning D: Society and Space* 20, 737–752.
- Nabi, I., N. Hamid, and S. Zahid (1986) *The Agrarian Economy of Pakistan: Issues and Options*. Karachi: Oxford University Press.
- Official Correspondent Daily Dawn (2004) Mirpurkhas: Farmers to Pay Drainage Tax. Daily Dawn, Internet Edition ed. The DAWN Group of Newspapers, Mirpurkhas.
- Pakistan, Government of (2012) *Pakistan Economic Survey 2010–2012*. Islamabad: Ministry of Finance, Finance Division, Economic Adviser's Wing.

- Prathapar, S. A., M. Hassan, Z. I. Mirza, and Z. Tahir (2001) Constraints on Enforcement of Water Policies: Selected Cases from South Asia. In D. Brennan (ed.) *Water Policy Reform: Lessons from Asia and Australia (an International Workshop)*. Bangkok, Thailand: Australian Centre for International Agricultural Research. pp. 171–176.
- Qureshi, A. S., P. G. McCornick, M. Qadir, and Z. Aslam (2008) Managing Salinity and Waterlogging in the Indus Basin of Pakistan. *Agricultural Water Management* 95, 1–10.
- Schlager, E. and E. Ostrom (1992) Property-rights Regimes and Natural Resources: A Conceptual Analysis. *Land Economics* 68, 249–262.
- Sindh Governor House (2002) *Sindh Water Management Ordinance 2002*. (Sindhi Edition ed). Hyderabad: Sindh Irrigation and Drainage Authority. p. 112.