Research article

Factors Influencing Equity in Farmer-managed Irrigation Distribution in Sindh, Pakistan

JUNAID ALAM MEMON*
Pakistan Institute of Development Economics, Islamabad, Pakistan
Email: memon@gmx.us

FATEH MUHAMMAD MARI
Sindh Water Sector Improvement Project, Karachi, Pakistan

Received 24 December 2012 Accepted 10 June 2013 (*Corresponding author)

Abstract Equitable distribution of irrigation has been one of the most compelling justification for irrigation management reforms in many countries. Policy response to such need in Pakistan had been the introduction of farmer-management of tertiary level irrigation affairs. This study presents an empirical analysis of the effect of reforms on equitable irrigation distribution in Farmer Organizations (FO) of three Area Water Boards (AWBs) in Sindh, Pakistan. Cross-sectional quantitative information obtained from secondary sources included the official datasets on irrigation discharge measurements, FO maturity indexes and FO profiles prepared by Sindh Irrigation and Drainage Authority (SIDA) and Water Sector Improvement Project (WSIP-I). A multinomial logistic regression model, having Equity between Head and Tail watercourses as the regressand and Institutional maturity index, Culturable command area, and Membership size of FO as the regressors_were used to model the determinants of Equity in Farmer-managed Irrigation Distribution. The study identified institutional maturity as one of the influential factors explaining variation in the irrigation delivery performance of FOs. With some caveats, findings have useful policy implications for the success of irrigation reforms for sustainable agriculture in Sindh Province of Pakistan.

Keywords farmer-managed irrigation, irrigation equity, delivery performance ratio, Pakistan

INTRODUCTION

Irrigation is the lifeline for millions of poor who eke out their livelihood from agricultural activities carried out in the developing regions of the world. As a key component of the green revolution package, developing countries have invested heavily in building irrigation infrastructure like dams, diversion structures and irrigation networks. The benefits of such investments can be observed from the fact that the total area under irrigation has more than doubled during 1961-2003 (Gleick et al., 2011). Probably it would not be exaggerating to say that human civilization avoided the Malthusian pessimism of food shortages and hunger (Malthus, 1806) partly because of the advances in irrigation engineering and technology. Today, agriculture consumes 60 percent of freshwater withdrawal worldwide, 69 percent in Africa and 75 percent in Asia, whereas in some countries, this figure could be as high as 99 percent (Gleick et al., 2011). Since 1950s, the irrigation policies in various developing countries had largely been an artifact of international donors (Suhardiman and Mollinga, 2012).The importance of irrigation development on donor agenda can be understood from the fact that irrigation could secure more than seven percent of the total lending by the World Bank since 1950s (Plusquellec, 1999 cited in Bassi and Kumar, 2011). The extent to which the donor intervention in irrigation issues and policies in developing countries is qualified is something external to the scope of this paper. However, it worth reading the illuminating article by Suhardiman and Mollinga (2012) nicely describing the way in which the international donors authored, suggested and pushed national irrigation policies in developing countries in general and Indonesia in particular.

Over the years, the donor prescription of irrigation policy for developing countries has largely shifted from the infrastructure expansion to institutional development. The new narrative described the hydraulic bureaucracy as incapable of making full cost recovery of irrigation service, adequate operation and management of infrastructure and equitable irrigation distribution; while assuming that if organized, farmers could efficiently manage the irrigation affairs (Bandaragoda, 2006; Memon, 2012; Mustafa, 2002; Suhardiman and Mollinga, 2012). The donors may have some empirical or systematic understanding of the inefficiency of hydraulic bureaucracy irrigation affairs, but it is highly tempting (see for example Suhardiman and Mollinga, 2012) to relate this shift to the ascendancy of participatory approaches promoted by Ostrom (1990), Chambers (1983, 1989, 1997) during the same period. Regardless of the label, the underline theme of reforms in most of the countries was full or partial involvement of farmers in different aspect of irrigation management (Bassi and Kumar, 2011; Poddar et al., 2011; Samad, 2002). Garces-Restrepo et al., (2007 cited in Bassi and Kumar, 2011) reported that 60 countries covering about 80 percent of the irrigated area worldwide have already implemented some form of institutional reforms in irrigation management. South Asian countries such as India (Arun et al., 2012; Poddar et al., 2011), Pakistan (Memon, 2012; Memon, 2006) and Sri-Lanka (Bandaragoda, 2006) were also not an exception of the donor driven reforms. All of these countries have initiated some form of Participatory Irrigation and Management (PIM) on secondary and tertiary level channels.

Institutional reforms in Pakistan are particularly important since the country features the Indus River, which houses a gigantic irrigation system unparalleled in the world. The system developed through substantial assistance of international donors. Consistent with donor narrative elsewhere in the world (see for example, Bandaragoda, 2006; Suhardiman and Mollinga, 2012), the external push for reforms triggered the policy shift for PIM, assuming that it will facilitate full cost recovery, adequate operation and management and equitable irrigation distribution (Memon, 2006). Memon (2012) reported that despite more than 15 years of implementation, the reforms were still in their infancy. Advocates often report Sindh province for its relatively better performance in the implementing the reforms, but actual implementation could hardly be seen beyond the canal command areas of three Area Water Boards (AWBs) against the targeted 14 canals (Memon, 2012). Call for speedy implementation of reforms in the remaining canal commands in Sindh Province might be reasonable, but there are virtually no empirical evidences suggesting the policymakers about the efficacy of the farmer-managed irrigation system in terms of full cost recovery, adequate operation and management of infrastructure and equitable irrigation distribution.

OBJECTIVE

Thus, the objective of this study was to carry out an empirical analysis of the extent to which the institutional reforms in the irrigation sector of Sindh Province in Pakistan could achieve its equitable irrigation distribution objectives hoping that findings will guide appropriate policymaking. In order to achieve this objective, the next section describes the materials and methods followed by a section on results and discussion. The final section concludes the study and draws policy implication besides highlighting the areas for future research.

METHODOLOGY

Selection of Study Area and Sample FOs

The study covered all three canal commands of Area Water Boards (AWBs) namely, Nara Canal AWB (NCAWB), Ghotki Feeder Canal AWB (GFCAWB) and Left Bank Canal AWB (LBCAWB) where the institutional reforms were implemented (Fig. 1). Farmer Organization (FO) served as the main unit of analysis. Selection of FOs was arbitrary based on the availability of required information across all data sources explained in the Table 1. This means that any FO, for which the required information was available, qualified the selection process. This process provided 34 FO (27 from NCAWB, four from GFCAWB and three from LBCAWB).

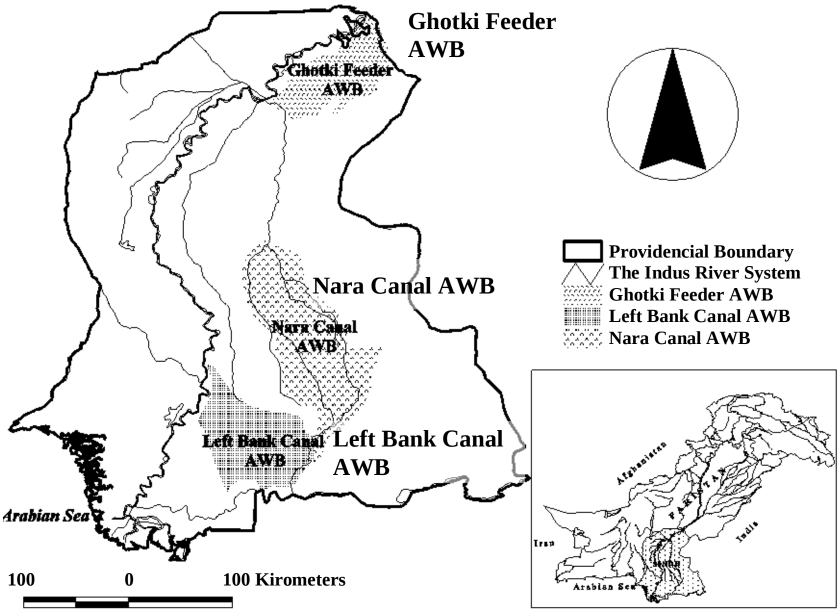

Fig. 1 Location of study area, main canals and three AWBs

Table 1 Description of data and indicators

Data set/Source	Description
1. Delivery Performance Ratio (DPR) (WSIP-I, 2012a)[1]	− DPR[3] calculated separately for any watercourse (WC): $DPR = ActualDischarge/MeasuredDischarge$ (1=getting designed share; <1= getting less than design share; and >1 getting more than the designed share) − Head to Tail equity[4] at the tertiary level channel was determined by: $HTEquity = (DPRHeadWC)/(DPRTailWC)$ (1= Equity between Head and Tail WCs of a FO; <1= Head WCs getting less than Tail WCs; and >1= Head getting more than Tail)
2. Institutional Maturity Index (2 Datasets) (SIDA,2012)[2] (WSIP-I, 2011)	− The institutional maturity index was the sum of four constituting indexes: 1. Organizational management 2. Financial Management 3. Conflict Resolution 4. O&M and Irrigation Service Delivery (Since both of the sources were different in terms of weights assigned to each of the above parameters, standardization was obtained by converting the original scores into percentages)
3. Profile Indicators (SIDA,2009) (WSIP-I, 2012b)	− CCA is Culturable Command Area in hectares irrigated on a tertiary channel − Size of FO (Membership)

Notes: [1.] *Water Sector Improvement Project* [2.] *Sindh Irrigation & Drainage Authority* [3.] *DPR calculated at Water Course level* [4.] *HT Equity calculated at FO level*

Materials and Methods

The study utilized secondary information obtained from two government agencies, namely: Sindh Water Sector Improvement Project (WSIP-I) and Sindh Irrigation and Drainage Authority (SIDA) (Table 1). Since the information was the part of official reports and publically inaccessible, the authors wrote emails and visited the concerned offices to get access. Some of the selected FO was present in both SIDA (2012) and WSIP-I (2011) maturity index datasets. In those cases, the information was extracted from the dataset provided by SIDA (2012) due to the consideration that it required no processing which could somehow affect the overall quality of the information.

Model Specification

Institutional reforms in the irrigation sector came out of a belief that organized and capable famers could take over the management responsibility of tertiary level irrigation affairs. This encouraged the policymakers to implant FOs and invest in building their institutional capacity until they become mature enough to assume the complete responsibility of tertiary level irrigation affairs. If such an assumption was reasonable, any increase in the maturity level of a FO could result in more equitable irrigation distribution. However, some other factors such as the membership size of FO and the agricultural area it served could also affect the equitable distribution of irrigation. With this premise, equity between head and tail watercourses (*HT Equity*) as dependent variable was regressed with three independent variables namely, the institutional maturity index of FO (*IMI*), the membership size of FO (*Mem*) and the culturable command area of FO (*CCA*). The dependent variable was re-coded into three categories (values < 0.90 = 1, head WCs drawing less water than tail WCs (*HDL*); values between 0.90 - 1.10 = 2, head and tail WCs drawing equal water (*HTDE*) by allowing ± 0.10 margin to 1:00 to account for technical and flow change reasons; and, >1.10 =3, head WCs drawing more water than tail WCs (*HDM*)). Thus, the dependent variable was categorical while all of the independent variables were continuous. Since *'HT Equity'* as a dependent variable had three categories, Multinomial Logistic Regression was an appropriate modelling choice. The model specifications were:

$$\log\frac{Pr(Y = HDL)}{Pr(Y = HTDE)} = \alpha + \beta_1 IMI + \beta_2 Mem + \beta_3 CCA$$
$$\log\frac{Pr(Y = HDM)}{Pr(Y = HTDE)} = \alpha + \beta_1 IMI + \beta_2 Mem + \beta_3 CCA \quad (1)$$

Where:
- *Y* was dependent variable: *HT Equity* having three categories (*HDL*, *HTDE*, &*HDM*)
- *HTDE* was the reference category
- *IMI*, *Mem* and *CCA* were independent variables
- α was a constant (the state of *HT Equity* without any effect of independent variables)
- β_1, β_2 *and*, β_3 were coefficient of independent variables

RESULTS AND DISCUSSIONS

An average FO in Sindh Province could be a sufficiently large entity all in terms of its social, geographic and operational attributes (Table 2). Serving thousands of hectares within the range of various kilometers and satisfying hundreds of farmers must be a complex task if purely seen from a micro lens of collective action problems. These complexities could multiply if one takes in to account the power structure in the agrarian society where landholding size symbolizes social status, power and prestige. The difference in land holdings of the largest and smallest farmer and in FOs indicates that not all of the members were equally advantageous in the local power structure (Table 2). Within this context of the complexities, shall one expect that a FO could achieve its objective of equitable irrigation distribution?

Based on the analysis of a small sample of arbitrarily selected FOs, the answer to the above question appears to be a cautious 'yes' (Table 3). Taking equity between head and tail watercourses as a base category of the dependent variable, the results of multinomial logistic regression revealed that with one percent increase in institutional maturity index score, while keeping all other independent variable constant, there is relative risk that the inequity will decrease for about 10 percent (Table 3). This seems to be valid in both cases of inequality, i.e. if head was drawing less irrigation than tail or head was drawing more irrigation than tail (Table 3). Relative risk that inequity of irrigation will decrease essentially implies that equity will increase. None of the other independent variable had any significant impact on equity except that membership size had significant impact on equity in the case of head watercourses drawing more irrigation than tail watercourses. With an increase of 10 members, a FO would probably move five percent towards equity (Table 3). If one looks at the effect of membership size with a "small is beautiful" lens, the contribution of membership size towards equitable irrigation distribution seems a paradox. This is because the complexities of irrigation management will perhaps increase with larger groups. Nevertheless, a valid explanation may come from the "mass effect" suggesting that increase in shareholders, will reduce the space for individual to demand more irrigation than their due share and thus compel FO management to ensure equitable irrigation distribution.

Table 2 Management context of an average FO in Sindh Province (N=354 FOs)

Salient Features (Unit)	NCAWB		GFCAWB		LBCAWB		Other AWB	
	x̄	SD	x̄	SD	x̄	SD	x̄	SD
CCA (Ha)	3280	3057	2659	2682	3457	2645	2414	2012
Design Discharge (Cusec)	35	32	59	57	112	102	68	91
Length of Channel (km)	10	13	12	11	11	6	9	3
Membership (Person)	280	231	347	401	348	383	280	138
Largest Landholder (Ha)	98	85	84	106	176	230	197	172
Smallest landholder (Ha)	3	2	2	3	5	22	2	2

Source: Prepared based on SIDA (2009)

Table 3 Results of multinomial logistic regression (irrigation equity as dependent variable)

Equity	RRR	Std. err	z	P> | z |	[95% confidence Interval]	
Head drawing less than tail						
– Institutional Maturity	.91991	.01055	–1.94	0.053*	.845374	1.001016
– Membership size	.98486	.01303	–1.15	0.249	.959645	1.010748
– CCA	1.00125	.00894	0.14	0.889	.983883	1.018921
Head drawing more than tail						
– Institutional Maturity	.89550	.01097	–2.45	0.014**	.819720	.978289
– Membership size	.95216	.02717	–1.72	0.086*	.900374	1.006927
– CCA	1.00987	.01113	0.89	0.373	.988291	1.031931

Notes:
1. *'Head and Tail are drawing equal' is the base outcome*
2. ** & ** denotes significance at 90 & 95 percent, respectively.*
3. *Supplementary statistics*

Number of observations	=	*34*
LR χ^2	=	*14.91*
Prob. > χ^2	=	*0.0210*
Pseudo R^2	=	*0.2154*
Log likelihood	=	*–27.15064*

CONCLUSION

Donors-pushed and demand-driven reforms in the irrigation sector posit various questions on the efficacy of FOs in achieving the intended objectives of PIM. One of the key questions raised in this study asked whether the implanted FOs could ensure equitable irrigation distribution. Drawing on the case of institutional reforms in Sindh Province of Pakistan, this paper concludes that it is plausible to expect that upon maturity FOs would deliver equitable irrigation distribution. Nevertheless, there are various caveats in accepting this conclusion. Surprisingly, when regressed individually none of the constituting indexes of IMI (Table 1) showed any significant impact on equity between head and tail watercourses. The impact came out only with the summation of the constituting indexes as IMI (Table 1). One may conclude that farmer organizations need an overall capacity building support in order to achieve its intended objectives. Nevertheless, given that the study was data constrained and carried out with a very small sample of arbitrarily selected FOs, this would be an imprudent jump into the conclusion. In order to serve as a real policy input, the study needs extension over adequate and representative sample of FOs. Such study should also include all constituting indexes as separate variables. This will not only confirm the tentative conclusions emerged out of this study but will inform policymakers about the specific areas of intervention for the success of institutional reforms in irrigation sector of Sindh Province.

ACKNOWLEDGEMENTS

The authors are extremely thankful to institutions – Sindh Irrigation and Drainage Authority, Sindh Water Sector Improvement Project – and officials Mr. Nazeer Ahmed Essani, General Manager Transition for providing access to the departmental datasets used in this study.

REFERENCES

Arun, G., Singh, D.J., Kumar, S. and Kumar, K., 2012. Canal irrigation management through water users associations and its impact on efficiency, equity and reliability in water use in Tamil Nadu. Agricultural Economics Research Review, 25, 409-419.

Bandaragoda, D.J. 2006. Limits to donor-driven water sector reforms: insight and evidence from Pakistan and Sri Lanka. Water Policy, 8, 51-67.

Bassi, N. and Kumar, M.D. 2011. Can sector reforms improve efficiency?: Insight from trrigation management transfer in central India. International Journal of Water Resources Development, 27, 709-721.

Chambers, R. 1983. Rural development: Putting the last first. Longman London.

Chambers, R. 1989. Managing canal irrigation: Practical analysis from South Asia. Cambridge University Press. USA.

Chambers, R. 1997. Whose reality counts?: putting the first last. Intermediate Technology Publications Ltd (ITP).

Gleick, P.H., Allen, L., Choen, M.J., Cooley, H., Christian-Smith, J., Heberger, M., Morrison, J., Palaniappan, M. and Schutle, P., 2011. The world's water Volume 7: The biennial report on freshwater resources (Data Tables). Island Press, Washington, Covelo, Landon. UK.

Malthus, T.R. 1806. An essay on the principle of population: or, A view of its past and present effects on human happiness. Reeves and Turner, London. UK.

Memon, J.A. 2012. Emerging issues in the implementation of Irrigation and Drainage sector reforms in Sindh Province of Pakistan. 28th AGM & Conference of PSDE Pakistan Institute of Development Economics. Islamabad, Pakistan.

Memon, N.A. 2006. Participatory irrigation management and institutionalizing irrigation service in Sindh, in: Hussain, I., Gill, Z.A., Naseer, Z. and Sarwar, S. (Eds.), INPIM's 9th International Seminar Participatory Irrigation Management. INPIM, Lahore, Pakistan, 78-93.

Mustafa, D. 2002. Theory versus practice: The bureaucratic ethos of water resource management and administration in Pakistan. Contemporary South Asia, 11, 39-56.

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press, New York, USA.

Poddar, R., Qureshi, M.E. and Syme, G. 2011. Comparing irrigation management reforms in Australia and India - a special reference to participatory irrigation management. Irrigation and Drainage, 60, 139-150.

Samad, M. 2002. Impact of irrigation management transfer on the performance of irrigation systems: A review of selected Asian experiences, in: Brennan, D. (Ed.), Water Policy Reform: Lessons from Asia and Australia. Australian Centre for International Agricultural Research, Bangkok, Thailand, 161-170.

SIDA. 2009. Profile of Farmers Organizations - 354 registered FOs up to April 2009. Social Development Cell of Sindh Irrigation and Drainage Authority, Hyderabad, Pakistan, 364.

SIDA. 2012. Institutional maturity index (IMI) of FOs. in: Transition Wing of Social Development Cell - SOFWMP (Ed.). Sindh Irrigation and Drainage Authority, Hyderabad, Pakistan, 20+Excel datashet.

Suhardiman, D. and Mollinga, P.P. 2012. Correlations,causes and the logic of obscuration: Donor shaping of dominant narratives in Indonesia's irrigation development. The Journal of Development Studies, 48, 923-938.

WSIP-I. 2011. FO Performance Quarterly Report (July - September, 2011). in: NESPAK (Ed.), Monitoring and Evaluation Consultants. Sindh Water Sector Improvement Project (ID:P084302), Karachi, Pakistan, 54.

WSIP-I. 2012a. Draft report on equity in water distribution based on Delivery Performance Ratio (DPR) during low flow season. in: NESPAK (Ed.), Monitoring and Evaluation Consultants. Sindh Water Sector Improvement Project (ID:P084302), Karachi, Pakistan, 48.

WSIP-I. 2012b. General assessment and profile of project farmer organizations. in: NESPAK (Ed.), Monitoring and Evaluation Consultants. Sindh Water Sector Improvement Project (ID:P084302), Karachi, Pakistan, 289.