Indian Journal of Agricultural Economics
Vol.75, No.2, April-June 2020

ARTICLES

Financial Performance of Major and Medium Irrigation Projects in India - Some Issues

Raj Kumar Kundu and Apurba Kumar Chattopadhyay*

ABSTRACT

Major and Medium (M&M) irrigation projects in India have lost its importance to ground water minor irrigation projects due to their financial problems resulting ostensibly from the highly subsidised and stagnant canal irrigation charges. This study examines financial performance of M&M irrigation projects during pre-reforms and post-reforms period and explores if higher irrigation charges may improve both irrigation efficiency and share of cost recovery. It has been found that during post-reforms period the M&M irrigation projects have faced problems of inadequate cost recovery coupled with continuous reduction of expenditure on 'maintenance and repair' which have led to reduction of irrigation efficiency. We have also found that only increasing the irrigation charges by the states may not bring about higher irrigation efficiency rather, it would be prudent on the part of the concerned state governments to wind up the revenue departments and assign the responsibility for collection of users' charges to the Gram Panchayats that will improve the financial performance of the M&M irrigation projects and also increase efficiency of the canal irrigation.

Keywords: Canal irrigation, Irrigation charges, Irrigation efficiency, Financial performance, WUAs.

JEL: Q14, Q15, Q25

I

INTRODUCTION

The state governments operate and manage the entire irrigation system of the major and medium (M&M) projects within their domestic territories in India but they often neglect the operation and maintenance (O&M) part of the projects due to paucity of funds. This is partly due to the government policies regarding the level of water rates and their recovery (Gulati *et al.*, 1994). The share of cost recovery of the O&M cost or working expenses has steadily declined, *inter alia*, due to highly subsidised canal irrigation charges and substantial time lag for the revision of water rates by some states (about 10 to 35 years till 2010).[1] It may be noted that while in 1975-76, about 96 per cent of the working expenses could be met by gross receipts (water charges and other receipts); a meager 5.8 per cent could only be met for this purpose in 1997-98. In 2013-14, this share increased to about 20 per cent (CWC, 2015). The improvement in this share in the later years reflects increased water charges by some states. It may be noted that National Water Policy statements (1978 and 2002), Vaidyanathan Committee Report (Government of India, 1992) and Tenth

*Department of Economics, Syamsundar College, University of Burdwan, Burdwan and Post Doctoral Fellow, IISER Bhopal, Madhya Pradesh and Professor of Economics, Department of Economics and Politics, Visva-Bharati, Santiniketan-731 235, respectively.

Finance Commissions (Government of India, 1994) recommended that to meet the rising cost of O&M of the major and medium irrigation projects, the water rates should be raised in such a way that it covered at least the annual cost of O&M and a part of the capital cost. In addition, the Vaidyanathan Committee has suggested revision of water rates in every five years.

There exists diversity of opinion regarding raising the charges for the irrigation water. Gulati, *et al.* (1994), Mitra (1997), Reddy (2003), Ray (2005) and Mishra (2014) are in favour of raising irrigation charges and are of the view that in the present social and financial context of irrigation management in India, irrigation charges should be made to vary with its supply. Further, the representatives of user-farmers or Water User Association (WUA) should also be incorporated in the irrigation management system so that they may help rational distribution of scarce water among head-reach, middle reach and tail-end areas. The inclusion of WUA in the irrigation management is also expected to enhance the financial sustainability of the existing irrigation projects. Deshpande and Narayanamoorthy (2001), however, questioned the arguments in favour of increasing water rates based on the prevailing gap between gross receipts (GR) and working expenses (WE) of the irrigation projects. They have opined that since GR constituted the actual receipts or earnings and in most cases it is the fraction of the 'expected receipts', it was necessary to rationalise the expenditure, rather than increase the price of irrigation water. Rath (1997), on the other hand, has argued that water rate should be determined based on opportunity cost of water use. Irrigation charges, in fact, have been raised in some states from 1995 and it will be an interesting study to review its impact on efficiency and financial management.

Given as above, our main objectives are to examine: (i) irrigation and financial performance of M&M irrigation projects in India during pre-economic reforms and post-economic reforms period; (ii) whether raising of irrigation charges have improved irrigation efficiency and share of cost recovery of the states and (iii) if there exists any avenues on the part of the state governments to enhance cost-recovery without increasing irrigation charges and (iv) the ways to rationalise the government expenditure of any M&M irrigation project as suggested in Deshpande and Narayanamoorthy (2001). It may be noted that Deshpande and Narayanamoorthy have indicated that it was necessary to rationalise the expenditure, rather than increasing the price of irrigation water. However, they did not suggest the ways through which this could be accomplished. We have tried to bridge this gap in our study.

Data Source and Methodology

In this study, we have used data on government expenditure on M&M irrigation projects in India during 1974-75 to 2013-14 as available in the reports of the Central Water Commission (CWC), to examine our first objective. We have considered

government expenditures on O&M and direction and administrative (D&A) on the one hand and GR on the other. To examine our second objective we have selected all major states of India and used secondary data as available in CWC (2015). The Panel data fixed effect or least square dummy variable (LSDV) model has been used to examine inter-state financial performance of M&M irrigation projects. Our unit of analysis is 13 major states and their performance on M&M irrigation projects during 1974-78 (5th Five Year Plan (FYP)) to 2007-12 (11th FYP). Here, we have used five quantitative variables: (i) Y^{IPU} = proportion of irrigation potential utilised (IPU) to ultimate irrigation potential (UIP); (ii) $X_1^{D\&A}$ = share of D&A expenses to total WE; (iii) X_2^{GR} = share of GR to total WE; (iv) X_3^{COL} = real value (Rs.) of capital outlay per thousand hectare irrigation potential created (IPC) with 2010 as base year and (v) X_4^{IC} = irrigation charges. We have also used five dummy variables: (i) irrigation department (ID) undertaking both assessment and collection of irrigation charges [D_1^{ID} = 1], assessment done by ID but collection is done by the revenue department (RD) or RD undertaking both the activities, D_1^{ID} = 0; (ii) RD undertakes both assessment and collection of irrigation charges [D_2^{RD} = 1] otherwise, D_2^{RD} = 0; (iii) Performance of WUAs [D_3^{WUA} = 1 if their performance is good in the respective state, otherwise = 0], (iv) D_4^{IPMJ} indicates category of irrigation projects; D_4^{IPMJ} = 1 if number of major irrigation projects is greater than medium irrigation project, otherwise = 0 and (v) D_5^{AER} is time dummy. D_5^{AER} = 1; for the period after economic reforms or = 0, for the period prior to the economic reforms.

The LSDV models are given below:

$$Y_{ijt}^{IPU} = \alpha_{ijt} + \beta_{ijkt}\left(\sum_{q=1}^{4} X_{ijqt} + \sum_{d=1}^{5} D_{dijt} + \sum_{p=1}^{3} X_{pijt}\, D^{AER}{}_{ijt} + D_{ijt}{}^{WUA} D_{ijt}{}^{AER}\right) + U_{ijt}^{1} \quad \ldots. (1)$$

$$X_{ijt}^{D\&A} = \theta_{ijt} + \gamma_{ijkt}\left(\sum_{q=1}^{3} X_{ijqt} + \sum_{d=1}^{5} D_{dijt} + \sum_{p=1}^{3} X_{pijt}\, D^{AER}{}_{ijt} + D_{ijt}{}^{WUA} D_{ijt}{}^{AER}\right) + U_{ijt}^{2} \quad \ldots.(2)$$

$$X_{ijt}^{GR} = \varphi_{irt} + \mu_{ikjt}\left(\sum_{q=1}^{2} X_{ijqt} + \sum_{d=1}^{5} D_{dijt} + \sum_{p=1}^{3} X_{pijt}\, D^{AER}{}_{ijt} + D_{ijt}{}^{WUA} D_{ijt}{}^{AER}\right) + U_{ijt}^{3} \quad \ldots.(3)$$

where i = 1 to 13 states[2] and t = 1 to 8, i.e., 5th FYP to 11th FYP with one annual plan (1979-80). j = a, b, c (i.e., number of equations in each model). Further, k = number of parameters; q = number of quantitative variables, d = number of dummy variables and p = number of interaction dummy variables used. In this model, dummy variable 'AER' shows time constant. It disintegrates the entire data set into pre-economic reform (PRER) and post-economic reform (POER) periods. On the other hand, dummy variables IPMJ, WUAs, ID and RD show state characteristics and these are state constants. However, use of all these variables in a single equation will not be appropriate on econometric ground since this will give rise to serious problems of

multicollinearity and simultaneity (Gujarati, 2011). Therefore, we have derived three separate equations in each model to identify the impact of the respective independent variables on the respective dependent variables.

Further, in order to realise our third objective we have used data pertaining to the Damodar Valley Corporation (DVC) irrigation project of West Bengal. The required data relating to financial activities of DVC irrigation projects have been collected from the Superintending Engineer's Office, Damodar Irrigation Circle, Irrigation and Waterway Directorate, Govt. of West Bengal. This paper is organised in terms of five sub-sections: Section II discusses irrigation and financial performance of M&M irrigation projects in India during pre-reforms and post-reforms period. In Section III we examine the nexus between higher irrigation charges and irrigation efficiency at the inter-state levels and analyse the financial performance of DVC Project in Section IV. Finally, in Section V, we make concluding observations.

II

IRRIGATION AND FINANCIAL PERFORMANCE OF M&M IRRIGATION PROJECTS IN INDIA DURING PRE- AND POST-ECONOMIC REFORM PERIODS

During the last six decades, the canals in India have lost their importance vis-à-vis wells as the main source of irrigation. In 1950-51, canal irrigation contributed about 40 per cent of the net irrigated area, which reduced to about 24.5 per cent in 2011-12. On the other hand, well irrigation contributed only about 29 per cent in 1950-51 and its contribution increased substantially to about 61.6 per cent in 2011-12 (Government of India, 2015). There are several reasons for the loss of importance of the canal irrigation to the well irrigation but one of the important causes is – reduction of the share of maintenance and repairing cost on O&M expenses. Gulati *et al.* (2005) revealed that during the 1960s the share of 'maintenance and repairing' cost to total O&M expenses was between 60 to 70 per cent. However, from the 1970s it started falling gradually. It may be noted that water management for irrigation is a state responsibility and the availability of funds to the state governments is limited and decreasing. In this section, we have examined the irrigation efficiency and financial performance of M&M irrigation projects in India before and after economic reforms.

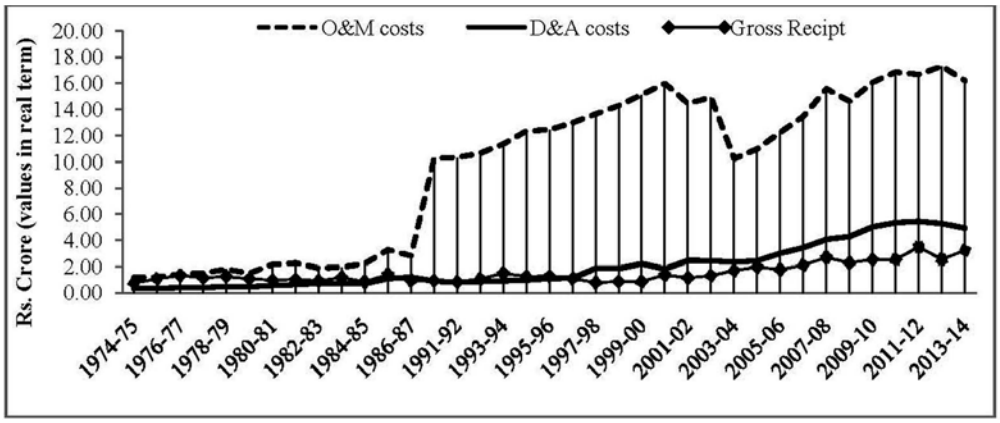
In 1951, the area under irrigation potential created (IPC) and irrigation potential utilised (IPU) under the M&M irrigation project was about 9.7 million hectare (m. ha). They have started to diverge thereafter. During 4th Five Year Plan (FYP) 1969-74, the area under IPC and IPU under the M&M irrigation project was about 20.7 m. ha and 18.39 m. ha, respectively. At the end of the 7th FYP (1985-90), India achieved IPC and IPU to the tune of 29.92 m. ha and 25.47 m. ha, respectively. Further, at the end of 11th FYP (2007-12) these figures were about 47.97 m. ha and 34.95 m. ha, respectively (Government of India, 2015). This implies that the gap between IPC and IPU during pre-economic reforms period (up to 4.45 m. ha or about 15 per cent) was

lower than that during the post reforms period (13.02 m. ha or about 27 per cent). According to Y.K. Alagh, the lower gap between IPC and IPU during the pre-reforms period may be explained in terms of the government's targeted programme for completing ongoing irrigation projects, which was started in 1975-76 as an instrument to support plan for food self-reliance and again in 1987-88 to give boost to the stagnating agricultural sector (Alagh, 2018). These programmes have helped to increase net irrigated area and irrigation intensity of Indian agriculture. However, in the post-reforms period, the gap between IPC and IPU widened even though the Accelerated Irrigation Benefit Programme (AIBP) was launched during 1996-97 for speedy completion of ongoing irrigation projects. The AIBP ultimately had failed to deliver. One of the reasons of its failure may be that the programme did not include a 'canal component to cover the last mile of water deliveries' among other things (Alagh, 2018, p. 49).

Further, the Command Area Development (CAD) programme was introduced in 1974-75 for adequate delivery of irrigation water up to the farmers' field through field channel construction that would enhance water use efficiency, production and productivity of crops per unit of land. During the pre-reforms period, 11.13 m. ha of field channel had been constructed, while in the post-reforms period it was only 9.7 m. ha (till the end of Eleventh Five Year Plan) (CWC, 2015).

It may be noted that there exists substantial variation of capital outlay on working expenses in M&M irrigation projects between pre-reforms and post-reforms periods. For instance, O&M costs in 1986-87 was about Rs. 492.7 crore which increased to about Rs. 3162.13 crore in 1992-93 and further to about Rs. 21853.08 crore in 2013-14 (Government of India, 1992; CWC, 2015). The emphasis of the government on 'new starts' is the main reason behind this sudden increase of the share of O&M in M&M irrigation projects during post reform period. 'New starts' is a process where Indian Government has tried to complete the ongoing projects (182 major and 312 medium) immediately which were in the advanced stage of completion (Government of India, 2011).

The Report of Working Group on M&M Irrigation for the 8th FYP revealed that the amount of money allotted for O&M of the existing irrigation projects was inadequate to manage the entire irrigation system because most of the allocated money for O&M was being spent on staff salary (Government of India, 1989). Thus, overhead expenses like wages and salaries occupied a significant part of the total amount of O&M expenses, leaving very little for actual maintenance and repairing purpose. The resulting impact was underutilisation of irrigation potential and reduced irrigation efficiency of the existing irrigation projects in the pre-reforms period. This led to various competent committees to recommend higher allotment for O&M expenses by the government. That is why government allocation for O&M increased suddenly in the post-reforms period to improve irrigation efficiency and to reduce underutilisation of irrigation potential of M&M irrigation projects (Figure 1).



Source: Government of India (1992) and CWC (2015).

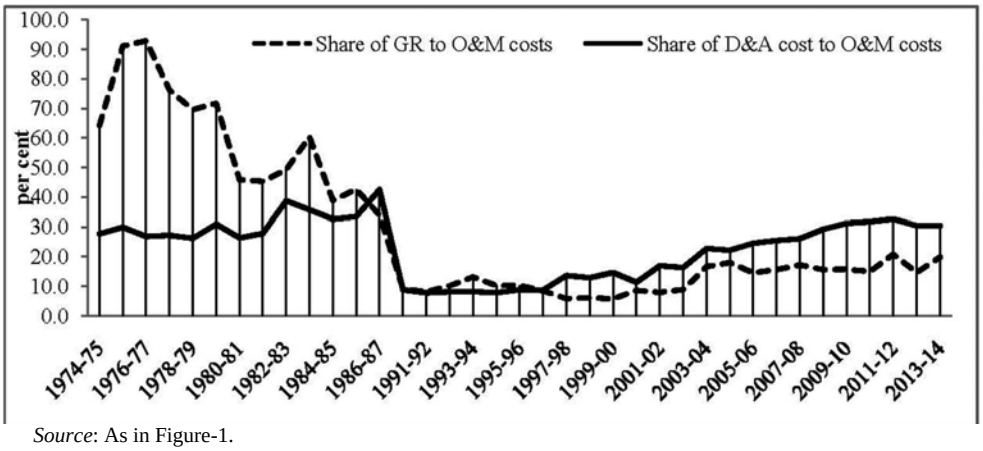
Note: Expenditure data of all categories are in real terms with 2010 as the base year. The data for the years 1987-88 to 1989-90 are not available (Gulati, *et al.*, 2005).

Figure 1. Government Expenditure on O&M Costs, D&A Costs and Gross Receipts (GR) during 1974-75 to 2013-14.

We have presented the share of direction and administrative (D&A) cost in total O&M costs in Figure 2. It reveals that the share of D&A cost, which was 27.7 per cent in 1974-75, increased steadily to reach 42.5 per cent in 1986-87, i.e., increased at a compound annual growth rate of about 3.35 per cent. But this share was reduced drastically from 1992-93 as the government increased allocation on O&M following the recommendations of various Working Groups of Irrigation Commission and Finance Commission. Interestingly, the share of D&A has started to rise again from 2000-01 and it increased from 8.1 per cent in 1992-93 to 30.4 per cent in 2013-14 with a compound annual growth rate of 6.2 per cent during post reforms period which is almost double the growth rate in the pre-reforms period. The share of D&A expenditure in total O&M costs is always increasing because of salary and other components, irrespective of efficiency of the projects in terms of delivery of water, farmers' income from cultivation and gross recovery (Deshpande and Narayanamoorthy, 2001). It is to be noted here that if D&A cost is allowed to increase at this rate then it will cross 42 per cent mark in 2019-20 and will be at par with the 1986-87 level and there will have similar demand for the increase of allocation for O&M.

Further, Figure 2 also reveals that during pre-reform period the share of gross receipts (GR) to O&M costs was more than the share of costs on D&A but after 1996-97, the share of GR was unable to recover the entire cost of D&A. In order to cover D&A cost, irrigation authorities have reduced their expenditure on other components of O&M costs, such as, 'maintenance and repair (M&R)' and 'machinery and equipment (M&E)'. The share of M&R was more than 60 per cent during 1960s, which started to decline thereafter (Gulati *et al.*, 2005). The share was reduced to 46 per cent during 8th Plan period (1992-97) and further to just 5 per cent

during 11th Plan (2007-12) period (Government of India, 2015). In consequence the gap between IPC and IPU has continuously widened and therefore, the irrigation efficiency[3] of the M&M projects has reduced from 85 per cent during the 7th Five Year Plan (1985-90) to 81 per cent during the 10th five year plan (2002-07) and further to about 73 per cent during 11th Five Year Plan (2007-12) (CWC, 2015).



Source: As in Figure-1.

Figure 2. Share of D&A Cost to O&M Costs and Share of GR to O&M Costs during 1974-75 to 2013-14.

Thus, it may be asserted that the inefficient management of financial aspects of M & M irrigation projects has resulted in reduction of irrigation efficiency of these projects and that the financial performance has been poorer during the post-reforms period compared to that during pre-reforms period and this has been reflected in terms of lower cost recovery, continuous reduction of expenditure on 'maintenance and repair' and 'machinery and equipment'. Therefore, it seemed logical to raise water charges so that the resultant increase of revenue (GR) can cover at least D&A cost and arrest impingement on irrigation efficiency; or the expenditure on D&A activities may be reduced in such a manner that it helps improvement of the financial management of the M&M irrigation projects. During the post-reforms period, some states have increased their irrigation charges to improve the share of cost recovery and used WUAs model to increase GR and irrigation efficiency. In the next section we will evaluate if the decisions of the states to raise irrigation charges have yielded the desired result.

III

HIGHER IRRIGATION CHARGES AND IRRIGATION EFFICIENCY: LOOKING AT THE NEXUS AT THE INTER-STATE LEVEL

It has been argued by many researchers (Gulati *et al.* 1994, 2005; Mitra, 1997; Nagaraj, 1999; Ray, 2005 and Shah *et al.* 2008) that canal irrigation charges levied on

the users are too low compared to the expenses incurred by government and also that the irrigation charges remained unchanged for absurdly long years in most of the states. Further, these canal irrigation charges are lower than the charges for well irrigation. This has led to inefficient use of canal water, which in turn has resulted in reduced irrigation potential utilisation (IPU) (Raby, 1991; Viswanathan, 2001, World Bank, 2005; Narayanamoorthy, 2007 and Mishra, 2014). Thus, they have recommended higher canal irrigation charges to reduce the burden of huge expenses on O&M. Even, the Working Group of the 12th Five Year Plan recommended that irrigation service fee collection should be increased by the state through WUAs to 50 per cent of the total working expenses for the M&M irrigation projects.

It may be noted that majority of the states in India have hiked their canal irrigation charges (IC) since 1995 (after a gap of 10 to 36 years) and that the average annual increase of IC ranged from 4 per cent to about 40 per cent (Table 2). In the post-reforms period percentage point change in IPU to UIP (irrigation efficiency) has been highest in Karnataka (34.41) although average annual increase of IC was modest (5.21 per cent). However, Maharashtra experienced about 25 percentage point increase in irrigation efficiency and average increase in IC had been highest (jointly with Orissa, about 40 per cent). Further, Gujarat experienced improvement in irrigation efficiency, although the average hike in the IC had been about 11 per cent. On the other hand, Orissa experienced just 12.11 percentage point increase in irrigation efficiency but the increase in IC was the highest. These data indicate an overall inverse relationship between irrigation efficiency and IC. The higher irrigation efficiency in Maharashtra even when hike in IC is very high is explained by the existence of better performing WUAs (Narayanamoorthy, 2007).

The above relationship is corroborated by our LSDV model (equation-1). The relevant data of the model showing state-wise financial performance of the M&M irrigation projects in India is presented in Table 1. It shows that if irrigation charges are increased by 100 per cent then irrigation efficiency will reduce by 1 to 0.2 per cent. Further, we have found that WUAs have positive impact (and statistically significant) on irrigation efficiency and the value of the coefficient is higher in post-reform period (16.76) compared to all period (11.7).

TABLE 1. STATE-WISE FINANCIAL PERFORMANCE OF THE M&M IRRIGATION PROJECTS IN INDIA

Factors	Equ_n-1a	Equ_n-1b	Equ_n-1c	Equ_n-2a	Equ_n-2b	Equ_n-2c	Equ_n-3a	Equ_n-3b	Equ_n-3c
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Y^{IPU}	#	#	#	×	×	×	×	×	×
$X_1^{D\&A}$	-0.23*	×	×	#	#	#	×	×	×
	(0.06)								
X_2^{GR}	×	-0.09*	×	0.001	×	0.1***	#	#	#
		(0.03)		(0.05)		(0.05)			
X_3^{COL}	0.48	1.26*	×	-0.67	×	-1.38	×	×	×
	(0.89)	(0.73)		(1.14)		(1.25)			
X_4^{IC}	-0.01*	-0.002***	-0.01*	×	×	×	0.02*	0.01**	0.02*
	(0.001)	(0.001)	(0.001)				(0.004)	(0.004)	(0.004)

Contd.

TABLE 1. CONCLD.

Factors (1)	Equ_n-1a (2)	Equ_n-1b (3)	Equ_n-1c (4)	Equ_n-2a (5)	Equ_n-2b (6)	Equ_n-2c (7)	Equ_n-3a (8)	Equ_n-3b (9)	Equ_n-3c (10)
D_1^{ID}	×	-18.97*	×	16.94*	14.82*	×	×	0.37 (12.50)	×
		(4.05)		(5.74)	(5.54)				
D_2^{RD}	×	9.47*	×	-15.03*	-13.67**	×	×	-15.35	×
		(3.42)		(5.67)	(5.51)			(10.44)	
D_3^{WUA}	11.7*	×	×	-18.94*	×	×	-24.83**	×	×
	(4.18)			(5.67)			(9.98)		
D_4^{IPMJ}	×	×	-6.49***	×	×	11.23***	13.97	×	15.84
			(3.84)			(5.88)	(10.74)		(10.73)
D_5^{AER}	×	6.51***	×	×	×	×	×	-41.45*	×
		(3.66)						(9.32)	
$X_1^{D\&A}$	×	×	-0.13**	×	×	×	×	×	×
D_5^{AER}			(0.06)						
X_2^{GR} D_5^{AER}	-0.08	×	×	×	0.18**	×	×	×	×
	(0.11)				(0.16)				
X_3^{COL} D_5^{AER}	×	×	0.13	×	-0.36	×	×	×	×
			(0.91)		(1.27)				
D_3^{WUA}	×	×	16.76*	×	-25.7*	×	×	×	-22.13**
D_5^{AER}			(4.98)		(5.99)				(10.36)
Constant	64.59*	55.78*	60.18*	41.88*	41.52*	28.42*	27.72*	58.12*	25.66*
	(3.64)	(3.67)	(3.35)	(4.48)	(3.89)	(4.27)	(8.95)	(9.62)	(8.93)
R^2	0.47	0.59	0.45	0.41	0.44	0.1	0.23	0.30	0.21
Adj R^2	0.44	0.57	0.42	0.38	0.41	0.07	0.20	0.27	0.19
F –value	17.25*	23.38*	15.91*	13.50*	15.45*	4.91*	9.67*	10.52*	9.02*
Obs.	104	104	104	104	104	104	104	104	104

Notes: # represents dependent variable; × implies concerned factor is not considered as independent variable in this model. *, ** and *** imply 1, 5 and 10 per cent level of significance, respectively.

Table 2 presents state-wise changes of IC and proportion of IPU to UIP during pre-reforms and post-reforms periods in India. It reveals that in Bihar and Madhya Pradesh IC increased about 10 per cent while irrigation efficiency declined during the post-reform period. This is because (1) higher percentage of D&A expenditure (more than 60 per cent) in Bihar and Madhya Pradesh compared to other states during this period for which irrigation department has been spending lower amount of their allotted money in the maintenance and repairing purpose (Figure 3) and resulting impact is lowering of irrigation efficiency. From equation-1a we have found that if share of D&A expenditure to WE is increased by 10 per cent then irrigation efficiency will reduce by 2.3 per cent. (2) Number of WUAs in Bihar is lowest (80) compared to other states and it covered only 11 per cent of gross canal irrigated area, while in Madhya Pradesh although the number of WUAs is more than two thousand, these are mostly inefficient or defunct (Shah, *et al.* 2016). Further, the irrigation inefficiency in Bihar is higher than that in Madhya Pradesh because the number of major irrigation project (MAIP) is higher than medium irrigation project (MEIP) in Bihar compared to Madhya Pradesh.[4] We get this relationship from equation-1c (Table 1, column 4). We may explain this phenomenon in terms of the huge length of canal network of a major irrigation project in comparison with the medium irrigation projects. Major irrigation projects are associated with tail-end

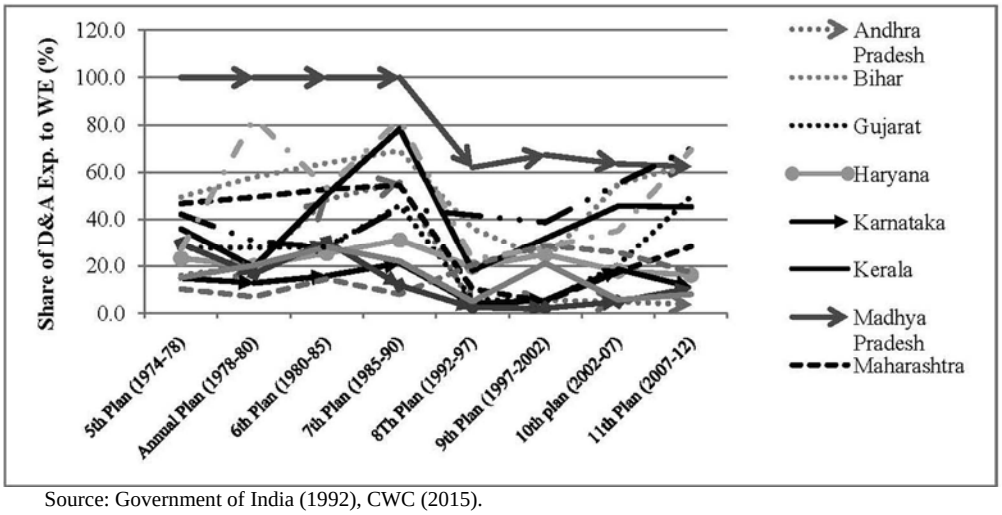
deprivation problem and incompetent use of canal water, which reflects inefficient management of its channel network (Kundu and Chattopadhyay 2020).

TABLE 2. STATE-WISE CHANGES OF IC AND PROPORTION OF IPU TO UIP DURING1974-78 TO 2002-07

	Pre-Reform (1974-78 to 1985-90)			Post-Reform (1992-97 to 2002-2007)			Average Annual increase of IC (per cent)	Use of UIP Up to 11th FYP (2007-12)
States	Year of change	Average IC (Rs./ha)	Per cent point change of IPU to UIP	First change after reform	Average IC (Rs./ha)	Per cent point change of IPU to UIP		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	1986	234.76	2.6	1996	691.6	7.22	19.46	64.9
Bihar	1983	102.3	13.5	1995	222.3	- 9.75	9.78	34.7
Gujarat*	1981	435	10.4	2001	1410	22.43	11.21	62.4
Haryana	1975	55.6	8.8	2000	111.15	1.98	4.00	63.1
Karnataka	1985	287.89	9.2	2000	512.75	34.41	5.21	93.3
Kerala	1974	68	-5.5	$	68	12.71	0.00	59.1
Madhya Pradesh	1984	163.09	5.4	2005	505	- 9.23	9.98	24.2
Maharashtra	1990	532.5	8.0	2003	3267.5	25.01	39.51	56.4
Orissa	1982	55.6	- 2.0	2002	495	12.11	39.51	52.2
Rajasthan	1982	82.78	17.6	1999	318.63	15.92	16.76	91.9
Tamil Nadu	1987	32.275	18.1	$	32.275	0.76	0.00	103.8
Uttar Pradesh	1983	144.03	11.4	1995	252	13.97	6.25	64.4
West Bengal	1977	81.305	- 17.7	$	81.305	10.48	0.00	68.4
India			7.3			11.23	15.14	59.9

Source: Government of India (1992) and Central Water Commission (2010).

Note: * after the economic reform irrigation charge was first increased to Rs. 1410 from Rs. 435 in 2001 which was subsequently reduced to Rs. 230 in 2007 and it was to increase annually by 7.5 per cent thereafter (GOG, 2017). $ implies no change.



Source: Government of India (1992), CWC (2015).

Figure 3. State-wise Share of D&A Expenses to Working Expenses (WE) in India during Pre-reforms and Post-reforms Periods.

It is interesting to note that till 11th FYP, Bihar and Madhya Pradesh have utilised only 35 per cent and 24 per cent of ultimate irrigation potential (UIP) respectively

which are lower than India's average (60 per cent). These two states as well as those states, which have covered less than 60 per cent of UIP, should increase utilisation of canal irrigation potential that will help to improve their agricultural production, farm income and underground water level. Development of irrigation infrastructure has long been perceived as a technique of development since it helps to increase cropping intensity, reduce probability of crop failures, raise yields of crops and thereby help farmers earn adequate income from cultivation (Dhawan, 1988; Vaidyanathan, 1999; Viswanathan, 2001; Narayanamoorthy and Kalamkar, 2005). It may be noted that irrigation efficiency and gross receipt (GR) are inversely related and this is indicated by the negative coefficients of X_2^{GR} and $X_2^{GR}D_5^{AER}$ (Column 2 and 1, Table 1). There is also not much variation in between values of the coefficients corresponding to the entire period under study and the post-reforms period. Therefore, enhancement of gross receipt does not help to improve irrigation efficiency of the M&M irrigation projects.

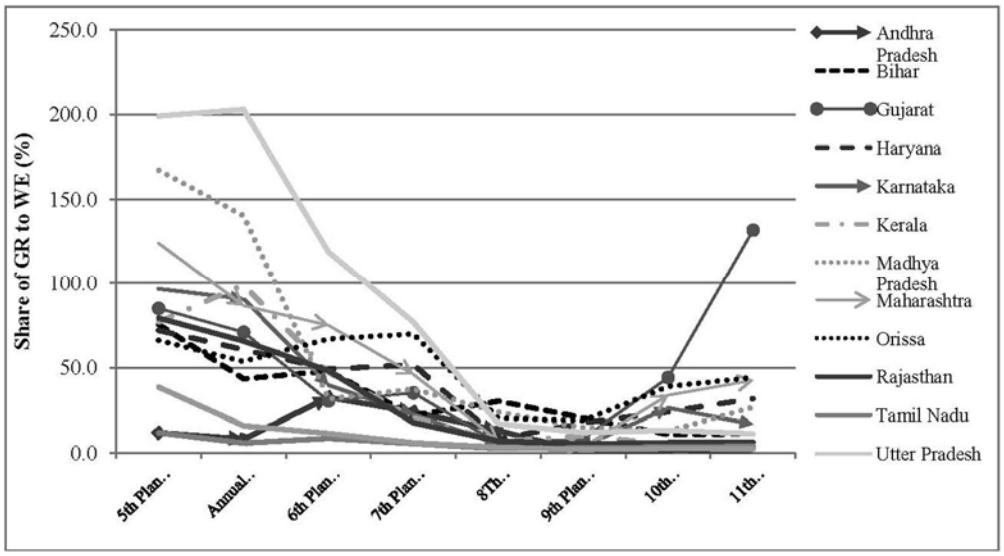
Table 2 also reveals that there have been no changes in IC in West Bengal, Kerala and Tamil Nadu. During pre-reforms period irrigation efficiency declined in the first two states while it increased during post-reforms period in all the states. Tamil Nadu is the only state, which has covered their entire UIP within 7th FYP for which growth rate of IPU is lower during the post-reforms period. It may be noted that increase in irrigation efficiency is higher in Kerala (13 percentage point) compared to West Bengal (10 percentage point) during post-reforms period even though the number of major irrigation projects is higher than medium irrigation projects (10 and 7 respectively) in Kerala while in West Bengal it is 6 and 17, respectively. This is because (1) WUAs have covered more than 32 per cent of gross irrigated area in Kerala while it covered only 2.35 per cent in West Bengal (CWC, 2015). (2) Revenue department (RD) undertakes both assessment and collection of irrigation charges in Kerala while in West Bengal these are done by the Irrigation department (ID) for which the share of D&A expenses to WE is always higher in West Bengal compared to Kerala which has lowered irrigation efficiency in West Bengal. It is corroborated by our model and this is also statistically significant (column 3, Table 1). (3) Average capital outlay (Rs.'000 ha) both in pre-reforms and in post-reforms periods is lower in West Bengal (0.46 and 0.60 crore respectively) compared to Kerala (1.93 and 1.59 crore respectively). From our LSDV model (Equation-1b) we have found that capital outlay has positive impact on irrigation efficiency. Thus, from the state-wise comparative study of M&M irrigation projects during pre-reforms and post-reforms periods we have found that the overall improvement in irrigation efficiency in the post-reforms period is only about 4 percentage points higher compared to the pre-reforms period (Table 2). This is because (1) there were larger number of major irrigation projects (MAIP)[5] in the post-reforms period compared to the pre-reforms period and (2) the average capital outlay per thousand ha was higher in the pre-reforms period compared to the post-reform periods (0.72 and 0.43 crore, respectively) (CWC, 2015).

It may be discerned from Table 1 (column 5, equation-2a) that WUAs has negative impact on D&A cost. Therefore, if the WUAs are involved in the affairs of M&M irrigation projects, the share of D&A cost in total O&A cost or working expenses will decline. Our model also reveals that the involvement of Irrigation Department (ID) and the Revenue Department (RD) have opposite impact on the share of D&A. It is found that if the ID undertakes the responsibility of both assessment and collection of irrigation charges, the share of D&A cost will increase significantly. Nevertheless, if the same responsibility is assigned to the RD, the share of D&A cost will reduce and the reduction will be more pronounced if WUAs are allowed to work in tandem. In the post-reforms period, because of the greater role of the WUAs and their wide institutionalization, its role in reducing the share of D&A cost has been increased (the value of the coefficient increased from -18.94 to -25.7). Further, greater involvement of the irrigation department (ID) in assessment and collection of IC increases D&A expenditure significantly. This can be clearly observed from Figure 3 in respect of Madhya Pradesh, Bihar and West Bengal but due to better performance of WUAs in Gujarat and Maharashtra, its impact is moderated. However, the share of D&A cost is significantly lower in Andhra Pradesh, Rajasthan, Tamil Nadu, Karnataka and Orissa where the respective revenue departments (RD) undertake both the activities.

It is interesting to note that (column 7, Table 1) category of the irrigation project is directly related to the expenditure on D&A. This implies that states having larger number of major irrigation projects relative to medium irrigation projects will experience higher D&A expenditure and vice versa. This is because the former requires higher maintenance and management cost to manage their longer and large number of channel network but this is not the case with the latter. This is reflected in Figure 3 pertaining to Bihar, Uttar Pradesh, Kerala and Haryana where proportions of MAIP to MEIP are higher. However, in Madhya Pradesh D&A cost is always higher compared to the other states because its Irrigation Department undertakes several works such as, non-agriculture water supply for household and industrial uses, water management for irrigation, assessment and collection of water charges from both farm and non-farm sectors. Further, our model also reveals that, the gross receipt (GR) is positively related with D&A expenditure. This is obvious because the Irrigation Department or Revenue Department needed to incur higher D&A cost on the salary of staff to assign and collect water charges.

Figure 4 depicts the graph of state-wise share of gross receipts (GR) to working expenses (WE) in India over the period of our study. It clearly shows that the share of GR to WE declined in all states of India from 5th FYP to 9th FYP and started to increase moderately in some states thereafter. However, our model reveals that overall this ratio declined significantly in the post reforms period also (column 9, Table 1). Further, our model reveals that if irrigation charges were to increase by 100 per cent then share of GR to WE would have increased by only 1 per cent to 2 per

cent (columns 8-10, Table 1). Therefore, hiking of irrigation charges has only marginal impact on working expenses.



Source: same as Figure 3.

Figure 4. State-wise Share of GR to WE in India during Pre-Reforms and Post-Reforms Periods.

Interestingly, from Figure 4 we find that during post-reform period the share of GR to WE has markedly increased since the 10th Five Year Plan in Gujarat. This is because of very high industrial water charges (from rupees 15 to rupees 30 per thousand liter of water) which became effective in 2011.[6] It also shows that the share of GR to WE is very high in Uttar Pradesh followed by Madhya Pradesh and Maharashtra in the pre-reforms period. This is because their higher revenue recovery rates (95 per cent, 90 per cent and 73 per cent respectively) (CWC, 2010). It may also be noted that the percentage of cost recovery is higher in the pre-reforms period compared to the post-reforms period because real value of water charges in the post-reform period is lower than pre-reform period in all states except Maharashtra, Orissa and Andhra Pradesh.

Furthermore, Table 1 (column 8) reveals that WUAs is negatively related with share of GR to WE and this relationship is statistically significant. This means that WUAs are unable to reduce financial burden of M&M irrigation projects by raising GR. However, WUAs may render very important service in managing distribution of canal waters among the recipients of water in different segments of the canal network, viz., distribution of canal water among farmers in head reach, middle reach and tail end areas. These Associations also help to reduce tail end deprivation and provide a link between the irrigation authorities and water users. In this way, WUAs

may be able to improve irrigation efficiency and reduce burden of high D&A cost in respect of canal water management. This has been corroborated in Gandhi and Namboodiri (2002). In a related study Gandhi and Namboodiri (2011) have indicated that active performance of WUAs may be instrumental in increasing gross cropped area by more than 8 per cent and gross irrigated area by about 32 per cent. The WUAs have significant role in increasing crop yield and improving water use efficiency. Moreover, irrigation department may be able to reduce its financial burden by shifting its responsibility of water distribution and channel network management to the WUAs. This will also ensure long-term sustainability of the existing irrigation projects (Vermillion, 1991). Furthermore, Asian Development Bank (2008) has found that after introduction of WUAs in the major irrigation projects crop yield rate has increased by 15-25 per cent in the tail-end areas in Andhra Pradesh because of increased water availability. The above analysis reveals that active performance of WUAs may not help in increasing relative gross receipts of the M&M irrigation projects but it will help to increase irrigation efficiency and reduce burden of high D&A cost. Further, higher irrigation charges will have negative impact on the irrigation efficiency of M&M irrigation projects. Thus, hiking of water charges and simultaneous incorporation of WUAs without their active involvements in the irrigation management may not be the best solution to reduce financial burden of the M&M irrigation projects.

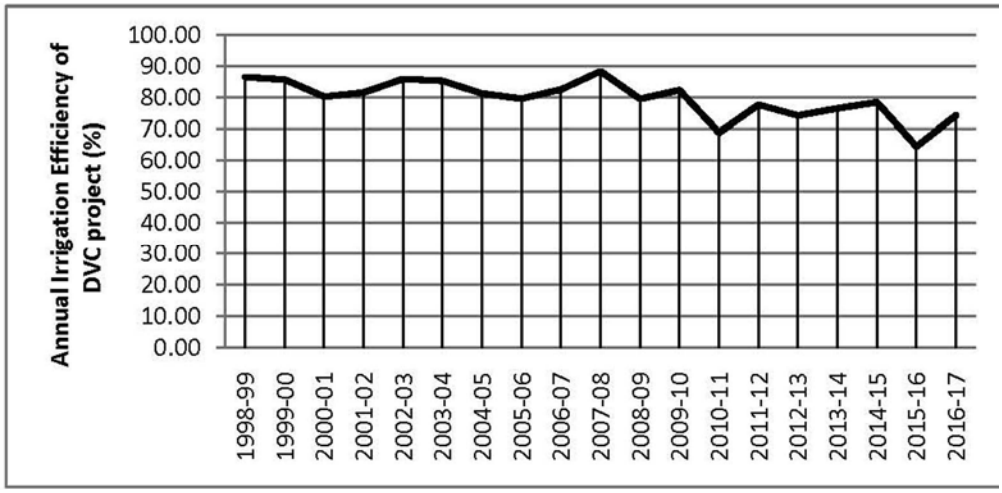
Therefore, we need to seek alternative measures to reduce the financial burden of M&M irrigation projects as well as to rationalise the expenditure in such a manner that will improve irrigation efficiency. In the next section, we have examined how the cost recovery of M&M irrigation project may be increased without increasing the IC by using secondary data pertaining to the Damodar Valley Corporation (DVC) multipurpose irrigation project.

IV

FINANCIAL PERFORMANCE OF DVC PROJECT IN WEST BENGAL

It is interesting to note that the annual O&M costs in West Bengal has increased from about Rs. 61 crore 1992-93 to Rs. 338 crore in 2013-14 which amounts to about 5.54 times increase. However, expenditure on Direction and Administration (D&A) which is the main constituent of O&M costs have increased by more than 12 folds during the same period (CWC, 2015). On the other hand, the annual cost recovery of O&M cost had been about 3.5 per cent in 1992-93, which slightly increased to 4.13 per cent in 2012-13. We have tried to make an appraisal of financial performance of DVC major irrigation project by using two parameters: (i) annual O&M cost which includes expenditure on extension and improvement (E&I), expenditure on water course development (WCD) and direction and administrative expenditure for revenue collection and (ii) cost recovery by water sale for irrigation and others.[7]

The increase in irrigation efficiency depended on expenditure on E&I and WCD of canal network. It has been found from the documents of DVC authorities that on an average only 9 per cent of total expenditure of O&M has been spent on E&I and WCD. But, more than 90 per cent of total expenditure was spent to meet D&A expenditure. So there is no wonder that neglect of extension and improvement and water course development resulted in declining irrigation efficiency of the DVC project throughout the period (Figure 5). Using primary as well as secondary data, Kundu and Chattopadhyay (2020) has shown that inept irrigation management on the part of the DVC authorities has made the DVC irrigation project inefficient and resulted in tail-end deprivation of irrigation water. This deprivation rate increased over the year from 35.26 per cent in 1998-99 to 42.71 per cent in 2013-14. Ray and Williams (1999) has found similar result in their study of Deccan Plateau canal network in Western Maharashtra.

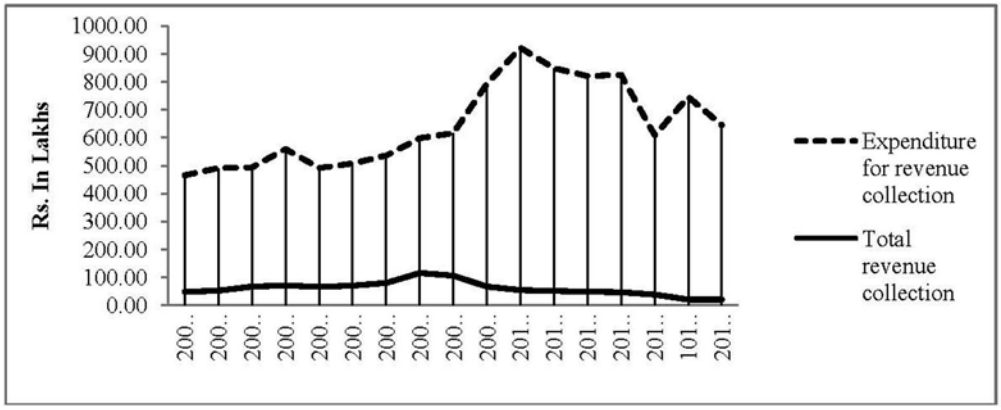


Source: GOWB (2013) and Superintending Engineer, Damodar Irrigation Circle, Irrigation and Waterway Directorate, Government of West Bengal.

Figure 5. Irrigation Efficiency of DVC Irrigation Project during 1998-99 to 2016-17.

Let us now turn our attention to the revenue generation aspect of the DVC project. During 2000-01 to 2016-17, for which data are available, only about 7.37 percent of working expenses (O&M) is recovered by the gross receipts (GR) which is collected from both sale of water (1.59 per cent) and others (5.79 per cent); while separately it covers about 21 per cent of E&I and WCD costs; or about 8.92 per cent of D&A expenditure. Further, we have also found that less than 50 per cent of expected revenue from IC is collected by the Revenue Department. However, it may be noted that even if 100 per cent of the expected revenue were collected by the Revenue Department then also only 30 per cent of expenditure of the Revenue Department would have been covered.

Figure 6 highlights the gap between total revenue collection and expenditure for collection of revenue, which remains substantially high during the entire period. This means that the Revenue Department is unable to cover their own expenditure. Thus, it would be beneficial for all concerned if the Revenue Department for collection of irrigation charges were wound up and responsibility for collection of users' charges be given to the Gram Panchayats (GPs). Since, it would be easier for the farmers to pay users' charges to the Gram Panchayats, which is familiar to them. In Tripura, Block Advisory Committees have taken the responsibility to collect irrigation charges (CWC, 2010). Further, by withdrawing the Revenue Department and by not imposing any irrigation charges on the users, West Bengal government would save on an average more than six crore rupees per year which could well be used for enhancing irrigation efficiency and thereby arrest, to some extent, ground water depletion. This may be the reason for some state governments in India (Arunachal Pradesh, Mizoram, Meghalaya, Nagaland, Andaman and Nicobar and Lakshadweep) to withdraw canal irrigation charges (CWC, 2010).



Source: Superintending Engineer, Damodar Irrigation Circle, Irrigation and Waterway Directorate, Govt. of West Bengal

Figure 6. Expenditure of Revenue Department and Revenue Collection from DVC Project during 2000-01 to 2016-17.

V

CONCLUDING OBSERVATIONS

M&M irrigation system has some advantages[8] that have not been explored in several studies, which tended to opine it as an inefficient irrigation system in view of the potential area under irrigation and government expenditure. It is a reality that canal irrigation has lost its importance to the ground water (well) irrigation. There are several reasons for the loss of importance of the canal irrigation to the well irrigation but one of the most important causes is poor management of M&M irrigation projects (Gulati *et al*., 2005; Chattopadhyay 2014). This study has revealed that during pre-reform period the share of direction and administrative (D&A) cost to operation and

maintenance (O&M) cost increased from 27.7 per cent in 1974-75 to 42.5 per cent in 1986-87 at an annual compound growth rate of 3.35 per cent. This created scarcity of resources for the crucial maintenance and repairing works, which in turn, necessitated larger allocation by the government on operation and management (O & M) cost following the recommendations of the Finance Commission and other agencies. We have further found that in the post-reform period, the share of D&A cost to O&M costs has been increasing at an annual compound rate of 6.2 per cent and it is expected to cross 42 per cent level in 2019-20, which may again require even lager government support. Further, share of 'maintenance and repair' cost has been substantially declining from 46.25 percent in 8th FYP to 5.44 percent in 11th FYP to meet excess demand of D&A expenses during post-reform period. Furthermore, during pre-reform period the share (as well as absolute value) of gross receipts was more than the D&A cost while after 1996-97 or during earlier stage of the economic reform, gross receipts was unable to cover entire D&A purpose cost. Thus, during post-reform period the M&M irrigation projects have faced problems of inadequate cost recovery in comparison with pre-reforms period. Coupled with this there has been continuous decline of expenditure on 'maintenance and repair' and the resultant effect is steadily declining irrigation efficiency of the exiting M&M irrigation projects. Therefore, it is necessary for both state and central governments to moderate their expenditure on D&A activities in such a manner that it will not create adverse impact on irrigation efficiency but will ease financial constraint of the M&M irrigation projects and raise gross receipts which would cover D&A cost, at the least.

We have also found that during post-reforms period (1992-93 to 2011-12), majority of the states of India have raised canal irrigation charges and incorporated WUAs in the water distribution system in order to reduce the financial burden and improve irrigation efficiency. Our study shows that irrigation charges are inversely related with irrigation efficiency and incorporation of WUAs may not be the best solution to raise gross receipts of the project.

Therefore, in order to improve irrigation efficiency and cost recovery of M&M irrigation projects, government needs to do the following: (i) Rationalise expenditure on M&M irrigation projects. (ii) Involve the WUAs only for management of canal water distribution rather than for collection of irrigation charges. (iii) Aim to reduce the share of D&A expenses in total O&M expenses and thereby increase the share of 'extension and improvement' cost for improving irrigation efficiency. (iv) The government should consider hiking the canal irrigation charges annually by about 5 percent as suggested in (CWC 2010) and practiced by Karnataka. Finally, (v) as the amount of revenue collected by the Revenue Department from the M&M irrigation projects is less than the expenditure incurred for the collection of the same; it would be beneficial for all concerned if the Revenue Department is withdrawn from the affairs of the M&M irrigation projects and responsibility for collection of users' charges are given to the Gram Panchayats. This is because it would be easier for the

farmers to pay users' charges to the Gram Panchayat official who collects usual village level taxes and is familiar to them.

Received May 2019. *Revised July 2020.*

NOTES

1. Kerala (35 years), West Bengal (33 years), Tamil Nadu (23 years), Haryana and Karnataka (10 years), etc. CWC (2010).

2. The states of Himachal Pradesh (HP) and Punjab were not considered for lack of required data.

3. Irrigation efficiency = (IPU ÷ IPC) ×100 (GOWB, 2013)

4. In Bihar number of completed MAIP is 16 and MEIP is 19 while in Madhya Pradesh it is 11 and 101 respectively (GOI, 2010).

5. The ratio of completed MAIP and MEIP in the pre-reform period was 0.16 = 67/425 while in the post-reform period it was 0.53 = 116/220.

6. https://timesofindia.indiatimes.com/city/ahmedabad/Gujarat-to-double-water-charges-for-industry/article show/ 6910841.cms (Rajiv Shah, *Gujarat to double water charges for industry*, Times of India, Nov. 2010, 3.24 P.M)

7. Rent from buildings, toll from bridge, etc.

8. It increases underground water level, reservoir or barrage with canal irrigation help to reduce intensity of flood in the downstream area and can facilitate navigation. Further, pisciculture in canals and reservoirs may increase farmers' income, etc.

REFERENCES

Alagh, Yoginder Kumar (2018), *Economic Policy in a Liberalising Economy: Indian Reform in this Century*, Springer, Singapore.

Asian Development Bank (2008), *Irrigation Management Transfer: Strategies and Best Practices*, Sage Publications India Pvt. Ltd., New Delhi.

Central Water Commission (2010), *Pricing of Water in Public System in India*, Water Planning and Project Wing, Government of India, New Delhi, October.

Central Water Commission (2015), *Financial Aspects of Irrigation Projects in India*, Government of India, New Delhi, December.

Chattopadhyay, A.K. (2014), "Water Resources in India: Some Issues in Irrigation Management", in S. Pan (Ed.) (2014), *Economic Reforms and Common Property Resources: Issues and Challenges*, Regal Publications, New Delhi.

Deshpande, R.S and A. Narayanamoorthy (2001), "Issues Before Second Irrigation Commission of Maharashtra", *Economic and Political Weekly*, Vol.36, No.12, 24 March, pp. 1034-1043.

Dhawan, B.D. (1988), *Irrigation in India's Agricultural Development*, Sage Publications India Pvt. Ltd., New Delhi.

Gandhi, V.P. and N.V. Namboodiri (2002), *Investments and Institutions for Water Management in India's Agriculture: Policies and Behaviour*, in Donna Brennan (Ed.) (2002), Water Policy Reform: Lessons from Asia and Australia, Australian Center for International Agricultural Research, Canberra, Australia.

Gandhi, V.P. and N.V. Namboodiri (2011), *Participatory Irrigation Management in India: An Evaluation of the Performance in Andhra Pradesh, Gujarat and Maharashtra*, CMA Publication No. 237, Centre for Management in Agriculture, IIM, Ahmedabad.

Government of Gujarat (2017), *Irrigation in Gujarat 2015-16*, Directorate of Economics and Statistics, Gandhinagar.

Government of India (1989), *Report of the Working Group on Major and Medium Irrigation Programme for the Eighth Plan, 1990-95*.

Government of India (1992), *Pricing of Irrigation Water*, Planning Commission, New Delhi, September.

Government of India (1994), *Report of the 10th Finance Commission*, New Delhi, Chapter – III, p. 16.

Government of India (2011), *Report of the Working Group on Major and Medium irrigation and Command Area Development for the 12*th *Five-Year Plan (2012-17)*, Ministry of Water Resources, November.

Government of India (2015), *Water and Related Statistics*, Water Planning and Projects Wing, April.

Government of West Bengal (2013), *Annual Report 2011-12*, DVCADA, Purta-Bhavana, Water Resource Investigation and Development Department, Burdwan.

Gujarati, D.N. (2011), *Econometrics by Example*, Palgrave Macmillan Publishers Limited, U.K.

Gulati, A.; R.M. Dick and K.V. Raju (2005), *Institutional Reform in Indian Irrigation*, International Food Policy Research Institute, Sage Publications India Pvt. Ltd., New Delhi, P. 78-79, 130.

Gulati, A.; Mark Svendsen and Nandini Roy Choudhury (1994), "Major and Medium Irrigation Schemes: Towards Better Financial Performance", *Economic and Political Weekly*, Review of Agriculture, Vol.29, No.26, 25 June, pp. A72-A79.

Kundu, Raj Kumar and Apurba Kumar Chattopadhyay (2020), "Water Resource Management of the Damodar Valley Corporation: Tail-end Deprivation of the Canal Network", *Economic and Political Weekly*, Vol.55, No.12, 21 March, pp.46-53.

Mishra, B. (2014), "Irrigation Development: The Story of an Underexploited Resource in Odisha", *Journal of Rural Development*, Vol.33, No.2, April–June, NIRD, Hyderabad, pp.183-196.

Mitra, A.K (1997), *Irrigation Management and Pricing of Irrigation Water*, Occasional Paper-4, National Bank for Agriculture and Rural Development (NABARD), Mumbai, February.

Nagaraj, N. (1999), "Institutional Management Regimes for Pricing of Water: The French Model – Lessons for India", *Agricultural Systems*, Vol.61, pp.191-205.

Narayanamoorthy, A. and S.S. Kalamkar (2005), "Indebtedness of Farmer Households across States: Recent Trends, Status and Determinants", *Indian Journal of Agricultural Economics*, Vol. 60, No.3, July-September, pp. 290-301.

Narayanamoorthy, A. (2007), "Turnaround in Financial Recovery in Maharashtra's Irrigation Sector", *Economic and Political Weekly*, Vol. 42, No.26, 30 June, pp.2679-2685.

Raby, N (1991), "Participatory Management in Large Irrigation Systems: Issues for Consideration, *World Development*, Vol.19, No.12, pp.1767-76.

Rath, N. (1997), "A Note on Approach to Irrigation in Maharashtra", Paper presented at the Workshop on 'Economic Problems of Water' Organized by the Second Irrigation Commission, Government of Maharashtra and Marathi Association, Sangli, Maharashtra, May 1.

Ray, I. (2005); "Get the Price Right: Water Prices and Irrigation Efficiency", *Economic and Political Weekly*, Vol.40, No.33, 13 August, pp.3659-3668.

Ray, I. and J. Williams (1999), "Evaluation of Price Policy in the Presence of Water Theft", *American Journal of Agricultural Economics*, Vol.81, No.4, pp.928-941.

Reddy, V.R. (2003), "Irrigation: Development and Reforms", *Economic and Political Weekly*, Vol.38, No.12/13, 22 March – 4 April, pp.1179-1189.

Shah, T.; Mehmood Ul Hassan, Muhammad Zubair Khattak, Parth Sarthi Banerjee, O.P.Singh and Saeed Rehman (2008), "Is Irrigation Water Free? A Reality Check in the Indo-Gangetic Basin", *World Development*, Vol.20, No.10, pp.1-18 (in Press).

Shah,T.; Gourav Mishra, Pankaj Kela, Pennan Chinnasam (2016), "Har Khet Ko Pani?: Madhya Pradesh's Irrigation Reform as a Model", *Economic and Political Weekly*, Vol.51, No.6, 6 February.

Vaidyanathan, A. (1999), *Water Resources Management: Institutions and Irrigation Development in India*, Oxford University Press, New Delhi.

Vermillion, D.L. (1991), *The Turnover and Self Management of Irrigation Institutions in Developing Countries*, International Irrigation Management Institute, Colombo.

Viswanathan, P.K. (2001), *Economics of On-Farm Development: A Study of Major Irrigation Projects in Kerala*, Ph.D. Thesis submitted to the Department of Economics, University of Mysore, Mysore, EEU, Institute for Social and Economic Change, Bangalore.

World Bank (2005), *India's Water Economy: Bracing for a Turbulent Future*, Report No.34750-IN, Agriculture and Rural Development Unit, South Asia Region, Washington D.C., U.S.A.