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Investments in Irrigation Projects — An Impact Analysis

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Abstract

Physical infrastructure development is a powerful means of promoting economic growth as (i) it creates production facilities, "crowds in" private investment and thereby stimulates economic activities, (ii) reduces transaction and marketing costs, improving competitiveness, and (iii) provides employment opportunities to the poor. Rural Infrastructure Development Fund (RIDF) supported irrigation projects help provide the necessary impetus for infrastructure development, thereby aiding in capital formation. Evaluation of irrigation investments under RIDF in the states of Uttar Pradesh, Haryana, Orissa, Maharashtra and Assam has revealed that the investments are economically viable. The net benefits realised by the user community from the investments in irrigation have been found fairly high, except in Orissa and Uttar Pradesh. Full benefits of medium irrigation projects in Uttar Pradesh could not be realised due to pending rehabilitation work and scanty rainfall. Similarly, non-completion of canal works in Orissa has adversely affected the returns to investment. The study has observed that adequate maintenance through budgetary provisions and/or through levying of user charges would ensure sustainability of benefits. It has suggested that creation of Water Users Associations (WUAs), envisaged under RIDF, would help in effective water distribution, maintenance and collection of water charges.

Introduction

The agriculture and allied sector witnessed an average annual growth rate of 2.5 per cent *vis-à-vis* growth of 6.6 per cent per annum for the economy as a whole during the period 1997-98 to 2006-07[1]. Further, agriculture continues to be largely rainfed and affected by weather-induced fluctuations. The envisaged annual growth of 4 per cent in agriculture calls for easing out of constraints, including availability of inputs, viz. fertilizers, certified seeds, irrigation, credit, technology, and appropriate price realization. However, an assessment of the trend growth of parameters affecting agricultural growth reveals that, except for an increase in the growth rate of credit supply to farmers, there has been a deceleration in the growth of all other variables/ factors during 1996-97 to 2005-06 (Table 1).

Of all the supply-side constraints gripping the agriculture sector, it becomes imperative to address the issue of infrastructure development through public funding[2]; more so because besides adding to capital formation, it facilitates access to other inputs.

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The paper is based on the evaluation studies undertaken by Agriculture Economists attached to respective states and have already been published. The paper attempts to consolidate the findings and draw few lessons for the future.

[1]Economic Survey 2007-08, p. 155.

[2] Capital-intensive nature of infrastructure projects, relatively low rates of return, long gestation period and high level of intangible benefits suggest the need for public investments. The Barker Hayami Hypothesis too elucidates that, while price support as well as subsidies are attractive alternatives for agricultural support in the short-run, creation of infrastructure facilitates self-reliance in the long-run.

Table 1.Trend growth rate in area, input-use, credit and capital stock in agriculture during 1980-81 to 2005-06

(per cent per year)

Particulars	1980-81 to 1990-91	1990-91 to 1996-97	1996-97 to 2005-06
Technology[a]	3.3	2.8	0.0
Net fixed capital stock			
Public sector	3.9	1.9	1.4[b]
Private sector	0.6	2.2	1.2[b]
Total	2.0	2.1	1.3[b]
Gross irrigated area	2.3	2.6	0.5[b]
NPK use	8.2	2.5	2.3
Terms of trade	0.2	1.0	-1.7[b]
Credit supply	3.7	7.5	14.4[b]
Total cropped area	0.4	0.4	-0.1
Net sown area	-0.1	0.0	-0.2
Cropping intensity	0.5	0.4	0.1

[a]Yield potential of new varieties of paddy, rapeseed/mustard, groundnut, wheat and maize.

[b]Up to 2003-04

Source: Economic Survey 2007-08, p.160.

Physical infrastructure promotes economic growth as (i) it creates production facilities, "crowds in" private investment and thereby stimulates economic activities, (ii) reduces transaction and trade costs, improving competitiveness, and (iii) provides employment opportunities.

Deceleration witnessed in the public investments in agriculture and rural infrastructure during the VIIIth Five-Year Plan and inadequate resources of state governments for the development and maintenance of rural infrastructure, was a serious cause for concern[3]. Thus, stepping-up plan outlays for creation and maintenance of rural infrastructure projects as well as quick completion of hitherto incomplete projects, therefore, became essential for accelerating the pace of capital formation in agriculture. This apart, it was observed that commercial banks, which were to channelise at least 18 per cent of their total lending to agriculture, were unable to fulfil their commitment. It was in this background that Government of India, in the Union Budget 1995-96, had announced the setting–up of the Rural Infrastructure Development Fund (RIDF) to be managed and operated by National Bank for Agriculture and Rural Development (NABARD).

The fund was created out of the shortfall in commercial banks' lending to agriculture and was set up with an initial corpus of Rs 2,000 crore in 1995-96 for providing loans to State Governments and State-owned Corporations. Initially, the support under RIDF was primarily for completion of irrigation projects and water & soil conservation schemes lying at various stages of incompletion owing to paucity of funds with the state governments. Subsequently, the coverage of RIDF was expanded. It now covers 31 broad sectors/activities pertaining to projects relating to rural roads and bridges, micro/ minor/medium/major irrigation, community irrigation wells, mini/small hydel projects, drinking water, soil conservation, watershed development, reclamation of waterlogged areas, drainage, flood protection, forest development, market yards, godowns, *apni mandi*, rural haats and other marketing infrastructure, cold storages (public or joint sectors) at various exit points, seed/agriculture/ horticulture farms, plantation and horticulture, grading and testing/certifying laboratories, fishing harbour/jetties, riverine fisheries, animal husbandry,

[3] The ratio of GCF in agriculture to agri-GDP has, however, improved steadily from 9.6 per cent to 12.5 per cent over the period 1999 to 2007, but has to improve to 16 per cent if 4 per cent annual growth rate in agriculture is to be achieved.

Source: Economic Survey (2007-08) p.164.

modern abattoirs, infrastructure for rural education and public health institutions (including mobile health clinics), construction of toilet blocks in existing schools, 'Pay and Use' toilets in rural areas, village knowledge centres, desalination plants in coastal areas and infrastructure for information technology in rural areas, construction of Anganwadi Centres and setting-up of Rural Industrial Estates/ Centres.

RIDF and Irrigation Infrastructure

Till date, 13 tranches (RIDF I to XIII) have been operationalized under RIDF. Cumulatively, 1.32 lakh irrigation projects involving an amount of Rs 25,009 crore have been sanctioned, constituting 47 per cent and 34 per cent of the total projects and amount sanctioned, respectively, as on 31 March, 2008. These projects include investments in shallow tubewells (STWs)[4], lift & medium irrigation projects, flood protection measures, etc. These projects would lead to creation of additional irrigation potential of 134.80 lakh ha and generation of 67.87 lakh jobs of recurring nature, and 20,440 lakh persondays of non-recurring employment[5].

Evaluation of Irrigation Projects Supported under RIDF

Several studies have attributed a significant output contribution to infrastructure. The paper by Anderson (2002) has highlightet that (a) roads & research have higher impact on growth and poverty reduction, (b) irrigation has impact on growth and not poverty, (c) education impacts reduction in poverty as it leads to increased wages and employment opportunities, (d) public investments have larger incremental impact on production in rainfed areas than irrigated areas, (e) investments in HYVs, roads and private irrigation have high impact in less-favoured regions, and (f) growth of fruits, oilseeds, milk and floriculture could benefit small farmers as well as others within and outside the country.

However, certain studies have found a negative relationship between infrastructure expenditure and economic growth due to excessive expenditure on unproductive projects[6]. In order to throw light on these issues, NABARD undertook *ex-post* evaluation studies of RIDF supported irrigation projects in five Indian states, viz.Uttar Pradesh, Haryana, Orissa, Maharashtra, and Assam. The impact of investments in physical infrastructure was primarily sought to be assessed in terms of income accrual as well as recurring and non-recurring employment generation. The findings of these studies are limited by location-specificities, levels of prices (constant) used for valuation, weather aberrations, etc. Nonetheless, the findings do provide insights into the impact of the RIDF projects.

Methodology

The studies were undertaken with the reference year 2004-2005[7]. In order to compute the Economic Rate of Return (ERR), the cost of investments incurred by the state governments was taken into account, while the benefits accruing to the local farmers and the farming community at large were considered. The cost of investment at historical prices was updated to reference year prices by using the index of manufactured products. Incremental income from the investments was estimated through 'before-after' approach[8]. To estimate the stabilised income, only those units which were completed by March 2004 were covered under the study. The ERR was worked out by taking 80 per cent of the cost of labour. In Orissa, the opportunity cost of unskilled labour was taken as zero due to unemployment even during the peak seasons.

Benefits of irrigation projects by way of improved watertable were difficult to estimate and hence do not figure in the benefit stream. Further, the value of land owned by farmers improved with irrigation facilities and it helped them in securing

[4] Owned by individuals in Assam and by state governments elsewhere.

[5] NABARD, *Annual Report 2007-08*, p. 67.

[6] Sahoo and Dash (2008), p.7

[7] In case of Maharashtra and Haryana, the reference year was 2005-06.

[8] In case of one of the flow irrigation projects in Orissa, 'with and without' approach was used, while unirrigated command area of sample farmers was considered as control. In other project, 'before and after' approach was used as entire command was irrigated by one or the other irrigation project.

Table 2 . Investment costs and benefits accruing from irrigation projects

State	Type of investment	Sample beneficiaries (No.)	Capital cost (Rs lakh/ ha)	Benefitted area (ha)	Incremental income (Rs lakh/ ha)
Haryana	Canal irrigation (2)	60	0.32	2294	0.14
Orissa	a. Flow irrigation (2)	20	1.99	167	0.10
	b. River lift (3)	15	0.28	20	0.42
	c. Tubewells* (10)	10	0.3	1.34	0.21
Uttar Pradesh	a. Medium irrigation project (1)	30	1.92	1804	0.08
	b. Tubewells** (8)	40	0.1	115	0.06
	c. Flood protection (2)	30	0.13	4654	0.04
Maharashtra	Kolhapur-type Weir (2)	28	0.48	2139	0.33
Assam	Shallow tubewells (60)	60	0.11	2.3	0.07

Notes: Figures within the parentheses indicate number of projects under study.

*Denotes individual farmers

**Denotes state-owned and investment was for modernisation of irrigation structures.

Source: Evaluation Studies conducted by NABARD

larger loan amounts from credit institutions. The impact of credit on farm and non-farm enterprises could not be assessed explicitly. Therefore, the results have to be viewed with caution.

Cost of Investment

Cost of investments varied substantially (Table 2) across investment type as well as states. Average cost per hectare of irrigation potential created through tubewells varied from Rs 10,000 in Uttar Pradesh and Rs 11,000 in Assam to Rs 28,000 under lift irrigation in Orissa. In Maharashtra, in addition to cost of Kolhapur-type Weir (KTW)[9], an expenditure of Rs 20,600 per ha was incurred by farmers for conveyance of water from irrigation structures to the field/s. Lesser realization of irrigation potential in case of Orissa and Uttar Pradesh in medium irrigation projects (MIPs), due to incomplete rehabilitation work and lesser rainfall in the catchment area increased the cost of creation of irrigation potential (around Rs 2 lakh per ha).

[9] Masonary/concrete bandharas constructed across river streams with a number of openings of 2 m width each. After mid-October every year, the water flow is obstructed by putting the steel needles in the opening of the bandharas. Thus, post-monsoon, flow is obstructed and stored and farmers are advised to lift water from bandharas.

Project Benefits

Investment in irrigation projects provided an array of quantitative (Tables 3 and 4) and qualitative (Table 5) benefits. However, within this sector, a dichotomy in benefits realized by minor irrigation on the one hand and medium irrigation on the other was clearly observed during these studies.

Quantitative Benefits

The small irrigation structures like lift irrigation and tubewells in Orissa, could provide irrigation during *kharif* and r*abi* seasons, whereas canal irrigation was available only during the *kharif* season (Table 3). Further, non-completion of canal works led to harnessing of only 45 per cent of irrigation potential. Technical reasons and people's resistance were indicated to be the reasons for non-completion of the targeted programme. Considering the experience of similar projects, NABARD has been insisting on more care in conceptualization and formulation of projects by the state governments.

With the average increased irrigated area of 1.41 ha per farmer in Maharashtra, the cropping intensity increased from 140 per cent to 198 per cent and average yield of bajra, wheat and sugarcane increased by 31 per cent, 58 per cent and 79 per cent, respectively. In the case of Uttar Pradesh, cropping

Table 3. Quantitative benefits from irrigation projects in different states

Investment	Quantitative benefits	State/s
Irrigation	• Increase in irrigated area[1] and yield[2] • Changes in cropping pattern and crop diversification towards commercial and value-added crops[3] • Sale of water to neighbouring fields/ farmers • STW programmes in Assam brought self-reliance in foodgrain production[4] • Small irrigation structures improved irrigation facilities for *kharif* and *rabi* crops	Assam, Haryana, Maharashtra, Orissa & Uttar Pradesh
Flood protection measures	• Barhya Kotha Bund Project: Protection of 73 villages with population of 30,000 and agricultural land of 1,561 ha • Sahjanwa Dumariya Baba Bund Project: Protection of 68 villages with population of 80,000 and agricultural land of 3,093 ha	Uttar Pradesh

[1]Details are given in Table 2.

[2] Analysis of cross sectional data of various districts of the states also confirmed a positive relationship between agricultural productivity in terms of foodgrains, value of output per ha and the rural infrastructure.

Source: NABARD, *Annual Report 2007-08*, p. 68.

[3]Details are given in Table 4.

[4] Farmers with irrigation were using HYX seeds as STWs minimized the risk of crop withering in case of monsoon aberration.

intensity improved from 153 per cent to 181 per cent. Yield improved by 24 per cent in the case of jowar and doubled in wheat. High yield was due to life-saving irrigation as well as use of HYVs and application of more fertilizers. In addition to improvement in yield and cropping intensity, changes in the cropping pattern towards vegetables were also witnessed (Table 4).

In the case of medium irrigation projects, low realisation of irrigation capacity was due to long distance (20 km) between dam and the command area. Water was available to command only after entire upper reach got irrigated. Non-lining of canals led to leakages and seepages and reduced the irrigation potential. Investments in flood protection measures helped in reducing the extent of fallow land from two-thirds of operational area to one-third, especially during the *kharif* season. These factors led to high rate of return in the case of minor irrigation projects, while in the case of canal irrigation, such benefits were not visible, resulting in low ERR in Orissa (-5%) and barely satisfactory in Haryana (18%).

Qualitative Benefits

Though intangible and non-quantifiable, such benefits have far reaching effects with accruals at a future date. Studies reveal that, owing to percolation effect, watertable has also gone up as the availability and quality of water improved in the project areas (Table 5). Further, construction of irrigation structures improved the value of land and in turn, the capacity of farmers to borrow from financial institutions and create assets, facilitating improved income and employment.

Economic Rate of Return

The average income realized from these projects also varied from Rs 4000/ha in Uttar Pradesh under flood protection to Rs 42,000/ha in Orissa in the case of river lifts. The income and cost variations also revealed that realisations were better in the case of minor irrigation projects as compared to medium/ canal irrigation projects (Table 2). Income realisation (Rs 33,000/ha) in Maharashtra needs to be viewed in terms of cost of creation of irrigation potential as well as cost incurred by farmers for water conveyance.

Table 4. Effect of irrigation projects on cropping pattern, cropping intensity and yield

State	Cropping intensity (%)		Increase in yield after project (% unless specified)	Remarks including cropping pattern
	Before	After		
Assam	144	204	*Boro* paddy – 1950 kg/ ha to 3200 kg/ ha (65%)	Area under *boro* paddy increased from 0.24 ha to 1.64 ha. The farmers also resorted to sale of water and realized an income of Rs 3000/-. Farmers also realized income through leasing-in of land, Rs 9100/-
Maharashtra	122	162	21 to 79	Area under onion, sugarcane, vegetables and fodder increased due to irrigation.
Haryana	202	220	27 to 38	Yield improvement was observed in wheat, paddy and cotton
Uttar Pradesh				
Medium irrigation project	160	178	20 to 157	Cropping pattern changed in favour of peas
Flood protection	116	167	25 to 113	The fallow area in *kharif* declined from 83 per cent to 35 per cent
Tubewells	199	199*	9 to 49	Yield of wheat and paddy recorded an increase of 40 per cent and 49 per cent, repectively
Orissa				
Canal	105	148	23 to 143	No change in cropping pattern
Lift	140	191	38	Area under pulses declined and increase was observed in case of high-value crops
Tubewells	148	194	86	Assured irrigation and market support lead to intensive farming

* As the investment was for modernisation/rehabilitation of irrigation structures, no change in cropping intensity was observed.

Table 5. Qualitative benefits from irrigation projects in different states

Investment	Qualitative benefits	State
Kolhapur- type Weir on Rivers – Bandharas	• Water availability in wells in command area improved due to percolation effect • Watertable improved from 70 feet to 60 feet* • Availability of water throughout the year induced farmers to construct houses on their farms and thus affected the settlement pattern	Maharashtra
Medium/ Canal irrigation	• Benefits of drinking water supplies and promotion of fisheries activities could not be quantified because of non-availability of data • Water availability in wells in command area improved due to percolation effect • Watertable and water quality improved from saline to sweet water in Haryana**	Haryana and Orissa

* After the project, availability of water in wells of command area was up to March as against up to October before the project.

**Level of watertable improved from 70 feet (four years back) to 60-63 feet.

In spatial terms, the returns to investments were better in the states of Orissa, Maharashtra, Assam and Uttar Pradesh (>30 %) and moderate in Haryana and Kerala (15-30 %). A comparison of ERR indicates that, except for canal irrigation in Orissa, all projects were viable, though minor irrigation projects revealed better viability *vis-à-vis* other irrigation projects (Table 6).

Employment Generation

Impact of projects was also assessed in terms of employment generation (per Rs one lakh of investment). Tubewell irrigation projects in Uttar Pradesh and Assam generated substantial recurring employment (Table 7). Regular/ routine maintenance of structures provided recurring employment, although major additional labour requirement was due to increased cropped area and yield. Larger benefits of small irrigation structures like tubewells with better ERRs and recurring employment generation suggested to give preference to smaller irrigation structures *vis-à-vis* medium irrigation projects.

Table 6. Benefit-cost analysis of irrigation projects in different states

State	Type of investment	ERR (%)
Haryana	Canal irrigation (2)	18
Orissa	a. Canal Irrigation (2)	5-7*
	b. River lift (3)	>50
	c. Tubewells (10)	
Uttar Pradesh	a. Medium irrigation project (1)	5
	b. Tubewells (8)	>50
	c. Flood protection (2)	37-57
Maharashtra	Minor irrigation (2)	41
Assam	Shallow tubewells (60)	50

Notes: Figures within the parentheses indicate number of projects under study.

* ERR was negative if cost of all the four canals instead of the two completed canals, was taken into account.

Source: Evaluation Studies conducted by NABARD.

Maintenance of Structures

The responsibility of maintenance of the structures was vested with the state governments. However, maintenance work suffered due to the paucity of funds. In respect of state tubewells in Uttar Pradesh, annual maintenance fund provided by the state government was Rs 12000 per unit, as against requirement of Rs 22000 per unit. Many of the structures in Orissa and Uttar Pradesh were old (15-30 years) and were prone to damages. Inadequate maintenance of such structures resulted in depletion of water stored, reduced irrigable area and had adverse impact on the benefits of investments on account of infirmity of the structures.

Water Users Association

The creation of Water Users Association (WUAs) was envisaged under RIDF supported projects, but their status and functioning in the study

Table 7. Employment generation from irrigation projects in different states

State	Type of investment	Employment generation (persondays per Rs lakh of investment)	
		Recurring	Non-Recurring
Haryana	Canal Irrigation	5 - 7	490
Orissa	a. Canal Irrigation	15	750
	b. River lift	400	54
	c. Tubewells	140	100
Uttar Pradesh	a. Medium irrigation projects	23	572
	b. Tubewells	357	61
	c. Flood protection	515	276
Maharashtra	Minor irrigation	15	298
Assam	Shallow tubewells	452	130

Source: Evaluation Studies conducted by NABARD.

Table 8. Status of Water Users Associations in selected states

State	Status of WUAs
Haryana	WUAs formed but functioning restricted to maintenance of watercourses. Distribution of water was undertaken by the Irrigation Department. The functions could be broadened and may include water distribution, dispute resolution, awareness generation among farmers about efficient water-use, ban on washing to prevent damage to structures and collection of water rates.
Maharashtra	WUAs not formed. Responsibility of formation of WUAs rests with Construction wing of Irrigation Department, which has no linkages/ contact with farmers, after completion of project.
Uttar Pradesh	WUAs formed and MoU to transfer the assets to WUAs was being finalized. After the transfer of canal system, WUA would be responsible for water charges.

areas under reference was not encouraging (Table 8). The studies indicated that better co-ordination between state government departments (Revenue and Irrigation) and wings within the irrigation department (construction and maintenance) would help in improving the performance of WUAs. Responsibility of forming WUA could be transferred to management wing of the Water Resources Department in Maharashtra, which has a regular contact with the farmers.

An exercise in Haryana and Orissa to assess the *willingness to pay* revealed that all the 100 sample respondents in Haryana expressed their *willingness to pay* for the new investments. Due to non-availability of sweet water in tubewells, farmers in Haryana preferred to draw water from the canals. Forty-one per cent of farmers were willing to pay up to Rs 500 per acre per year. Actual collection was just 16 per cent of the amount the farmers were willing to pay for assured continuous supply of irrigation water. Similar studies need to be conducted elsewhere.

Conclusions

The net benefits realised by the user community in most of the states from the investments in irrigation, flood protection, etc. have been found fairly high, except from canal irrigation in Orissa. Maximum benefits in the case of medium irrigation projects in Uttar Pradesh were not realised due to pending work of rehabilitation and scanty rainfall. Adequate care in conceptualization and formulation besides peoples participation is expected to reduce the cost over run and time taken for completion, especially projects with large outlays. The studies have also highlighted the poor maintenance of assets by the state governments, poor status and functioning of the WUAs and 'Willingness to Pay' by the user-farmers.

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