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Research Note

An Economic Analysis of Public Interventions for Amelioration of Irrigation-Induced Soil Degradation

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Abstract

The study has reported the impact of public interventions for amelioration of soil degradation through subsurface drainage technology in the Tungabhadra Project area in Karnataka. The primary data, obtained from 105 farmers of TBP area, have been analysed using budgeting, discounted cash flow measures and gini ratio. The provision of subsurface drainage through public interventions, has increased the productivity of land appreciably (166 per cent) and has provided a source of regular income (Rs 13,636/ha from paddy) to resource-poor households. The technology has been found to be cost effective, socially acceptable and economically feasible. The equity analysis has indicated reduction in inequalities in income distribution during the post-drainage period. The study has suggested that the government should aim at encouraging and educating the affected farmers in adopting subsurface drainage technology on a large-scale.

Introduction

India's primary concern is to increase food production to feed its ever increasing population. But, increase in agricultural production is not possible due to many factors that include soil degradation and unscientific water management practices. Irrigation-induced soil degradation is posing severe threats to agricultural production due to its adverse impact on sustainability of soil and water resources. Excessive irrigation / unscientific water management practices coupled with poor drainage are the major causes of

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soil degradation. Soil degradation in the form of soil salinity and waterlogging is wide spread in the irrigated tracts of arid and semi-arid regions. All these forms of soil degradation are restricting crop production in about 45 million hectares of irrigated land at the global level. Out of 270 million hectares of irrigated land in the world, about 1.0-1.5 million hectares land is lost annually due to salinity and waterlogging (FAO, 1990). The extent of damage due to salinity has been estimated at 11.4 billion US dollars (Ghassemi, 1995). A recent estimate has pointed out that damage due to salinity and waterlogging is of the order of 20 - 30 per cent of the annual production on normal soils (Datta and Dejong, 2002). Joshi *et al*. (1995) have indicated yield reduction in the range of 64-74 per cent in paddy due to salinity under Sharada Sahayak irrigation project. There are no accurate and reliable data on the extent of soil salinity and waterlogging. It has been reported that the area under these problem soils in the country is in the range of 5.5-13 million hectares (Datta and Joshi, 1993). The Central Soil Salinity Research Institute (CSSRI), Karnal, had started research on salinity and waterlogging during 1980s on pilot basis by installing subsurface drainage in Haryana. The results indicated that soil salinity and waterlogging could be reclaimed through subsurface drainage. Overwhelmed by the success of the experiments carried out by CSSRI, the scientists and the policymakers have advocated sub-surface drainage to ameliorate problem soils to boost agricultural production.

Realizing the importance of utilizing vast tracts of saline and waterlogged soils for crop production, focus has been on the drainage aspects of soils by the policymakers at the government level. Both central and state governments have been initiating several measures from time to time to address these critical issues. In an attempt to augment land resources for productive use, sizeable investments are being made. How far these investments are economically feasible needs to be evaluated. Successful working of the technology and its favourable economic gains would convince the government in prioritizing investments in land improvement. It is with this background, that a study was undertaken with the overall objective of examining the various economic dimensions of public interventions through subsurface drainage for amelioration of soil degradation induced by irrigation.

Methodology

The study was undertaken to get insights into the problem of soil degradation in the irrigated tracts of Karnataka state. The state has five irrigated command areas, namely Cauvery, Malaprabha and Ghataprabha, Bhadra, Tungabhadra and Upper Krishna. Among these, Tungabhadra project has the highest area under soil degradation due to salinity and waterlogging (about 49000 ha). Hence, Tungabhadra project area was purposively selected for the present study. The Tungabhadra dam has four branch canals, two each on either side, namely Right Bank High Level Canal (RBHLC), Right Bank Low Level Canal (RBLLC), Left Bank High Level Canal (LBHLC), Left Bank Low Level Canal (LBLLC).

The Left Bank Low Level Canal has highest area under the above two problematic soils (29600 ha). Of the 106 distributaries of LBLLC, 76th distributory which accounts for the largest area of soil degradation (7000 ha) was chosen. The government is implementing land reclamation programmes in collaboration with Tungabhadra project area authorities in the affected area by installing subsurface drainage. The village Byagwat was the major beneficiary of such government sponsored programmes as severity of the problem was more in the village. The state government had implemented land reclamation schemes during 1990-92. Hence, this village was chosen for evaluation of the impact of state interventions in amelioration of irrigation-induced soil degradation. For this, a list containing 55 beneficiary farmers of government-sponsored land reclamation programmes was obtained from CADA office (adoptors). Another sample of 50 affected farmers who had not taken any land reclamation measures was chosen for a comparison (non-adopters). Thus, the overall sample size comprised 105 farm households. The data were collected from the respondent farmers with the help of pre-tested interview schedule by survey method. The data included general information, landholdings, land-use pattern, cropping pattern, yields, area under salinity and waterlogging, reclamation measures, etc. The data were analysed using budgetary method and discounted cash flow techniques such as benefit-cost ratio, net present value, internal rate of return, payback period and gini coefficient.

The respondent farmers were post-stratified into resource-rich and resource-poor farmers, based on the size of their landholdings; farmers having landholdings of less than one hectare were classified as resource-poor and with one and more than one hectare were classified as resource-rich farmers.

Results and Discussion

Socio-economic Characteristics of Sample Farms

The average age of the respondent farmers in both the groups was in the range of 45-46 years, indicating that they were in the middle age group with adequate mental maturity. Education is yet another factor that provides a positive mindset in the process of decision-making. A majority of the farmers had not crossed the primary level of education, indicating poor educational status in the area. The education level of the adopters category was very poor as compared to that of non-adopters. Irrespective of their education level, the adopters were compelled to adopt sub-surface drainage technology to ameliorate their limited land resources and to ensure food and employment for their families. The family size of both non-adopter and adopter groups has been found to be almost at par. The average size of landholding across the two groups was 2.70 ha and 0.73 ha, respectively, indicating that most of the non-adopters were medium farmers and adopters were small and marginal farmers. The average size of landholdings was relatively larger for non-adopters than adopters. The proportion of degraded land due to salinity and waterlogging was 52.60 per cent in non-adopters and 100 per cent for adopters. This indicated that soil degradation due to soil salinity and waterlogging was posing severe threats to agricultural productivity in the region. The soils in the study area are vertisols, which further aggravate the problems. The problem of soil degradation has been persisting in the region for more than a decade (Table 1).

Drainage Investment

Subsurface drainage technology has been advocated for amelioration of saline and waterlogged soils. The technology has been demonstrated and implemented at farmer's field by the government agencies. The details about drainage investment have been given in Table 2. The estimated cost of providing drainage at current prices for reclamation of one hectare of problem

Table 1. Socio-economic profile of the respondent farmers in Tungabhadra Project area

Particulars	Non-adopters (Unreclaimed farms)	Adopters (Reclaimed farms)
Age (years)	45	46
Education (years of formal education)	3	1
Family size (No.)	6	5
Farm size (ha)	2.70	0.73
Degraded land (ha)	1.42	—
Duration of the problem (years)	11	15
Percentage of soil degradation	52.6	100
Land reclaimed (ha)		0.59
Soil type	Black	Black
Cropping system	Paddy-Paddy	Paddy-Paddy
Source of irrigation	Canal	Canal
Economic status		
a) Resource-rich (No.)		7
b) Resource-poor (No.)		48

Table 2. Cost of installation of sub-surface drainage

(Rs/ha)

Particualrs	Cost
Earthwork	
Main drain	340
Lateral drain	1513
Sub-total	1853 (11.59)
Pipe work	
Main drain	2226
Lateral drain	11066
Sub-total	13292 (83.11)
Accessories	
T- joints	75
Cement pipe	271
Construction of protection wall	170
Inspection chamber	264
Sub-total	780 (4.88)
Cost on survey	67 (0.42)
Total	15992 (100.00)

Note: Figures within the parentheses indicate percentages to the total

land works out to be Rs 15992/-. Digging of trenches, laying of pipes and covering it by envelop material accounted for a huge share (83.11 %) in the total cost. It was substantially high due to inclusion of costs on labour and material. The drainage material consisted of burnt clay pipes; the laterals were perforated while the main pipes were unperforated. The drainage removed excess water and created congenial environment for plant growth. The optimum spacing advocated for lateral drains was 30 metres. The amount involved in laying drainage at the farm level was too large to be spent by small and marginal farmers. Therefore, it calls for public interventions to mitigate the hardship of this vulnerable section of society.

Productivity Changes

It was noticed that subsurface drainage technology had a profound impact on crop productivity. Before reclamation, the productivity was 18.30 q/ha; it increased to 48.68 q/ha after reclamation, depicting a gain of 30.38 q/ha, i.e. 166 per cent.

Income

The increased output on reclaimed farms provided additional income to the farmers. The net income on reclaimed farms was of Rs 13,636/ha, as against the loss of Rs 2999/ha on unreclaimed farms, registering an appreciable increase (Table 3). The loss-making farms became profit-earning farms after reclamation. Thus, the government interventions had positive impact on productivity and income. Joshi and Singh (1990) had also reported similar findings in their study.

Economic Feasibility

Investment on drainage is a long-term proposal involving long gestation period. It is necessary to examine the feasibility of such long-term investment proposals. Hence, data were analysed to find the economic feasibility of investment on drainage by using discounted cashflow techniques such as

Table 3. Costs and returns of paddy production on reclaimed and unreclaimed lands of Tungabhadra Project area

(Rs/ha)

Particulars	Amount	
	Reclaimed	Unreclaimed
Variable costs		
Human labour	4838	4160
Bullock labour	515	315
Machine labour	2343	2459
Seeds	892	793
Manure	63	444
Fertilizers	4693	3655
Chemicals	1587	1752
Irrigation charges	87	87
Zinc sulphate	344	-
Annual repairs	35	262
Interest on W.C. @ 14%	538	484
Sub-total	15935	14411
Fixed costs		
Land revenue	19	18
Interest on fixed assets @ 10%	35	481
Depreciation	160	513
Rental value of land	3675	1217
Amortized cost of subsurface drainage @ 2% for 20 years	625	-
Sub-total	4514	1397
Grand total	20449	16640
Value of output		
Main product	34076	13356
By-product	729	285
Sub-total	34805	13641
Net income	13636	-2999
B.C. ratio	1.71	0.82

Table 4. Economic feasibility measures of sub-surface drainage in Tungabhadra Project area

Measures	Sensitivity analysis			
	Actual values	10% increase in costs and 10% decrease in benefits	Constant in costs and constant benefits	10% increase costs and 10% decrease in benefits
Net present value (Rs)	1,27,624	67,663	1,04,025	91,262
Benefit - cost ratio	1.54	1,26	1.40	1.38
Internal rate of return (%)	69	43	56	55
Pay back period (Years)	0.58	-	-	-

net present value, benefit-cost ratio, internal rate of return and payback period. An interest rate of 15 per cent was considered as opportunity cost of capital to discount the cost and benefit streams by assuming the life period of subsurface drainage to be 20 years. The results of this analysis are given in Table 4. The net present value was positive, indicating that drainage could recover a sum of Rs 1,27,624/- over its life period after accounting all the costs, including the opportunity cost of capital. The benefit-cost ratio was more than unity, indicating that investment on drainage was worthwhile generating a gross returns of Rs 1.54 for every rupee of investment. It is encouraging to note that internal rate of return was 69 per cent. Since the internal rate of return was higher than the prevailing interest rate, the investment is economically feasible.

The sensitivity analysis has been carried out to know the impact of changes in cost and benefit streams on the above parameters. Under the first scenario, even if the costs increased by 10 per cent and returns decreased by 10 per cent, still the investment on subsurface drainage was economically feasible. Similarly, under the second (10 per cent increase in costs and no change in benefits) and third (10 per cent decrease in benefits and constant costs) scenarios also, there was not substantial impact on NPV, BCR and IRR. Thus, the sensitivity analysis indicated that investment on subsurface drainage technology was economically feasible. Joshi *et al.* (1987), Joshi (1983) and Datta and de Jong (1997a,b; 2000) have also reported similar observations.

Farmers' Perceptions of Subsurface Drainage

Farmers' perceptions about subsurface drainage was elicited to know their opinion about the technology. More than 72 per cent of the adopters reported that adoption of subsurface drainage technology had become inevitable for them due to their limited land resources. Most of the adopters of subsurface drainage were small and marginal farmers, and their livelihood was at stake with degradation of their landholdings. About 62 per cent of the sample farmers opined that technology had helped them to increase their crop yields and according to 36 per cent farmers, it provided adequate food security to them. For 42 per cent adopters, it was the availability of government subsidy that served as incentive to adopt technology on their farms. Very few farmers (9.10%) were of the opinion that more area could be brought under cultivation by adopting subsurface drainage. Thus, it could be inferred that subsurface drainage technology was socially acceptable in the area.

Equity

The data presented in Table 5 indicated that resource-poor farmers had benefited more from the public interventions than the resource-rich farmers. The resource-poor farmers owned a major portion (80 per cent) of the reclaimed land, while the resource-rich farmers had only 20 per cent share in the total reclaimed land. The land reclamation schemes by the government had enabled the resource-poor farmers, who were hitherto agricultural workers, to become owners of better quality land. Agricultural labour was the main source of livelihood in the past due to degradation of their lands. But, after reclamation, cultivation had once again become their primary activity. Thus, schemes of land reclamation had a positive impact on the income levels of resource-poor farm households and reduced inequalities existing between 'haves' and 'have nots'.

Income Distribution

A perusal of Table 6 revealed that there had been improvement in income distribution on reclaimed farms. The share of bottom 10 per cent of the farmers increased from 1.21 per cent to 5.25 per cent, registering a net

Table 5. Particulars of beneficiaries of land reclamation in Tungabhadra Project area

Category	No.	Farm size (ha)	Area reclaimed (ha)	Investment (in lakh Rs)
Resource-rich (> 1 ha)	7 (13)	1.51	6.60 (20)	0.68
Resource- poor (up to 1 ha)	48 (87)	0.54	25.84 (80)	2.64
Total	55 (100)	-	32.44 (100)	3.32

Note: Figures within the parentheses indicate percentages to the total.

Table 6. Distribution of income among unreclaimed and reclaimed farms of Tungabhadra project area

Decile group	Unreclaimed farms		Reclaimed farms	
	Income (Rs/ ha)	Cumulative percentage of income	Income (Rs/ha)	Cumulative percentage of income
1	25680	1.21	53850	5.25
2	110910	5.24	118884	11.58
3	228597	10.79	206531	20.12
4	382044	18.04	284402	27.71
5	577752	27.28	384075	37.42
6	788098	37.21	473516	46.14
7	1025020	48.41	597293	58.20
8	1313271	62.01	709886	69.17
9	1686451	79.63	852626	83.07
10	2117780	100.00	1026275	100.00
Gini ratio	0.32026		0.18268	

increase of 4.04 per cent. This trend was maintained in all decile groups. It was a positive aspect of public interventions in land improvement. It clearly demonstrated that the inequity in distribution of income decreased during post-reclamation period.

Conclusions

The cost on amelioration of irrigation-induced degraded soils due to salinity and waterlogging at 1999-2000 prices has been found to be Rs 15992 per ha, which is too high for a majority of small and marginal farm households of Tungabhadra Project area. The provision of subsurface drainage through public interventions has increased the productivity of land appreciably (166 per cent) and has provided a source of regular income (Rs 13,636/ha from paddy) to resource-poor house holds. The study has indicated high potential of subsurface drainage technology in boosting productivity and profitability of degraded soils. The subsurface drainage technology has been found to be cost effective, socially desirable and economically feasible. The government should aim at encouraging and educating the affected farmers in adopting subsurface drainage technology on a large-scale.

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