Agricultural Engineering Today, Vol. 25 (3-4) : 20-28, 2001

IMPACTS OF DRAINAGE TECHNOLOGY AND ITS ALTERNATIVES IN THE COASTAL BARACHOUKA BASIN - A CASE STUDY

S.K.Patra and R.Ray*

ABSTRACT

The agricultural activities in the low-lying coastal Barachouka Basin in Midnapore district of West Bengal had remained abandoned for about 200 years due to extreme soil salinity and waterlogging. To address the problem at the field level, the Indian Council of Agricultural Research and the Government of West Bengal initiated the 'All India Coordinated Research Project on Agricultural Drainage' in 1983 with a view to develop site specific drainage technologies for land reclamation to ensure sustainable crop production and socio-economic improvement of the local farming community. The findings have demonstrated that land drainage or its alternatives along with the other remedial measures were technically feasible, socially acceptable and economically viable to restore agricultural production by the resource poor farmers. The technologies helped to bring more barren and uncultivable area under reclamation programme, increasing cropping intensity, changing cropping pattern to include more remunerative crops and in maintaining soil health. The adopted technologies increased farm and family income in particular and promoted the socio-economic status of rural people, in general.

1. INTRODUCTION

Barachouka basin of the Rasulpur river in coastal Midnapore district is an important agroecological situation in West Bengal. Out of 5277 ha cultivable land, 1812 ha (35%) is vulnerable to sustained waterlogging, soil salinity and seawater ingress (Anon, 1984). There is a dearth of good quality surface water for irrigation during summer. The principal crop rice in kharif, rabi and summer seasons was adversely affected causing either poor yield or total crop failure (Maity et.al. 1996; Bhattacharya, 1998). The land was badly deteriorated due to blocked natural drains and was completely abandoned for over 200 years prior to embarking upon the field based research programme on drainage and alternative technologies. Reclamation of this cropped land through conventional drainage measures is not feasible due to adverse physiograpy and absence of drainage outlets (Anon., 1994). To address this problem at the field level, the Indian Council of Agricultural Research and the Government of West Bengal in a joint venture initiated a project on land reclamation through drainage technology or its alternatives at Barachouka basin during late 1983. The objective was to tackle the twin problems of waterlogging and soil salinity, in maintaining soil health and in improving crop yields. During the opera-

* All India Coordinated Research Project on Agricultural Drainage, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, 741 235

tional stage (1984-'94) a number of technologies specific to the social needs and having low cost involvement were developed and simultaneously disseminated to the farmers' fields on a small scale to ensure sustainable crop production. Thereafter, the working site had been shifted to another waterlogged region of Dankuni basin of the Hooghly river. In the present study, an attempt has been made to investigate the pattern of adoption of the adaptable technologies, level of improvement of crop production, cropping intensity, cropping patterns and socio-economic benefits accrued from the drainage technologies during the post drainage period.

2. MATERIALS AND METHODS

2.1 Description of the study area

The study area is located in between 87° 31' 44" to 87° 37' 30" E longitude and 21° 58' 55" to 22° 03' 47" N latitude. The area is mildly concave in topography and situationally lies at 2 m above MSL. The average annual rainfall is 1853 mm, with more than 80 per cent of it being received during the four monsoon months of June through September. The mean monthly temperature fluctuates within 10° to 37° C during the year. Rice is the main staple crop. Vegetables are also partly grown. The soils are alluvium and potentially fertile. The limitation for crop production is the situation of waterlogging during and after monsoon season caused by high accumulation of runoff water and saline seawater intrusion. The inadequate drainage of excess water due to absence of natural drains, non-functioning of drainage outlets and adverse land characteristics aggravate the situation. Acute soil salinity and scarcity of good quality irrigation water in lean post-monsoon season is also a constraint for crop production. The soils are saline and heavy (40 - 50 % clay) with poor physical condition, low infiltration and hydraulic conductivity. The farmers mostly are of small and marginal category (91.8%)

2.2 Survey

During the operational stage of the project (1984-94), a number of technological interventions viz., hydrological separation of a portion of waterlogged saline land (8 ha) by protective ring bund, partial drainage for salt washing and fertigation, conjunctive use of brackish canal water and fresh ground water, recharging deep aquifer ground water with excess runoff water in monsoon season and subsequent discharging it in post-monsoon season and other remedial measures on a small scale were developed for profitable crop production. With farmers participation, the techno-economic feasibility of those interventions were tested, demonstrated and disseminated among them. In the postdrainage period, a detailed sample survey covering 18 villages under jurisdiction of lower Barachouka was conducted during March, 1999 to find out the impacts of the earlier findings on land reclamation for crop productivity. About 45 farm families of each village having different land holdings and socio-economic status were randomly selected and investigated. In the subsequent years, the data pertaining to the study was also collected from the local Panchayet.

3: RESULTS AND DISCUSSION

The major findings in terms of land reclamation, improvement of soils, crops and cropping pattern and socio-economic benefit due to the adoption of appropriate drainage and its alternatives are as follows :-

3.1 Land reclamation

In the coastal Barachouka basin the waterlogged saline land hitherto uncultivated was 1812 ha (Table 1). The farmers had abandoned the area due to acute soil salinity and waterlogging hazards. Subsequently, many technological interventions were developed and adopted by the farmers during the operation of the project (1984-94). Accordingly, about 370 ha of barren land was reclaimed and brought under cultivation programme. Out of which, the entire 8 ha ring bunded area was remedied by the project itself and the remaining 362 ha by the cooperating farmers. In addition to the technological support, a package of critical inputs like seeds fertilizers, pesticides etc were also distributed among the beneficiaries. This enabled the farmers to tackle the twin menaces of waterlogging and soil salinity. However, due to limited financial resources of the project, the reclamation programme and the corresponding benefits was not simultaneously reached to the farmers of the remaining 1442 ha of unreclaimed land. In the post-drainage period (1998-99) the progress of land reclamation programme was, however, spectacular. An additional 610 ha of barren land contributing 54.1% 980 ha of the total uncultivable land was brought under cultivation by the farmers after corrective measures (Table 1). This improvement was achieved mainly due to the cost effectiveness of the technologies and the involvement of the farmers.

Table I: Land improvement as influenced by drainage and its alternatives

Type of land	Pre-drainage	Post - drainage	
(ha)	1984 - '85	1993 - '94	1998 - '99
Unreclaimed	1812	1442	832
Reclaimed	-	370	980
% improvement	-	20.4	54.1

3.2 Adoption of drainage and alternative technologies

3.2.1 Protective bunding

The major emphasis has been given to the adoption of site specific alternative drainage technologies in relation to the improvement of soils and crops. In the initial part of drainage period, about 8 ha of low-lying land was protected by earthen ring bund with

suitable design specification to prevent from inundation by saline seawater. The farmers were able to get a higher yield of paddy crop in kharif and rabi seasons and remunerative vegetable crops in rabi season in the bunded areas (Table 2). The cultivation outside the bunded failed due to high depth of water stagnation. In the subsequent period, the local Panchayet was apprised about the techno-economic feasibility of bunding and the corresponding benefits in the degraded saline land. The panchayet mobilised a large number of farmers and constructed another ring bund in a 68 ha barren land (Table 3). The indigenous technology of protective bunding has been found to be much beneficial to the farmers for profitable crop production.

Table 2 : Crop yield as influenced by drainage and its alternatives

Technology developed	Crop yield (t/ha)
A. Protective bunding	
a) Kharif season	
Local paddy	3.10
HYV paddy	3.65
b) Rabi season	
HYV paddy	3.20
Chilli	1.60
Tomato	18.2
Potato	15.2
Okra	3.9
Brinjal	13.5
Pumpkin	29.7
Basella	31.8
c) Conjunctive use of waters	
a) Summer paddy	5.3

3.2.2 Partial drainage for salt washing

The technology of intermittent drainage for salt washing by surface drainage enabled the farmers to raise paddy in summer season on the earlier abandoned land. From a zero production level, the adopted technology helped achieving an average kharif paddy yield of 2.8 t/ha and rabi paddy yield of 3.3 t/ha. In the farmers' demonstration plot, paddy yield as high as 6.9 t/ha was obtained by adopting proper fertilizer management and drainage (Table 2). In the post drainage period, the area was extended to 405 ha with this technology and many diversified crops like chilli, brinjal, mustard and wheat were also grown involving 1280 numbers of small and marginal farmers (Table 3).

Table 3 : Adoption pattern of drainage technology and its alternatives amongst farmers

Technology developed	Test crop	Area under cultivation (ha)			No. of farmers involved		
		Pre-drainage	Post - drainage		Pre-drainage	Post-drainage	
		1984 - 85	1993-94	1998-99	1984 - 85	1993-94	1998-99
Protective bunding	paddy, wheat, vegetables	-	8	76	-	35	118
Partial drainage for salt washing	paddy, chilli, brinjal, mustard, wheat	-	160	405	-	420	1280
Conjuctive use of brackish canal and fresh ground waters	summer paddy, chilli	-	210	510	-	510	1315
Recharging and discharging ground water	paddy, wheat, vegetables	-	2	2	-	5	5

3.2.3 Conjunctive use of waters

The conjunctive use of brackish canal water and fresh ground water (1:1) to summer rice was found economically profitable in this backward region because of the reduced investment on costly ground water and improvement of crop productivity. The average yield was obtained as 5.3 t/ha by adopting this technology (Table 2). This practice has been followed by a large number of farmers for cultivating summer paddy on an area of 510 ha (Table 3).

3.2.4 Alternate drainage by recharging ground water

Disposing off the accumulated surface runoff into deeper aquifer through recharge wells for reducing submergence damage to paddy plants was found to be feasible. The steady state recharge rate was about 2 liters per second. Superimposing the cumulative recharge over the time distribution of the magnitude of plant submergence, it was calculated that one recharge well per two hectares would be required to reduce the depth of plant submergence to safe limit. During the operational period (1984-94) about 2 ha of land belonging to 5 number of farmers was under this system (Table 3). In the subsequent period the area has not been extended further employing this procedure because of high cost and lack of technical support. However, this innovation is observed to be useful in this area due to scarcity of surface and subsurface irrigation water in the post monsoon season.

3.3 Crop productivity

Transfer of technology relating to reclamation of land followed by judicious fertigation and selection of crops and varieties was found to increase the productivity levels of crops. The average yields of different crops during the pre and post-drainage periods are presented in Table 4. It is observed that the yield of paddy during rabi and summer season was increased by 3.3 to 3.9 and 2.8 to 3.0 times over the same in pre-drainage situation, respectively due to adoption of drainage. Besides, the gradual replacement of traditional low-yielding local varieties, of paddy (Kubja, Kamot, Panikalas) by short duration high yielding varieties (IR 36, CR 126, IET 2233, NC 472) resistant to salinity and waterlogging also gave an impetus to the increase in yield. Similarly, in the pre-drainage period the yields of mustard and vegetables were 0.65 and 6.8 t / ha, respectively. But due to the technology adoption in the post drainage period the yields of the same crop were increased to 1.38 and 9.5 t /ha during 1993-94 and 1.55 and 13.8 t/ ha during 1998-99, respectively.

Table 4 : Improvement of crop productivity as influenced by drainage and its alternatives

Test crop	Average yield (t/ha^{-1})		
	Pre-drainage	Post-drainage	
	1984-'85	1993-'94	1998-'99
Kharif paddy	-	1.90	2.20
Rabi paddy	1.02	2.35	2.95
Sumer paddy	1.15	2.20	2.57
Wheat	1.20	1.90	2.35
Mustard	0.65	1.10	1.20
Vegetables	4.20	7.56	8.60

3.4 Crop rotation and income generation

With the areal expansion of reclaimed land, the emphasis has also been given to strengthen the staggered farming system by allowing crop diversification (vegetables, mustard, groundnut, wheat) for generating maximum agricultural production and farmer incomes. The land before the pre-drainage stage remained either fallow or was monocropped with tall indica rice. However, in the post-drainage situation, there was intensification of agriculture and inclusion of various types of crop rotations by the farmers (Table 5). It is evident that HYV paddy-vegetable-vegetable is the most remunerative cropping sequence followed by vegetable -vegetable and paddy - mustard - vegetable.

Table 5 : Crop rotation and annual return as influenced by drainage and its alternatives

Crop rotation	Cost of cultivation (Rs ha^{-1})	Cost of drainage (Rs ha^{-1})	Total cost (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})
Paddy - Paddy - Fallow	22000	1000	23000	33475	10475
Paddy - Wheat - Fallow	16200	1000	17200	28635	11435
Paddy - Mustard - Fallow	15500	1000	16500	32300	15800
Fallow - Paddy - Vegetable	29000	1000	30000	62175	32175
Paddy - Mustard - Vegetable	30500	1500	32000	75300	43300
Fallow - Vegetable - Vegetable	30000	1000	31000	86000	55000
Paddy - Vegetable - Vegetable	38000	1500	39500	100300	60800

Coat of cultivation (Rs/ha) : kharif paddy 8000, rabi paddy 14000, wheat 8200, mustard 7500, vegetables 15000.
Market price of produce (Rs/t) : paddy 6500, wheat 6100, mustard 15000, vegetables 5000.

3.5 Soil improvement

There was a considerable improvement in the physical and chemical environment of soils after adoption of drainage technology or its alternatives. In the pre-drainage period the soil was highly saline with poor infiltration and hydraulic conductivity. But due to the adoption of reclamatory measures, these problem soils was transformed into non-saline with favourable soil reaction and safe limits of toxic soluble salts (Table 6). However, there was considerable loss of organic carbon and available nitrogen, phosphorus and potassium status from soils due to successive cropping in the post drainage period. This demonstrates the necessity of judicious fertilizer application to avoid the loss of crop production.

Table 6 : Soil properties as influenced by land reclamation measures and cropping

Soil parameter	Pre-drainage	Post-drainage	
	1984-'85	1993-'94	1998-'99
pH (1 : 2)	8.1	7.5	7.2
EC (dSm-1)	12.8	2.5	1.2
CEC [c mol (p+) kg-1]	25.3	19.3	15.4
Organic C (%)	3.2	1.9	1.6
Available N (kg ha-1)	451	335	315
Available P (kg ha-1)	25.6	21.2	19.3
Available K (kg ha-1)	397	325	310

3.6 Land valuation

With the qualitative changes of soil and improvement of agriculture scenario due to adoption of drainage and related technologies in the erstwhile barren lands, there was an increase in crop production and income of farm families. This improving situation has led a sizeable uncultivated area under cultivation programme by investing more finance in reclamation measures. This trend has resulted in the increase of land value. It is observed that land value in the pre-drainage period was Rs 32,500 per ha, which was subsequently enhanced by 2.3 times in 1993-94 and by 6.9 times in 1998-99 during the post-drainage period (Table 7).

Table 7 : Valuation of crop land as influenced by drainage and its alternatives

Parameter	Pre-drainage	Post-drainage	
	1984-'85	1993-'94	1998-'99
Crop land (Rs ha-1)	32500	75000	225000

3.7 Social acceptance and economic achievement

With the dissemination of drainage and related technologies and the potential benefits accrued from the adoption of those remedial measures, more and more farmers either individually or in groups came forward to participate in the reclamation and cropping programme (Table 3). This changing attitude of the farmers had enabled to bring more fallow land under cultivation. Such a shift in land use rendered increase in cropping intensity, change in the cropping pattern with inclusion of high valued crops and crop diversification. The traditional local paddy was gradually replaced by high yielding paddy resistant to salt and waterlogging. Besides, the remarkable increase in crop yields (Table 4), there was more employment opportunity to the farmers due to land reclamation and crop production programme. The favourable net incomes from the major crops and cropping system and change in cropping pattern towards more remunerative crops (Table 5) increased the income of farm families in particular and of the area in general.

4. CONCLUSION

The low cost site specific drainage and alternative technologies in the low-lying part of coastal Barachouka basin have a great bearing on the improvement of soils and crops, increase in cropping intensity and a shift in cropping pattern towards high value crops which ultimately promoted the socio-economic status of the farm people by generating family incomes.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial assistance received from the Indian Council of Agricultural Research to the AICRP (Drainage) Centre at the Bidhan Chandra Krishi Viswavidyalaya and the cooperation of the farming community of the project area of the Barachouka basin where the study was conducted.

REFERENCES

Anonymous. 1984. Annual Report (1983-84) of AICRP on Agricultural Drainage under actual farming condition on watershed basis. BCKV, Kalyani, Nadia, West Bengal, 3-5p.

Anonymous. 1994. Annual Report (1993-94) of AICRP on Agriculturalr Drainage under . actual farming condition on watershed basis. BCKV, Kalyani, Nadia, West Bengal, 12-20p.

Bhattacharya, A.K. 1998. Research on Agricultural Drainage under actual farming condition on watershed basis. Agril. Engg. Today, 22(1 - 2) : 45 - 70.

Maity, S.P., Ghosh, R.K., Das, N.C. and Patra, S.K. 1996. Drainage and crop productivity in saline waterlogges soil. AICRP (Drainage), BCKV, Kalyani, Nadia, West Bengal, 55 pp. .