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Vol XXXIII
No. 3

ISSN 0019-5014

CONFERENCE
NUMBER

OCTOBER-
DECEMBER
1978

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

and from the point of view of the society, shows that though the project is financially not profitable to the State Electricity Board, from the point of view of the society, it is economically viable. A project, particularly for the agricultural sector, having a great deal of public utility in terms of creating infrastructural facilities, need not only be assessed from the angle of financial criterion. There is the wider question of costs and benefits to the society of such projects, which too needs to be taken into consideration. Further, any scheme to be feasible and operative must take into consideration the benefits accruing to the sections of the population directly affected by the project. In this case it is clear that the farmers affected by the energisation project stand to gain. Once the wells are energised, the operating cost of using electric power for irrigating a standard acre is much smaller than the operating cost of using oil engines and *mhots*. In view of this, the farmers actually would not increase their economic activity of irrigating larger area if there were to be no electricity. To that extent there would be reduction in the total social product. These are thus some of the considerations which need to be kept in mind in evaluating a project.

KANDI WATERSHED AND AREA DEVELOPMENT PROJECT OF THE PUNJAB STATE : AN *EX ANTE* APPRAISAL OF THE FORESTRY COMPONENT

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The Kandi area of the Punjab comprises parts of Hoshiarpur, Gurdaspur and Ropar districts of the State. The peculiar characteristics of this area such as undulating topography, heavy precipitation, steep land gradients, loose nature of the soil, low man-land ratio, over-grazing, illicit felling of trees and the like, have caused denudation of vegetative cover and gully erosion of the Shiwaliks. This has ultimately resulted in the formation of flashy torrents (choes) which cause havoc down the hills during the rainy seasons. The flashy flows in the choes erode adjoining agricultural lands and spread sterile sands over the fertile fields rendering them unsuitable for agricultural purposes. Besides, they cause considerable damage to human and animal life and public property year after year. The frequent changes in the courses and the profiles of the choes aggravate the situation further. Realising the gravity of the matter, the State Government has, in consultation with the Punjab Agricultural University, formulated the Kandi Watershed and Area Development Project[1] for the integrated development of land and water resources in five selected choe catchments, *viz.*, Dholbaha, Janauri, Chohal,

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1. A. C. Sharma, R. K. Sabharwal and Y. P. Chowdhary: Kandi Watershed and Area Development Project, Punjab, submitted by the Punjab Government to the World Bank for financial assistance, February 1978.

Maili and Patiala-Ki-Rao and their outfall reaches. The programme of work envisaged in this project includes such components as (*i*) afforestation of the upper catchments with *khair* trees, (*ii*) development of pasture lands by growing *bhabhar* grass, (*iii*) promotion of dairy enterprise, (*iv*) construction of dams to moderate flashy run off and improvement of groundwater recharge, (*v*) utilization of impounded waters for irrigating farm crops and fruit plants and the development of fisheries, (*vi*) construction of embankments to minimize the recurrence of floods, and (*vii*) soil conservation programmes for the reclamation of waste lands. The relevant administrative departments of the State Government are expected to execute these programmes. An important feature of the project is to treat the choe catchments before the completion of the dams so that soil erosion in the hills is reduced, damage to cultivated lands below minimized and the life of the storage improved. This treatment comprises afforestation of 12,716 hectares, construction of vegetative and stone check dams to cover 21,559 hectares, development of 4,698 hectares of pasture lands, stabilization of embankments through the plantation of 840 km. of their length, and construction of vegetative spurs over 210 km. length of the choes. These forestry works are to be taken up on priority basis in the higher reaches of the choes so as to facilitate follow up action down below by other departments.

This paper aims at an *ex ante* appraisal of the forestry component of the Kandi Watershed and Area Development Project through (*i*) estimation of costs and benefits of the sub-project, (*ii*) financial and economic analyses by computing net present worths, cost-benefit ratios, and rates of return at market and economic efficiency prices, (*iii*) study of the economic viability of the component by running the sensitivity analysis, and (*iv*) identification of externalities which are difficult to quantify.

METHODOLOGY

The study is based on the secondary data collected from the Forest Department of the Punjab Government and the publications brought out by the World Bank. Information on the estimated expenditure and income, at the 1978 market prices, relating to the forestry component of the project was obtained[2] from the Working Plan Division of the Forest Department on the basis of 'with and without the project'. These data were appropriately classified and transformed for the appraisal exercise which aimed at the ultimate determination of the 'Internal and Economic Rates of Return' (IRR and ERR). The former involved the financial analysis of these data considering market prices, while the latter focused on the economic analysis based on efficiency prices.

For financial analysis, costs were categorized as compensation for acquiring managerial rights in land, skilled and unskilled labour, material, equipment and machinery, motor vehicles, staff, contingencies and taxes. The cost of overseas training of officials was ignored for the purpose of this

2. The help extended by Shri Y. P. Chowdhary, I.F.S., is gratefully acknowledged.

investigation, the reason being its subsequent reimbursement by the World Bank. Gains were identified in terms of the sale proceeds of forest trees and grasses over the project period.

The compensation paid to the landowners for acquiring managerial rights in land was reckoned with at the rates actually prevalent in the area. The skilled and unskilled labour for the execution of the proposed works was accounted for at the current wage rates. The cost of material and contingencies were charged in accordance with the market rates. The replacements of machinery, equipment, and tools were considered during the life of the project. The payments to the staff were budgeted out keeping in view the existing salary scales. Such taxes as are actually payable on the purchase of goods and services from the market were accounted for in the financial analysis.

The income estimates were based on the assumption that 500 *khair* trees would be planted per hectare and that 60 per cent of the total stock would become available for harvesting at the rotation age. This percentage in the case of protection bunds (embankments) was assumed to be 40 due to the prevalence of unfavourable factors. Income was also expected to accrue from pasture lands through the sale of *bhabbar* grass which attains maturity after three years of planting. The yield per hectare of this commodity was taken at 13.33 quintals. A *khair* tree was expected to fetch Rs. 100 while *bhabbar* grass Rs. 15 per quintal. Further, incremental increase was anticipated from increased production, through more intensive care, of local grasses and miscellaneous trees raised in certain portions of the area proposed to be acquired by the Forest Department. This increase in income was computed in consultation with the Department at current prices.

The economic analysis was based on costs and benefits net of taxes calculated at efficiency prices. These prices were estimated in accordance with the following relationship:

$$EP = MP \times CF$$

where

EP = efficiency price,
MP = market price,
CF = conversion factor.[3]

The economic efficiency price of *bhabbar* grass was quoted[4] to be the same as the market price whereas this information on *khair* and miscellaneous trees and local grasses was not available. Following the price pattern of the former (*bhabbar* grass), the efficiency prices of the latter (*khair* and miscellaneous

3. Conversion factors had been computed by the World Bank separately for traded and non-traded goods in some of its recent publications, *e.g.*, (*i*) Colin Bruce: Social Cost-Benefit Analysis: A Guide to Country and Project Economists to the Derivation and Application of Economic and Social Accounting Prices, World Bank Staff Working Paper No. 239, The International Bank for Reconstruction and Development, August 1976, and (*ii*) Assumptions for the Shiwalik Watershed Development Project (Punjab), 1978.

4. Assumptions for the Shiwalik Watershed Development Project (Punjab), 1978.

trees and local grasses) were also assumed to be identical with their market prices.

The net present worths (NPWs), cost-benefit (C-B) ratios, and the rates of return (IRR and ERR) were computed using (*i*) market prices and (*ii*) efficiency prices, in accordance with the following formulae.

$$(a) \quad \text{NPW} = \sum_{j=1}^{n} \frac{B_j - C_j}{(1+i)^j}$$

$$(b) \quad \text{C-B ratio} = \frac{\sum_{j=1}^{n} \frac{B_j}{(1+i)^j}}{\sum_{j=1}^{n} \frac{C_j}{(1+i)^j}}$$

$$(c) \quad \text{IRR/ERR} = \sum_{j=1}^{n} \frac{B_j - C_j}{(1+i)^j} = 0$$

where

B_j = benefits for the jth year,
C_j = costs for the jth year,
n = number of years,
i = interest (discount) rate.

The economic viability of the forestry sub-project was ascertained through sensitivity analysis which aimed at the examination of the changes in the NPW, C-B ratio, and IRR/ERR, assuming changes in total costs and total benefits as under:

(*i*) a 5 per cent increase in costs without corresponding increase in benefits,
(*ii*) a 5 per cent increase in benefits without corresponding increase in costs,
(*iii*) a 5 per cent increase in both costs and benefits,
(*iv*) a 10 per cent increase in costs without corresponding increase in benefits,
(*v*) a 10 per cent increase in benefits without corresponding increase in costs,
(*vi*) a 10 per cent increase in both costs and benefits,
(*vii*) a 5 per cent increase in costs and a 10 per cent increase in benefits, and
(*viii*) a 10 per cent increase in costs and a 5 per cent increase in benefits.

ESTIMATED COSTS AND BENEFITS

The estimated costs and benefits at both market and economic efficiency prices and their break up into various elements in respect of the forestry component of the Kandi Project are summarised in Table I.

It is evident from Table I that the total cost of the forestry sub-project worked out to Rs. 51.25 million at market prices and Rs. 39.58 million at efficiency prices, the difference between the two being Rs. 11.67 million, indicating that the latter was 22.77 per cent less than the former. The sub-project benefits were estimated at Rs. 432 million. The difference between

TABLE I—ESTIMATED COSTS AND BENEFITS OF VARIOUS ELEMENTS, FORESTRY COMPONENT, KANDI WATERSHED AND AREA DEVELOPMENT PROJECT, PUNJAB, 1978

(*Rs.*)

	Particulars (1)	At market prices (2)	At efficiency prices (3)
A.	Costs		
	(*i*) Compensation	18,79,500 (3·67)	18,79,500 (4·75)
	(*ii*) Skilled labour	33,63,100 (6·56)	26,90,480 (6·80)
	(*iii*) Unskilled labour	2,49,43,150 (48·67)	1,67,11,910 (42·22)
	(*iv*) Material	33,63,100 (6·56)	26,90,480 (6·80)
	(*v*) Equipment and machinery	16,82,000 (3·28)	16,82,000 (4·25)
	(*vi*) Motor vehicles	16,81,700 (3·28)	16,81,700 (4·25)
	(*vii*) Staff	95,50,000 (18·63)	95,50,000 (24·13)
	(*viii*) Contingenies	31,09,500 (6·07)	26,92,827 (6·80)
	(*ix*) Taxes	16,81,550 (3·28)	—
	(*x*) Total costs (*i* to *ix*)	5,12,53,600 (100·00)	3,95,78,897 (100·00)
B.	Benefits		
	(*xi*) *Khair* trees	37,22,45,000 (86·17)	37,22,45,000 (86·17)
	(*xii*) *Bhabbar* grass	2,91,00,000 (6·73)	2,91,00,000 (6·73)
	(*xiii*) Incremental revenue from local grasses and miscellaneous trees	3,06,60,000 (7·10)	3,06,60,000 (7·10)
	(*xiv*) Total benefits (*xi* to *xiii*)	43,20,05,000 (100·00)	43,20,05,000 (100·00)

the benefits and the costs at market prices was Rs. 380.75 million and at efficiency prices Rs. 392.42 million.

The analysis of the cost elements brought out that the most important cost item was 'unskilled labour'. This element alone accounted for more than 48 per cent of the total cost of the sub-project at market prices and more than 42 per cent at efficiency prices. The next in importance was the 'expense on staff' which entailed about 19 per cent of the cost budget at market prices and about 24 per cent at efficiency prices.

The benefits from *khair* trees far exceeded the gains from *bhabbar* grass. The former comprised 86 per cent while the latter 7 per cent of the total gains. The increase in revenue from the sale of local grasses and miscellaneous trees accounted for another 7 per cent of the benefits from the forestry sub-project.

FINANCIAL AND ECONOMIC ANALYSES

The financial and economic analyses of the forestry component were run by computing the NPWs and C-B ratios at both market and efficiency prices. These values are set out in Table II.

TABLE II—NET PRESENT WORTH AND COST-BENEFIT RATIO, MARKET AND EFFICIENCY PRICES, FORESTRY COMPONENT, KANDI WATERSHED AND AREA DEVELOPMENT PROJECT, PUNJAB, 1978

	Discount rate	Net present worth (Rs.)	Cost-benefit ratio
A.	Market prices		
	(*i*) 10 per cent	+76,91,272	1·22
	(*ii*) 12 per cent	—33,94,728	0·89
B.	Efficiency prices		
	(*i*) 12 per cent	+34,51,419	1·13
	(*ii*) 14 per cent	—33,48,793	0·86

It is clear from Table II that the NPW at market prices was positive (Rs. 76,91,272) at 10 per cent and negative (Rs. 33,94,728) at 12 per cent discount rate with the C-B ratio of more than one (1.22) in the former and less than one (.89) in the latter case. At efficiency prices, the NPW was found to be positive (Rs. 34,51,419) at 12 per cent and negative (Rs. 33,48,793) at 14 per cent discount rate. The C-B ratio was more than one (1.13) in the first case and less than one (0.86) in the latter case.

The analysis was extended to compute the IRR and the ERR. These values were estimated at 11.38 and 13.01 for the forestry sub-project.

SENSITIVITY ANALYSIS

The sensitivity analysis was carried out by assuming 5 and 10 per cent increases in costs and benefits of the sub-project. The NPWs, C-B ratios, and rates of return at market and efficiency prices incorporating these changes in the estimated costs and benefits are shown in Tables III and IV.

TABLE III—SENSITIVITY ANALYSIS OF NET PRESENT WORTH AND COST-BENEFIT RATIO AT MARKET PRICES, AND INTERNAL RATE OF RETURN, FORESTRY COMPONENT, KANDI WATERSHED AND AREA DEVELOPMENT PROJECT, PUNJAB, 1978

Increase in costs and benefits	Net present worth (Rs.)		Cost-benefit ratio		Internal rate of return (per cent)
	10 per cent discount rate	12 per cent discount rate	10 per cent discount rate	12 per cent discount rate	
1. 5 per cent increase in costs without corresponding increase in benefits	+59,55,527	—50,25,851	1·16	·85	11·08
2. 5 per cent increase in benefits without corresponding increase in costs	+98,11,581	—19,33,341	1·28	·94	11·67
3. 5 per cent increase both in costs and benefits	+80,75,836	—35,64,464	1·22	·89	11·38
4. 10 per cent increase in costs without corresponding increase in benefits	+42,19,783	—66,56,975	1·11	·81	10·77
5. 10 per cent increase in benefits without corresponding increase in costs	+1,19,31,888	—4,71,954	1·34	·98	11·92
6. 10 per cent increase both in costs and benefits	+84,60,399	—37,34,201	1·22	·89	11·38
7. 5 per cent increase in costs with 10 per cent increase in benefits	+1,01,96,143	—21,03,077	1·28	·94	11·65
8. 10 per cent increase in costs with 5 per cent increase in benefits	+63,40,092	—51,95,588	1·16	·85	11·10

TABLE IV—SENSITIVITY ANALYSIS OF NET PRESENT WORTH AND COST-BENEFIT RATIO AT ECONOMIC EFFICIENCY PRICES, AND ECONOMIC RATE OF RETURN, FORESTRY COMPONENT, KANDI WATERSHED AND AREA DEVELOPMENT PROJECT, PUNJAB, 1978

Increase in costs and benefits	Net present worth (Rs.)		Cost-benefit ratio		Economic rate of return (per cent)
	12 per cent discount rate	14 per cent discount rate	12 per cent discount rate	14 per cent discount rate	
1. 5 per cent increase in costs without corresponding increase in benefits	+21,62,603	—45,61,887	1·08	·82	12·64
2. 5 per cent increase in benefits without corresponding increase in costs	+49,12,806	—23,03,139	1·19	·90	13·36
3. 5 per cent increase both in costs and benefits	+36,23,990	—35,16,233	1·13	·86	13·01
4. 10 per cent increase in costs without corresponding increase in benefits	+8,73,786	—57,74,982	1·03	·78	12·26
5. 10 per cent increase in benefits without corresponding increase in costs	+63,74,193	—12,57,484	1·24	·94	13·67
6. 10 per cent increase both in costs and benefits	+37,96,560	—36,83,673	1·13	·86	13·01
7. 5 per cent increase in costs with 10 per cent increase in benefits	+50,85,377	—24,70,578	1·18	·90	13·34
8. 10 per cent increase in costs with 5 per cent increase in benefits	+23,35,173	—47,29,328	1·08	·82	12·66

Table III indicates that the NPWs at market prices were positive and the C-B ratios more than one when a discount rate of 10 per cent was used to work out these values. The former (NPWs) turned out to be negative and the latter (C-B ratios) less than one at 12 per cent discount rate. The computation of net present worths at efficiency prices using 12 per cent discount rate (Table IV) gave positive values with C-B ratios of more than one. At 14 per cent discount rate, the former (NPWs) were negative quantities and the latter (C-B ratios) less than one.

The IRR of the forestry sub-project worked out to be 11.38 per cent at 1978 prices while the ERR was 13.01 per cent. These values increased to 11.65 and 13.34 when the costs increased by 5 per cent and the benefits by 10 per cent. The IRR expanded further to 11.67 and 11.92 and the ERR to 13.36 and 13.67 when the benefits increased by 5 and 10 per cent without any corresponding increase in costs. The former reduced to 11.10 while the latter to 12.66 when costs increased by 10 per cent and benefits by 5 per cent. The IRR declined further to 11.08 and 10.77 and the ERR to 12.64 and 12.26 when the costs increased by 5 and 10 per cent without any increase in benefits.

EXTERNALITIES

The net costs and benefits not accounted for in the financial and economic analyses of this sub-project but likely to accrue to the economy are identified below:

1. The additional production of *bhabbar* grass and other cellulose raw material consequent upon the implementation of the forestry component of the Kandi Project would facilitate the establishment of a paper mill in the area.
2. The choe menace endangering agricultural lands in Ropar, Hoshiarpur and Jullundur districts of the State would be considerably reduced and the prospects of reclaiming waste lands comprising choe beds for cultivation would improve substantially.
3. The protection and improvement of vegetative cover on the Shiwaliks would improve the sub-soil water resources of the Kandi area.
4. The execution of the proposed sub-project would generate additional employment opportunities for 4,000 men, particularly during the planting and harvesting seasons.
5. Kandi area is likely to become more productive resulting in increased per capita income of its inhabitants.
6. The proposed afforestation of the upper catchments of the selected choes would provide recreational facilities to the people and abode for the wild life.
7. The plantation of forest trees has the potentials of stabilizing ecological balance and providing attendant benefits in the area.

CONCLUSIONS

The *ex ante* appraisal of the forestry component of the Kandi Watershed and Area Development Project, Punjab, brought out that the total cost of the sub-project at 1978 market prices amounted to Rs. 51.25 million and the total benefits Rs. 432 million with a margin of Rs. 380.75 million. The financial analysis showed that the NPW of the sub-project was positive and the C-B ratio more than one at 10 per cent discount rate. The economic analysis indicated that the NPW at efficiency prices was positive and the C-B ratio more than one at 12 per cent discount rate. The IRR was estimated at 11.38 per cent and the ERR at 13.01 per cent. The sensitivity analysis revealed that the IRR was about 11 per cent and the ERR over 12 per cent even when the cost of the sub-project increased by 10 per cent without any corresponding increase in its benefits. Again, the proposed sub-project is likely to provide employment to 4,000 persons annually and has the potentials to contribute towards the establishment of a paper mill in the area, besides increasing the productivity of its land resources.

Thus, the forestry component is an economically viable sub-project of the Kandi Watershed and Area Development Project of the Punjab State.