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THE WATERSHED APPROACH TO DEVELOPMENT AND MANAGEMENT OF LAND, WATER, AND FOREST RESOURCES: A CASE STUDY IN KARNATAKA, INDIA

by

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This paper is based on a case study that I conducted in 1988 in the Karnataka state of India at the behest of the Society for Promotion of Wastelands Development (SPWD). I am thankful to SPWD for financial support for the case study. A large part of the paper was written at the Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, where I was a visiting scholar for four months from January to April 1989. I am highly grateful to Professor Elinor Ostrom, Co-Director of the Workshop, for her encouraging me to write this paper and for the facilities and the congenial environment provided to me to complete this work.

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Abstract

This paper presents the results of a case study of a watershed development project in the Karnataka state of India. The case study was conducted in 1988 in Mittemari, which is one of the sub-watersheds of the Chitrawati watershed in Kolar district of the state.

The Mittemari project covered 750 ha of land out of the total geographical area of 1245 ha of the sub-watershed. The project was launched in January 1984 and by March 1987 almost all the targets set for the project had been achieved at a total expenditure of Rs.21.07 lakhs. The average cost of soil and water conservation measures was Rs.1582 per ha and of afforestation Rs. 5000 per ha. The average yields of all the major crops grown in the sub-watershed increased markedly as a result of the project. The average incremental net benefits from the agricultural land covered under the project was Rs.1712 per ha in 1986-87. It was not possible to estimate the benefits from the horticultural and forestry activities because of their long gestation and from reduced soil erosion. A major indirect benefit of the project was increased availability of water in the sub-watershed. This was evident from the increase in number of bore wells from 5 in 1983 to 28 in 1988, open wells from 11 to 18, and irrigated area from 60 ha to 150 ha over the same period of time. On the basis of these results, we could say that the Mittemari project was successful in achieving its objectives.

The main factors that contributed to the success of the project were a strong support from the Government of Karnataka (GOK), availability of appropriate technology, an appropriate organisation structure, availability of adequate funds, and use of a well-tested and proven methodology of watershed planning and management. The major weaknesses of the project were inadequate people's participation, omission of animal husbandry activities, and lack of effective coordination with other agricultural and rural development programmes. On the whole, we could say that the watershed approach as developed and adopted in the Mittemari sub-watershed holds a high promise as a basis for planning and management of land, water, and forest resources in India.

THE WATERSHED APPROACH TO DEVELOPMENT AND MANAGEMENT OF LAND, WATER, AND FOREST RESOURCES: A CASE STUDY IN KARNATAKA, INDIA

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Introduction

Natural resource endowments of an area or a region or a nation are important factors contributing to economic growth and development in general and agricultural and rural development in particular. This is especially true in the developing countries of the world where artificially-created resources and technologies are not yet available in abundance so as to replace the natural resources in the production process.[1] In the process of economic growth in these countries, it is mostly the natural resources that are transformed into commercial goods. It is now widely believed that in the process of economic growth many natural resources like land, water, forests, fish, wild life, etc., have become scarce and degraded. For example, in India, vast tracts of arable-land are degraded due to water erosion, wind erosion, salinity, alkalinity, water logging, etc.[2] Pastures are rendered completely denuded of any vegetative cover due to over-grazing. Forests are disappearing due to indiscriminate lopping and illicit felling. Rivers and lakes are polluted by discharge of toxic pollutants and sewerage. Most of the rainwater is lost into the seas as surface run-off causing on its way floods and consequent immense misery to the life and property of people.[3] In the absence of adequate harvesting and storage of rainwater, many areas in the country including those with high rainfall face severe shortage of water even in the years of high rainfall. Both the floods and the droughts to a great extent are, thus,

the consequences of India's failure to manage her water resources properly. According to a conservative estimate the damages caused by floods and soil erosion amount to a staggering sum of Rs.70,000 million every year.[4] The ground water table in most of the agriculturally advanced areas has been progressively going down over time due to excessive and unregulated pumping that exceeds the natural recharge rate.

The degradation is much more acute and visible in the case of communally held or common property resources of land, water, and forests than in the case of private property resources. The former suffer from what Hardin (1968) calls "The Tragedy of the Commons." It is high time now that India take appropriate action to halt the growing degradation of her natural resources, especially land, water, and forests.

The Central and the State governments in India now have realised the need for improving the management of land, water, and forest resources and have initiated a number of measures to achieve this. Some of the important measures include the establishment of a National Land Use and Wastelands Development Council with the Prime Minister as its Chairman, announcement of a National Water Policy, and launching of a National Watersheds Development Programme. What is needed, however, is an integrated policy for management of land, water, and forest resources on a watershed basis.

A watershed may be defined as an area of land that is drained by a river system. The watershed has a clear conceptual identity in hydrology, physical geography, and other natural sciences. The use of this term in social sciences is of rather recent origin. The term is often used synonymously with two other words, namely, basin and catchment.[5] Basically, a watershed is a hydrologic unit which, in view of the interdependence of its natural and human resources, is ideally suited for natural resource planning and management (Tolley and Riggs, 1961).

The watershed approach is holistic in that it requires simultaneous consideration of all the physical, biological, social, economic, political, and institutional factors existing in a watershed and its surrounding environment for planning and management (Dixon and Easter, 1986). In this sense, a watershed is an integrated biophysical-cum-socioeconomic system and therefore requires the systems approach for its development and management.

This paper aims at describing and analysing the experience of the Mittemari sub-watershed project in the Karnataka state of India, which is considered an innovative and successful effort in using the watershed approach for development and management of land, water, and forest resources. The case study on which this paper is based was conducted in the months of March, April, and May, 1988 as part of a more comprehensive study (Singh, 1988a). It is hoped that the lessons that we have drawn from the case study will be useful in planning and management of watershed development programmes elsewhere in India and other developing countries of the world.

The Evolution of The Watershed Approach in India

In India the watershed approach was first adopted on a significant scale in 1974 when the Government of India (GOI) enforced its implementatiori under the centrally-sponsored "Scheme of Soil Conservation in the Catchments of River Valley Projects" (Bali, 1988: 55-56). In 1982, GOI, under the auspices of the Indian Council of Agricultural Research (ICAR), sanctioned 46 model watershed projects to be implemented in the dry land areas of the country. These projects are being implemented by the

State governments through their Agriculture Departments and technical back up is provided by the All India Coordinated Research Project for Dryland Agriculture (AICRPDA), the Central Research Institute for Dryland Agriculture (CRIDA), and the Central Soil and Water Conservation Research and Training Institute. The CRIDA and AICRPDA scientists are responsible for monitoring of 30 of these model watershed projects.

In July 1986, the Union Ministry of Agriculture and Rural Development launched the National Watershed Development Programme (NWDP) for rain-fed agriculture as a centrally-sponsored scheme. It is currently in operation in 16 states in the country covering 99 districts. The criteria for selection of districts are: (1) the annual rainfall should be 500-1125 mm and (2) the irrigated area should be less than 30 percent of the cultivated area. The programme has been taken up on a watershed basis. The main objective of the programme is to optimally utilize the available rainwater and minimise the risk of crop failure. The programme is financed by the Central and State governments in the 50:50 ratio.

Watershed Development Programme in Karnataka

The Government of Karnataka (GOK) has recently taken quite a few pioneering steps in the development and management of dry land watersheds. A project in Integrated Watershed Development was launched in a selected watershed, Kabbalnala, in Bangalore district in. 1983 with financial aid from the World Bank. In 1984, GOK decided to replicate the Kabbalnala model of watershed development in all the 19 districts of the State. For this purpose, GOK created, by an administrative fiat, an ingenious three-tier organization structure with a State level Watershed Development

Council, divisional level Dry Land Development Boards (DLDB), and project level Watershed Development Teams and launched in 1984-85 a District Watershed Development Programme (DWDP) in the state. The main objective of DWDP was to enhance and stabilise the productivity of both arable and non-arable lands. DWDP covered one purposively selected watershed in each of the 19 districts in the state.

The Mittemari Sub-Watershed Project: A Profile

The Mittemari sub-watershed is located in the Bagepalli taluka of Kolar district in Karnataka state. The Bagepalli taluka is included in the drought prone areas of the state. Mittemari constitutes one of the sub-watersheds of the Chitravati watershed, which is one of the 19 watersheds in the state selected under DWDP. Three villages, namely, Mittemari, Chinnaobaiahgaripalli, and Chokkampalli, fall within the boundaries of the Mittemari sub-watershed.

The sub-watershed was selected under the Model Watersheds Programme of ICAR in 1983 and the watershed development project activities launched in January 1984 by the GOK Departments of Agriculture, Horticulture, and Forestry in collaboration with the scientists of the Dryland Agriculture Project (DAP) of the University of Agricultural Sciences (UAS), Bangalore. The main objective of the project was to improve and stabilise the productivity of both the arable and non-arable lands in the sub-watershed through improved soil and water management practices and restructuring of crop-pattern and land use pattern. In February 1985, an Operational Research Project (ORP) was launched in the sub-watershed. This project was sponsored by ICAR and executed by a team of UAS scientists. The project

activities in the sub-watershed are monitored by CRIDA. In 1986-87, the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) and CRIDA in collaboration with the UAS scientists conducted a few studies to measure run-off and sediment load under different tillage practices and to determine the effect of contour trenching on the yield of groundnuts and red gram in the sub-watershed. The Mittemari sub-watershed project is generally considered successful and has been given an award by DLDB, Bangalore, for its exemplary work.

Some of the basic statistics about the sub-watershed are presented in Exhibit 1. The sub-watershed has a total geographical area of 1245 ha of which nearly 47 percent is arable or cultivated and the remaining 53 percent is non-arable. Of the non-arable land, 167 ha (13.41 percent of total) is suitable for pasture and forestry and the remaining 495 ha is barren and wasteland suitable for only wildlife. The watershed is basin-shaped and is interspersed with small hillocks. The area drains into Ghitravati river through sub-surface flow. Annual rainfall varies from 400 mm to over 700 mm with most (over 70 percent) of it occurring in 30-40 days during the period, May through October. Even though the mean annual rainfall is sufficient to support a good kharif crop, its uneven distribution with long dry spells extending up to four weeks results in low and uncertain yields and consequently poor economic condition of the farmer. Soils are shallow to medium in depth in most parts of the sub-watershed and have low water holding capacity. High intensity rainfall, undulating topography, and along-the-slope cultivation result in heavy soil erosion as seen from the riles and gullies of various lengths and sizes existing in the sub-watershed. The peak run-off from the hill slopes suggests the possibility of harvesting run-off water in serveral places for supplemental irrigation during dry spells.

Exhibit 1: Basic statistics about the Mittermari sub-watershed before the start of the project, 1983.

	Item	Unit	Magnitude
1.0	Total geographical area	ha	1245
2.0	Arable (cultivable) land	ha	583
3.0	Non-arable land	ha	662
3.1	Land suitable for pasture and forestry	ha	167
3.2	Area under forests	ha	0
3.3	Barren and wastelands	ha	495
4.0	General slope of the terrain (East-West direction)	%	2r5
5.0	Annual rainfall in	mm	
5.1	1985		387
5.2	1986		711
5.3	1987		606
6.0	Irrigated area	ha	60
7.0	Tanks	No	5
8.0	Bore-wells (tube wells)	No	5
9.0	Open wells	No	11
10.0	Human population	No	2857
11.0	Total households	No	710
12.0	Farm (landed) households	No	554
13.0	Agricultural labour households	No	80
14.0	Landless labour households	No	46
15.0	SC and ST households	No	128
16.0	Marginal farmers (< 1 ha)	No	340
17.0	Small farmers (1-2 ha)	No	196
18.0	Big Farmers (> 2 ha)	No	18
19.0	Average size of arable land holding	ha	1.05
20.0	Livestock population		
20.1	Cows and calves	No	115
20.2	Buffaloes and calves	No	153
20.3	Draft animals (bullocks)	No	500
20.4	Sheep	No	1600
20.5	Goat	No	1150
20.6	Poultry birds	No	1450
20.7	Pigs	No	410
21.0	Area under crops		
21.1	Ragi (finger millet) with inter-crops	ha	400
21.2	Groundnuts with inter-crops	ha	150
21.3	Sole groundnuts	ha	0
21.4	Other crops	ha	33
22.0	Average yields		
22.1	Ragi	Q/ha	6
22.2	Groundnuts	-do-	3
23.0	Village institutions and organisations		
23.1	Primary School	No	1
23.2	High school	No	1
23.3	Primary health centre	No	1
23.4	Post office	No	1
23.5	Farmers' service society	No	1
23.6	Gramin bank	No	1
23.7	Milk producers' cooperative society	No	1

Finger millet and groundnuts were the two major crops grown in the area. Traditionally, pigeon pea was intercropped with both these major crops. In the pre-project year, i.e., 1983-84, the average yields of finger millet and groundnuts in the demonstration plots in which improved dryland practices were followed were 20 quintals and 10 quintals per ha, respectively. This shows that there exists high untapped yield potential in the area.

Recommended Technologies for Watershed Development

The major activities of the project included the following:

1. Soil and water conservation and land development in both the arable and non-arable lands;
2. Introduction of improved crop production practices in the dry lands;
3. Initiation of dry land horticulture in marginal lands and introduction of agro-horticultural systems;
4. Afforestation of wastelands and tank foreshore areas; and
5. Support of existing supplementary enterprises like sericulture, pisiculture, etc.

Animal husbandry was not included in the project. Given its important place in the rural economy of the area, its exclusion constitutes a serious drawback of the project and a significant deviation from the systems approach. Our interviews with the project authorities revealed that this was due to lack of interdepartmental coordination at the state level.

Appropriate technologies for adoption in the sub-watershed were identified by a team of UAS scientists working in DAP and approved by a State-level Consortium of scientists drawn not only from the UAS but also from other national institutions like the National Bureau of Soil Survey

and Land Use Planning, the Central Soil and Water Conservation Research and Training Institute's Research Centre, Bellary, the Indian Institute of Science, Bangalore, etc. The Director of Agriculture, GOK, and the Director, State Watershed Development Cell, GOK, were also members of this body. The Chief Scientist, DAP, UAS, Bangalore, was convenor of the Consortium.

The following recommended technologies were implemented in the project area:

I. Soil and Water Conservation Measures in Private/Individual Land Holdings.

1.1 Strengthening of existing bunds to a total cross-section of 0.35 m^2 and providing a gradient of 0.2 to 0.4 percent along the upstream toe of the bund.

1.2 Open end contour bunds.

1.3 Graded bunds.

1.4 Establishing vegetation on the upstream side of the bund.

1.5 Graded border strips (only for deep soils).

1.6 Providing grassed outlets to water ways from individual fields.

1.7 Internal smoothening, rough grading and, inter-terrace management.

1.8 Construction of farm ponds.

II. Soil and Water Conservation Measures in Community and Public Lands

2.1 Diversion drains at the junction of cultivated and uncultivated areas.

2.2 Gully checks and gully stabilisation through vegetation.

2.3 Waterways and drop structures on the boundaries of fields.

2.4 Pick-up weirs and gully checks for erosion control and recharge of underground water.

2.5 Nala bunding.

2.6 Small bunds on key lines to facilitate contour cultivation. Recent recommendation is to establish vegetative live barriers of either khus (vetiver) or subabul (Lucaenea) on contours to facilitate all the field operations on the contour itself.

2.7 Furrows at 3.3 m interval for moisture conservation and smooth disposal of excess runoff.

III. Improved Crop Production Technology

3.1 Deep tillage.

3.2 Introduction of K.M. ploughs and improved seed-cum-fertilizer drills.

3.3 Use of improved/hybrid seeds.

3.4 Adoption of balanced fertilizers and their proper placement.

3.5 Intercropping of pigeon pea with groundnuts or finger millet combined with inter-terrace management.

3.6 Timely sowing and weeding.

3.7 Need based plant protection.

IV. Alternate Land Use System

Introduction of social and farm forestry and horticultural programmes in non-arable lands.

V. Socioeconomic Measures

5.1 Encouraging maintenance of bullocks as a source of power and improving fodder supply.

5.2 Making available improved implements on a subsidised basis.

5.3 Ensuring timely supply of seeds and fertilizers locally.

5.4 Improving the functioning of the cooperative society.

5.5 Training the agricultural officers and the farmers in improved crop production, forest maintenance, and other enterprises.

Choice of Technology

Decisions about the type, size, and design of various soil and moisture conservation structures, about crop production technology, and about tree species to be adopted in the sub-watershed were taken jointly by the UAS scientists and the GOK officials in consultation with the farmers. In general, the predominant type of soil conservation work recommended for adoption in the sub-watershed was strengthening of existing bunds and construction of small section bunds across the slope at an interval of 10 m. Wherever soil conservation measures were required to be introduced afresh, either graded bunds or open end contour bunds were recommended. In both the cases, waterways with grassed outlets were provided for safe disposal of excess run-off. The trials conducted under ORP in the sub-watershed demonstrated that the small section graded bunds at a distance of 20-30 m were most cost effective. Similarly, strengthening of existing bunds was found to be less expensive and more acceptable to farmers as compared to contour bunds (UAS, 1988).

Similarly, introduction of improved varieties of finger millet and groundnuts along with recommended dose of fertilisers and other management practices was found to be more profitable and acceptable to farmers as compared to the local varieties grown with traditional practices. Intercropping of groundnuts with red gram was also a new cropping system introduced in the area, which was very profitable and hence acceptable to the farmers.

Many improved agricultural implements like seed-cum-fertiliser drill and mould board plough were introduced in the project area and their advantages demonstrated in trials conducted in the farmers' fields. But we

found that few farmers had adopted the improved implements in spite of heavy subsidies on them.

In the social forestry sector, tree species, namely Acacia auriculiformis, Dalbergia sissoo, and Acacia nilotica were recommended for adoption by farmers to meet their fuel, wood, and timber requirements. All these tree species thrive well in the area and are acceptable to the farmers. Fruit trees like jack fruit, tamarind, cashew, and ber have also been successfully tried and introduced in the area.

Programme Planning and Project Formulation

As mentioned earlier, the Mittemari sub-watershed was selected under the Model Watersheds Programme of ICAR in 1983. It was the first model watershed taken up by UAS, Bangalore. The sub-watershed was selected because: (1) the Soil Conservation Wing of the Department of Agriculture, GOK, had already done some work there and had established an office in Mittemari village; and (2) the villagers were willing to cooperate and participate in the project.

After a rapid topographic survey of the area, a Master Plan was prepared jointly by a team of UAS scientists and the GOK Department of Agriculture staff and the project activities started in January 1984. The plan provided for treatment of 750 ha of land comprising 583 ha of dry arable lands and 167 ha of forest lands. The plan specified what soil and water conservation measures and agricultural, horticultural, or forestry activities would be appropriate for each and every parcel of land in the sub-watershed.

Project Implementation and Financing

The Soil Conservation Wing of the Department of Agriculture, Department of Horticulture, and the Department of Forestry, GOK, were primarily responsible for implementing the project. Technical guidance in implementation was provided by the DAP staff of the UAS, Banagalore. Besides the Chief Scientist, DAP, and his colleagues, CRIDA scientists also visited the project area occasionally and provided on-the-spot guidance in implementation.

Funds for implementation of the project were provided by ICAR and GOK out of the DPAP allocation for Kolar district. The ICAR funds were used for meeting the establishment cost and contingent expenditure incurred on adaptive research conducted in the project area. The GOK funds were used for soil and water conservation structures, crop demonstrations, and afforestation purposes and released by the Project Director, DPAP, Kolar, directly to the implementing departments.

All the community works like diversion drains, waterways, gully plugging, nullah bunding, etc., were executed entirely at the project cost.

All the works taken up on individual holdings like construction of field bunds, strengthening of existing bunds, land shaping, farm ponds, etc., were executed with 75 percent subsidy and 25 percent contribution by the farmers either in cash or work. In case the farmer was not able to contribute in either of the ways, the work was executed at the project cost and recovery of the farmer's share of 25 percent was to be made as per the Karnataka Land Improvement Act, 1961 and Rules of 1962 except from marginal and small farmers and the Scheduled Caste (SC) and the Scheduled Tribes (ST) beneficiaries.

To make the farmers convinced of the benefits from use of modern inputs, improved seeds, fertilisers, and pesticides were supplied to farmers at 75 percent subsidy but only once during the implementation of the project. The total expenditure per ha on this account was kept within the limit of Rs.750 per ha.

The low cost implements like ploughs, land development equipment, seed drills, and plant protection equipment were supplied to all the willing farmers at 75 percent subsidy. The maximum benefit per farmer on this account was restricted to Rs.500.

For farm forestry, social forestry, and horticultural programmes, seedlings were provided free of cost. The pattern of subsidy on other inputs In the case of horticultural and sericulture programmes was the same as in the crop production programmes.

The total outlay envisaged for land development, crop production, horticultural, and afforestation programmes was Rs.21.06 lakhs over a period of three years.

Training

To improve the skills of the project staff responsible for Implementation, practical training was imparted to them. The contents of the training programme included alignment and construction of bunds, working out seed and fertiliser requirements, demonstration of use of Improved implements, and selection of crop varieties. Farmers of the project were also trained in key line formation, use of Improved implements including sprayers and dusters, and identification of pests and diseases. Village meetings of farmers -- both men and women -- were organized for

creating awareness among them about soil erosion problems and the need for adoption of soil conservation measures and alternate land use patterns suited to physical capability of land. Farmers' visits were organised at crop harvest time and then they were shown the gains from adoption of recommended crop patterns and crop production technologies. Despite these efforts, there was no significant participation and contribution of farmers in the programmes.

Project Monitoring and Control

As per the ICAR guidelines, the following three committees were constituted to review and monitor the progress of the project:

1. A State Level Review Committee headed by the Agricultural Production Commissioner, GOK.
2. A District Level Review Committee headed by the Special Deputy Commissioner/Project Director, Kolar.
3. A village Resource Development and Management Society (not yet registered but model bye-laws were ready) having the Scientist S-2, ORP, as its Convenor.

As mentioned earlier, CRIDA was responsible for monitoring this project. CRIDA prepared a Guide for monitoring the Model Watersheds Programmes and prescribed formats for reporting the annual progress of the programme. The formats were being used for the purpose. Exhibit 2 presents cumulative physical and financial achievements as of 1986-87 of the soil conservation works, the cropping plan, and the alternate land use plan for the Mittemari project. A perusal of the exhibit would show that a sum of Rs.21.07 lakh had been spent on the project by March 31, 1987. Of the total expenditure of Rs.21.07 lakh, Rs. 9.33 lakh were spent on soil and water conservation works, Rs.3.39 lakh on cropping programme, and Rs.8.35 lakh on

Exhibit 2: Physical and financial achievements of soil and water conservation works, cropping and alternate land use plan in Mittemari project as of 1986-87.*

	Particular	Cumulative Achievements	
		Physical	Financial (Rs.'000)
I.	Soil and Water Conservation Works		
	1. Contour bunds	50 ha	21.77
	2. Diversion channels	12,620 m	50.26
	3. Grassed water ways	350 ha	36.31
	4. Gully checks	413	248.00
	5. Strengthening of existing bunds	449 ha	204.35
	6. Land smoothening	350 ha	53.69
	7. Farm ponds	11	54.31
	8. Planting of subabul on bunds	270 ha	20.16
	9. Nala bunding	1	30.00
	10. Drop structures	360	20.60
	11. Vegetative checks	120	10.00
	12. Gully revetments	920 m	29.24
	13. Small section bunds	370 ha	72.56
	14. Pick up weir	2	54.42
	15. Graded bunds	4 ha	1.20
	16. Graded border strips	4 ha	10.00
	17. Surveying	1,245 ha	5.63
	Sub-total (I)	--	922.50
II.	Cropping Plan and Alternate Land Use Plan		
	18. Distribution of subsidised inputs (seeds, fertilizers, pesticides and insecticides)	444 ha	250.58
	19. Number of saplings of fruit plants distributed to farmers	500	6.00
	20. Afforestation	167 ha	834.75
	21. Number of improved implements distributed	426	88.80
	22. Number of fingerlings distributed	3,000	4.00
	SUB-TOTAL (II)	--	1184.13
	Grand Total	--	2106.63

*Source: Status Report of the Model Watershed, Mittemari, Dry Land Agriculture Project, University of Agricultural Sciences, Bangalore, April 1988, pp. 16-17.

afforestation. The average cost of soil and water conservation measures worked to Rs.1582 per ha and of afforestation Rs.5000 per ha. This does not include the establishment cost of ORP staff and the GOK staff engaged in the project.

Impact Evaluation

A study aimed at evaluating the impact of the Mittemari Model Watershed Programme was commissioned by GRIDA in 1984-85 (Reddy and Pandurangaiah, 1988). Using the principle of "With and Without," the study was conducted in four villages within the sub-watershed (Project) and four villages outside the sub-watershed (Control) at two points in time, 1984-85 and 1986-87. In 1984-85, a sample of 99 farm households each was selected from the Project and the Control villages and the 1986-87 samples consisted of 87 farm households from the Project villages and 74 from the Control villages. Although it is not wholly correct to attribute all the observed differences in the values of selected parameters between the Project villages and the Control villages to the project, the observed differences give the best possible estimates of the impact of the project presuming that all other factors affecting the performance variables were comparable in the two types of villages. It is not possible to attribute the observed differences in yield rates to various factors like graded bunds, improved seeds, fertilisers, etc., without using a sophisticated econometric technique like the multivariate analysis, which is beyond the scope of this study.

The impact of the project was evaluated in terms of changes in cropping pattern, adoption of new dry land crop production technology,

increase in crop yields, and incremental net returns and benefit cost ratio. The study revealed that in 1986-87 (the third year of the project) the area under high yielding varieties of groundnuts and finger millet was markedly higher in the Project villages than in the Control villages. Similarly, the number of adopters as well as the level of adoption of improved seeds, fertilisers, plant protection chemicals, and improved weeding practices were substantially higher in the Project villages than in the Control villages and were higher in 1986-87 than in 1984-85.

Exhibit 3 shows incremental yields due to the project of the major crops grown in the sub-watershed in 1984-85 and 1986-87. As can be seen from the exhibit, incremental yields were higher in the intercropping systems than in the sole crops in both the years and the 1986-87 yields of intercrops were higher than the 1984-85 yields. The higher incremental yields in 1986-87 seemed due partly to the higher level of adoption of new technology in the Project villages in 1986-87 and partly to better weather conditions in 1986-87 than in 1984-85. Another important observation is that the incremental yields of the high yielding varieties were higher than those of the local varieties for both groundnut and finger millet and in both the years.

Exhibit 4 presents incremental net benefit and incremental benefit-cost ratios for the major crops grown in the area. The average incremental net benefit was Rs.1300 per ha in 1984-85 and Rs.1970 per ha in 1986-87. It can be seen from the exhibit that the incremental net benefit was the highest for the groundnuts (HYV) + pigeon pea crop combination in both 1984-85 and 1986-87 and so also its incremental benefit-cost ratio. The incremental benefit-cost ratios for the crops considered were significantly greater than 1.00 indicating that the new crop technology was

Exhibit 3: Incremental yields of crops due to the project in Mittentari Sub-watershed*

	Incremental Yield (Q/H)					
	1984-85		1986-87		Two-year Average	
	Main Crop	Inter Crop	Main Crop	Inter Crop	Main Crop	Inter Crop
1. Groundnut (L)@	1.68	-	N.A.	-	1.68	-
2. Groundnut (HYV) +	1.99	-	0.38	-	1.19	-
3. Finger millet (L)	0.88	-	N.A.	-	0.88	-
4. Finger millet (HYV)	1.89	-	2.91	-	2.40	-
5. Groundnut (L) + Pigeon pea	2.00	1.11	3.35	1.53	2.68	1.32
6. Groundnut (HYV) + Piegon pea	4.16	1.00	4.68	0.95	4.42	0.98
7. Finger millet (L) + Pigeon pea	1.40	0.33	2.38	0.20	1.89	0.27
8. Finger millet (HYV) + Pigeon pea	4.26	1.57	6.19	2.11	5.23	1.84

Status Report on Economics and Adoption Levels of Dryland Technology in Model Watershed at Mittemari, CRIDA, Table 7, p.26.

@ L = Local

\+ HYV = High Yielding Variety

Exhibit 4: Incremental net benefit and incremental benefit cost ratio for different crops in Mittemari Sub-watershed*

Sl. No.	Crop	1984-85		1985-86	
		Incremental net benefit (Rs./ha)	Incremental benefit-cost ratio	Incremental net benefit (Rs./ha)	Incremental benefit-cost ratio
1.	Groundnut (L)@	475	2.25	NA	NA
2.	Groundnut (HYV)+	972	-	36	4.27
3.	Finger millet (L)	146	2.25	NA	NA
4.	Finger millet (HYV)	124	1.64	NA	NA
5.	Groundnut (L) + Pigeon pea	1513	13.30	2167	6.57
6.	Groundnut (HYV) + Pigeon pea	2194	5.01	3276	7.30
7.	Finger millet (L) + Pigeon pea	708	5.37	334	1.84
8.	Finger millet	1402	5.90	1697	3.50
	ALL	1300**	-	1970**	-

*Source: Computed from the "Status Report on Economics and Adoption Levels of Dry Land Technology in Model Watershed at Mittemari", CRIDA, Hyderabad, Table 7(a).

@ L = Local

\+ HYV = High Yielding Variety

** The average incremental net benefit for all crops was computed by multiplying the incremental net benefit from each crop by its percentage share in the total cropped area and then summing up all the products.

financially viable. A similar conclusion is reached by looking at the figures of the incremental net benefit presented in the exhibit. Therefore, we can infer that the new dry land crop production technology was financially viable in terms of private benefit-cost calculus of the participating farmers. Even if we deduct from the average net benefit per ha Rs.258 on account of amortised value of Rs.1582 that was spent on soil and water conservation works, the project is still economically viable.[6]

An indirect beneficial effect of the project was increased recharge of ground water in the area. As a result, the number of bore wells in the area increased from 5 in 1983 to 28 in 1988 and that of open wells from 11 in 1983 to 18 in 1988 and the area irrigated increased from 60 ha in 1983-84 to 150 ha in 1987-88. However, there is need for a systematic hydrological study to determine the effect of the project on the availability of ground water and surface water in the area.

Given the long gestation of forestry and horticultural projects, it was not possible to estimate their benefits at that stage. Similarly, no value was put on the reduction in soil loss and siltation of tanks due to adoption of soil and water conservation measures. Inclusion of these benefits would further enhance the economic viability of the project.

To find out the extent of awareness and opinions of the farmers about the project, we interviewed a sample of 55 farmers randomly selected from the sub-watershed. Our study revealed that all of the sample farmers were aware of the project and were participating in it in the sense that each one had adopted at least one of the recommended technologies. Some 85 percent of the respondents reported that they had benefited from the subsidised inputs and improved farm implements made available under the project.

Some 62 percent of the respondents reported that their crop yields had increased substantially after the launching of the project but they attributed the increased yields to improved seeds and fertilisers more than to the soil and water conservation measures like bunding, levelling, etc. As a matter of fact, most of the farmers interviewed reported that the bunds in their fields had been constructed by the GOK staff without their consent and that most of the bunds had already been washed away in the absence of needed repair and maintenance. We were also told by quite a few farmers that in many cases no new bunds were made or old bunds strengthened but the payment was made by the GOK staff to the contractors against the bogus bills.

People's Participation

People's participation in a watershed development programme is crucial for its success because unless every household having land in the watershed accepts and implements the recommended plan, the watershed approach cannot be implemented in its true sense. People will accept a recommended plan only if they are convinced that the plan will bring them substantial net benefits commensurate with the efforts required to implement the plan.

To secure people's participation, GOK adopted quite a few innovative measures such as night meetings with the villagers in the sub-watershed to present and discuss the annual action plans, organization of a village resource development and management society, and informal consultation with villagers on important matters. However, during the course of our interviews with a sample of watershed dwellers, we were told that the night meetings were conducted rather hurriedly and half-heartedly and not enough

time was devoted to discussion of the recommended technologies and their benefits. So, the plan remained a government plan; it never became a people's plan. There is, therefore, a need to involve people more fully and actively in the planning stage itself.[7]

Lessons

From the case study of the Mittemari sub-watershed project presented in this paper, many lessons useful for framing an integrated policy for planning and management of land, water, and forest resources can be drawn. Some of the important lessons, their implications, and our recommendations are presented below.

Delineation and Selection of Watersheds

The case study has demonstrated that the watershed approach to management of land, water, and forest resources is technically, financially, and administratively feasible to adopt under the existing set up and can enhance the productivity of these resources markedly. For adoption of this approach, it will be necessary to delineate watersheds in an area/region and sub-watersheds within the watersheds so demarcated, A watershed may not always fall within the boundaries of an administrative unit like a village, or a taluka, or a district. But that need not create any obstacle to adoption of the approach insofar as all the villages/talukas/districts are to be covered eventually. Selection of watersheds and sub-watersheds for treatment may be done on the basis of urgency of treatment and willingness of people to cooperate; the latter deserves a higher weightage than the former.

Choice of Improved Technologies

Technologies for development of land, water, forests, and other resources are now available in India. What is required is an institutional arrangement for their adaption to area-specific situations and transfer of the proven technologies to their potential users. The Mittemari model seems to be the appropriate one for this purpose.

Programme Planning and Project Formulation

Necessary technical expertise and manpower for programme planning and project formulation using the watershed approach are now available with the Departments of Agriculture, Soil Conservation, Horticulture, Forestry, etc., and the agricultural universities/ICAR research institutes in every state. What is needed is an orientation and training programme in watershed planning and management for in-service personnel of various departments concerned. Similar programmes will also be needed for farmers, local leaders, bankers, etc. Such programmes could be conducted by the state agriculture university or an ICAR institute, if located in the state.

Organisation and Management

A vertically integrated three-tier organisation structure of the Karnataka type with a state level Watershed Development Council or Board, a divisional level Watershed Development Board, and a project level multidisciplinary Watershed Development Team seems to be an appropriate machinery for watershed planning and management in every state. At the state level, a Directorate of Watershed Development may be created to direct, coordinate, monitor, and oversee the programme in the state. Evaluation of the programme may be entrusted to an independent research institute of repute.

Financing

Funds available under such rural development programmes as the National Rural Employment Programme, Rural Landless Employment Guarantee Programme, Drought Prone Area Programme, Social Forestry Programme, etc., can be used for construction of soil and water conservation structures and creation of other basic infrastructures in selected watersheds. Sectoral development programmes can be drawn up for funding sectoral schemes. The National Bank for Agriculture and Rural Development now permits refinancing of watershed development projects. Besides, a number of international development agencies are also interested in funding watershed development projects in India.

People's Participation

People's participation is essential for the success of a watershed development programme. Every household having land in a watershed must accept and implement the recommended technologies on his land, if the programme is to achieve its intended results. This is possible only if the farmers living in the watershed are aware, educated, and convinced about the profitability of the new watershed development technologies. Voluntary agencies can supplement and complement the government efforts in educating and training farmers to enable them to adopt the watershed approach and in organising them to make and implement joint decisions relating to communally-held resources and assets.

Role of Government

In Karnataka, the State Government took unusually high interest in the watershed development programme. The Chief Minister himself headed the

State Watershed Development Council and took keen personal interest in the programme. The political commitment to the programme at the highest level in the state evoked similar commitment at the lower levels. GOK also supported research and development efforts of UAS in watershed development and cooperated with ICAR and other institutes in these matters. It is, therefore, essential for the success of a watershed development programme that the state government concerned supports the programme whole-heartedly and creates a congenial environment through appropriate policy measures for its success.

Concluding Remarks

To conclude, we can say that the watershed approach holds high promise as a basis for planning and management of land, water, and forest resources in India. Karnataka has shown a way to do it. It is now high time for the other states to follow Karnataka's model and improve the productivity of their land, water, and forest resources. The Mittemari model can be easily replicated elsewhere in India because it neither requires any drastic changes in the existing administrative structure nor any additional funds and manpower over and above what is normally available under various on-going agricultural and rural development programmes.

Notes

[1]The natural resource poor but highly developed countries of Japan, South Korea, Hong Kong, Israel, Denmark, and Switzerland have compensated for the lack of natural resources by appropriate technologies, institutions, and highly developed human resources.

[2] It is estimated that nearly 140 million ha out of the total area of 329 million ha in India are affected by water and wind erosion, about 7 million ha by waterlogging and salinity, and about 20 million ha by floods (Swaminathan, 1977).

[3] According to an estimate, approximately 130 million hectare metres (MHM) of water of the average annual precipitation of some 400 MHM in India is lost to the seas as run-off (CSE, 1985: 29).

[4]These estimates are based on the actual amount spent on the flood relief programmes by GOI every year in the form of grants to the state governments and Union Territories requesting such grants and the estimated loss due to soil erosion (Vohra, 1985).

[5]5 The terms "basin" and "catchment" are generally used to imply drainage areas of large river systems such as the Ganga, the Brahamputra, the Narmada, etc., whereas the term "watershed" usually implies drainage area of small rivers or rivulets, tributories of rivers, streams, ponds, lakes, nullahs, etc.

[6]6 The amortised value was computed at the 10 percent discount rate and assuming 10 years of productive life for the soil and water conservation works.

7 However, in another sub-watershed, Wadegera, in Gulbarga district of Karnataka, a voluntary agency, the Mysore Resettlement and Development Agency (MYRADA), in a collaborative project with GOK and the Swiss Development Cooperation (SDC), has successfully organised the watershed community into small homogeneous groups/associations and involved them in planning, execution, and monitoring of all the project activities (Singh, 1988b). GOK needs to replicate the MYRADA approach in its other watershed development projects.

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