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Impact of Watershed Development Programme on Productivity and Benefits Cost Ratio of Crops: A Case Study of the Itagi Watershed in Karnataka

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ABSTRACT

In India, a large portion of rain-fed land has low productivity, is at high risk, has little exposure to technology, and is vulnerable to the degradation of natural resources. Watershed Development Programmes (WDP) have been started in India to improve the production and sustain the ecology in dry and semi-arid areas by adopting appropriate technology in production and conservation, along with fulfilling the basic necessities of communities for food, water, and shelter. In the present study area of the Itagi watershed, various types of water and soil conservation structures, such as contour bunds, check dams, farm ponds, recharge pits, earthen checks, rubble checks, etc., were constructed in an area of 4636 hectares under 'Sujala' WDP during the year 2004. The total costs of these soil and water conservation structures were Rs. 356.6 lakhs, including administrative costs of Rs. 19.81 lakhs. The present paper reveals the impact of WDP on crop area, productivity, and benefit-cost ratios of various crops. The analysis of the data illustrates that after the implementation of the WDP, the productivity of various crops has increased by 16–80%, the area of cultivation has increased, and the benefit-cost ratio for all the crops has increased.In addition, many more benefits, like a change in cropping pattern, groundwater recharge increment, reduction in soil erosion, increased employment opportunities, etc., were also noticed.

Keywords -Watershed, Conservation, Assessment, Productivity, Benefits

1. INTRODUCTION

Nature has given water, land, and vegetation as a gift to mankind. These are dependent on each other; one cannot be managed without the other two. Hence, conservation and management of these resources are vital to the development of a nation, in particular agricultural productivity and food security.

Erratic and low rainfall, low fertility soils, changes in climate, inadequate infrastructure development, and an increased population with low literacy are mainly responsible for low productivity and poverty in the semi-arid tropics of India.

In India, increasing population and overutilization of natural resources will result in water scarcity by 2050. In tropical areas, the low fertility of the soil leads to land degradation. In India, 51% of the rainfed agroecosystem area (taking up 329 million ha) is degraded [1]. Water and soil are considered non-renewable resources in each human being's life period; prolonged misuse and improper management cause the degradation of such resources [2].

Watershed development projects are designed to conserve natural resources and ensure proper usage of water, soil, and vegetation while increasing agricultural productivity [3]. Several evaluation studies proved that the implementation of WDP helped in improving moisture holding capacity, reducing nutrient losses, and reducing soil erosion, thereby increasing crop yields and irrigation water availability through ponds and shallow wells [4], [5], [6], and [7]. Additionally, WDP helped improve employment opportunities and decrease local migration [8].

WDPs are widespread in all fields, like research institutes, government departments, non-governmental organizations, etc. Therefore, many schemes by the Government of India show a large variation in their implementation and in their benefits.

2.STUDY AREA

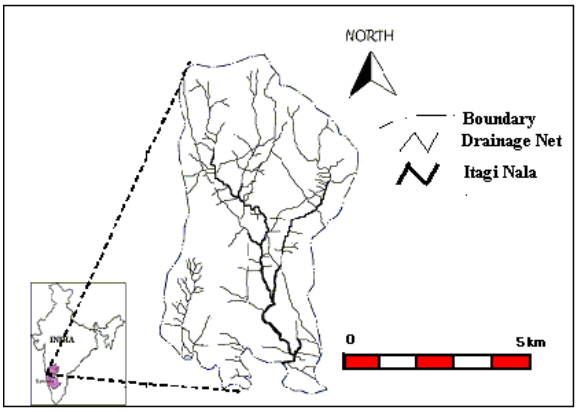

Fig.1.Location of the Itagi watershed

Itagi sub-watershed is located 10 kilometersto the east side of the headquarters of Ranebennur Taluk. It is the under-plain region in the Karnataka State's Haveri District's Ranebennur Taluk. The study area lies in latitudes 140 18’ to 140 32’ N and longitudes 750 37’ to 750 43’ E. Fig. 1 shows the location of the study area. The total watershed study area is 4636 hectares, which covers six villages, namely, Devagondanakatte (14.43%), Itagi (24.78%), Magod (16.33%), Kamdodu (19.91%), Manakur (9.19%), and Mustur (15.36%). It is the northern transitional zone according to agriculture regions and zones in Karnataka, land slope varies from 1-4 percent, and the soil type is red sandy loamy soil and black clay of shallow to medium depth, with the soil depth varying from 0.3 to 1.5 meters. The main economic activity in this area is agriculture. Bajra, tiny millets, groundnut, jowar, maize, pulses, cotton, and vegetables are the main crops farmed in the region. The annual rainfall average is 613 mm. The temperature ranges from $20^0$to 38^0Celsius. Early in 1980, there were 174 open wells, and at present, they are all defunct. In the study area, the total number of tube wells is 377, of which 85 have dried up, and in 2003, the bore well drilling depth was 140 m. The farmers here are socio-economically poor, with the total number of farmers as per the collected data being 2115. In total, 974 covers are classified as marginal, 487, 451, and 203 are classified as small, medium, and large farmers, respectively. The majority of the land holdings in this region are marginal (less than one hectare) or tiny (between one and two and a half and five hectares), with an average land holding size of 1.86 hectares, which can support six people on average per household.

3. THE SOIL AND WATER CONSERVATION

The most crucial practices for a watershed management plan are those that save soil and water since they lead to the growth of agriculture. The development of water resources in the watershed leads to many developments. The experiments are made to collect rainfall in the soil layer and reservoirs. Implementation of crop improvement measures, namely contour farming, crop rotation, adaptation of agricultural operations, etc., is practiced in the WDP.

The land use systems covering forestry and agroforestry are essential, as this is the source of productivity and income for dry land farmers. All these together reduce the drought condition in the catchment area, decrease soil erosion, and increase groundwater recharge, which balances the flood condition. Watershed management, therefore, proves the productivity of land and indirectly results in a nation’s progress. This ultimately results in an ecological balance in the environment.

The Itagi WDP has been implemented by "Sujala" a watershed development project planned by the Government of Karnataka with financial aid from the World Bank and other beneficiaries. The various structures, such as contour bunds, check dams, farm ponds, recharge pits, earthen checks, rubble checks, etc., were constructed over a study area of 4636 hectares under the WDP during the year 2004 (see Table 1) for conservation of soil and water. The total cost of these structures was Rs. 356.6 lakhs, which includes administrative costs of Rs. 19.81 lakhs.

4. RESULTS AND DISCUSSIONS

To study the impact of the Watershed Development Programme, data regarding, crops grown, extent of area under different crops, the pattern of growing, productivity of each crop, etc., were collected and analyzed before and after the WDP in the Summer,Kharif, and Rabi seasons. The rainfall is the dependent factor for the yield or crop production and as the rainfall changes over the years, yield varies. Therefore three years 2001, 2002, and 2003 averaged data were taken for analysis of the pre-period of the project, and the average data during 2005, 2006, and

2007 were taken to analyze the post-period of the project.

4.1. IMPACT ON THE CROP GROWN AREA AND THE PRODUCTION RATE

The area of crops grown throughout the summer, kharif, and rabi seasons has expanded due to changes in the land area and the installation of new water conservation resources in watershed areas. Table 2 gives the variation in the cropped area during the Summer, Kharif, and Rabi seasons. The cultivation of onion, maize, garlic, cotton, vegetables, sericulture, and other crops changed noticeably in the Kharif season, leading to higher yields and higher market prices for the products, as shown in Table 2.

A similar observation is made when conversing with the farmers. Vegetables have the highest productivity percentage increase (46.3) during the Kharif season, while other crops range from 25 to 42.9 percent.

In the Rabi season, the highest productivity percentage increase is 33.3 gram and varies from 14.3 to 30 percent for other crops. In the summer season, the highest productivity percentage increase is 45.5 for maize and varies from 15 to 41.2 percent for other crops. As per the observation, the cultivation area has improved in all three seasons of the post-period of the project, with a rate of 5.4 percent in Kharif, 13.8 percent in Rabi, and 42.2 percent in the summer season. Table 2 gives the detail. Due to the implementation of WDP, the majority of cultivators reported between 20 and 50 percent of the productivity increment. From this, soil erosion is reduced, groundwater storage is increased, and the moisture content of the soil is increased, which results in a notable increase in the yield of wells. The same has encouraged farmers to follow summer irrigation and impact agricultural development.

4.2.PRODUCTION COST AND ITS BENEFITS:

For the pre-project period and thepost-project period, the total cultivation costs and gross returns per hectare for all the crops on the entire land area were computed.

Here, the cost of the land is seen as a fixed cost (FC). The agriculture department's office of the joint director, land records, Ranebennur, is where the regarded land fixed cost is gathered.

Variable costs (VC) include the price of seeds, various manures, fertilizers utilized, insecticides, labor, etc. The overall cost (total cost TC) is determined by adding these two charges. The economic benefits of the crops under consideration are computed based on each crop's productivity and market price. The prices and financial advantages of various crops are listed in Table 3.

In the pre-period of the project, the maximum value of BCR, 1.82, was found to occur for vegetables. The minimum BCR, 0.71, is found with respect to jowar. The BCR for the other crops is found to vary between 0.90 and 1.18. However, the maximum BCR value for veggies during the project's post-period is 2.86, and the lowest BCR value for jowar is 0.86. The BCR values for the various crops under consideration range from 1.2 to 1.73.

The above analysis indicates there is a significant improvement in BCR value for vegetables from the pre-project to the post-project period. It can also be observed that there has been an improvement in BCR values for all other crops from pre-project to post-project.

Farmers prefer jowar cultivation since it is the primary crop for food and fodder, despite the fact that the increase in BCR value for jowar is lower than for other crops.

Despite the fact that all crops have increased their production rates, several crops, including groundnut, jowar, pulses, and sunflower, have seen a decrease in cropping intensity due to the grains' long-term stable market prices.

5. CONCLUSION

The Itagi watershed has benefited from the execution of the watershed development programme in the following ways.

- The soil moisture capacity has been improved by land and water conservation activities, resulting in improved crop production ranging from 14.3 to 46.3%.
- The increase in cultivation area under the Kharif, Rabi, and summer seasons was 5.4, 13.8, and 42.2 percent respectively.

- The decrease in crop diversification is observed for maize in the Kharif season, Jowar, Vegetable, and Gram in the Rabi season, and groundnut in the summer season.
- The benefit-cost ratio has been increased for all the considered crops, ranging from 9% (sunflower) to 57% (vegetable).

In addition to the above advantages, the following additional benefits were also noticed.

- The socio-economic condition of the people has improved.
- Employment opportunities for the villagers, in particular the landless group.
- Bringing awareness among the public to encourage active participation in the initiative to add sustainability.

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Table 1. Details of soil and water conservation measures in Itagi Watershed

Activity	**Physical**	**Unit**	**Finance involved (Lakhs)**	**Water storage capacity (m^3)**
PRIVATE LAND				
Contour Bund	3221	Hectares	163.640	1743290
Recharge Pits	11	No.	2.000	2376
Farm Ponds	131	No.	33.104	64138
Loose Boulder Checks	138	No.	3.072	10350
Ravine Réclamation Structures	34	No.	10.200	20400
Check Dam	10	No.	10.000	11250
Earthen Checks	1	No.	0.250	350
Rubble Checks	342	No.	11.277	48094
Farm Forestry	303.33	Hectares	21.355	--
Horticulture	218.06	Hectares	15.344	--
Land Leveling	87.57	Hectares	11.118	--
Vegetative Bunds	12.47	Hectares	0.050	--
Waterways	112	m^3	0.139	--
Diversion Channel	2757	m^3	0.744	--
COMMON LAND				
Block Plantation	104.98	Hectares	20.46	--
Farm Ponds	1	No.	0.25	432
Ravine Reclamation Structures	4	No.	1.2	2400
Desilting of Tanks	4	No.	3.575	15000
Check Dams	36	No.	25.685	33750
Nala Stabilization	15.6	m^3	0.909	--
Farm Forestry	0.49	Hectares	0.143	--
Road Side Plantation	14	Hectares	2.235	--
School Garden	0.5	Hectares	0.05	
Administrative Cost	-----	-----	19.813	--
		TOTAL	**356.613**	**1951830**

Table 2. Change in cropping pattern, crop area, production, and % increase in production of various crops

Crops	Pre-project (Average of 3 years 2001, 2002 & 2003)			Post-project (Average of 3 years 2005, 2006 & 2007)			Percentage Increase	
	Area (ha)	Productivity (q/ha)	Production (q)	Area (ha)	Productivity (q/ha)	Production (q)	Area	Productivity
KHARIF SEASON								
Maize	702.0	21.00	14742.0	894.7	30.0	26841.6	27.5	42.9
Jowar(Hybrid)	453.0	16.00	7248.0	345.0	20.0	6900.00	-23.8	25.0
Groundnut	450.0	14.00	6300.0	365.0	18.0	6570.00	-18.9	28.6
Onion	356.0	42.00	14952.0	380.3	60.0	22815.3	6.8	42.9
Garlic	245.0	7.00	1715.0	272.0	9.5	2584.00	11.0	35.7
Sunflower	512.0	7.00	3584.0	428.7	9.0	3858.48	-16.3	28.6
Cotton(Jayadh	584.0	10.00	5840.0	708.3	13.0	9208.16	21.3	30.0
Vegetable	68.0	82.00	5576.0	130.5	120.0	15657.6	91.9	46.3
Pulses	124.0	7.00	868.0	111.8	10.0	1118.40	-9.8	42.9
Sericulture	23.3	6.00	139.8	70.0	8.0	560.00	200.4	33.3
Total	3517.3		60964.8	3706.3		96113.6	5.4	
RABI SEASON								
Jowar (Local)	212.0	10.00	2120	261.0	13.0	3392.48	23.1	30.0
Cotton(Niranj	137.0	8.00	1096	158.0	10.0	1580.00	15.3	25.0
Gram	108.0	9.00	972	142.0	12.0	1704.00	31.5	33.3
Seteria	95.0	7.00	665	102.0	9.0	918.00	7.4	28.6
Safflower	163.0	7.00	1141	156.0	8.0	1248.00	-4.3	14.3
Vegetable	74.0	100.00	7400	128.0	120.0	15360.0	73.0	20.0
Pulses	164.0	8.00	1312	138.0	10.0	1380.00	-15.9	25.0
Total	953.0		14706	1085.0		25582.5	13.8	
SUMMER								
Vegetable	95.0	125.0	11875	158.0	145	22910.0	66.3	16.0
Maize	120.0	22.00	2640	162.0	32	5184.00	35.0	45.5
Groundnut	112.0	10.00	1120	142.0	14	1988.00	26.8	40.0
Water melon	10.0	85.00	850	18.0	120	2160.00	80.0	41.2
Total	337.0		16485	480.0		32242.0	42.4	
Units: q-quintal ; ha-Hectare								

Table 3. Economics of crops grown

Crops	Productivity (q/ha)	Price (Rs./q)	Fixed cost (Rs./ha)	Variable cost (Rs./ha)	Total cost 'TC' (Rs./ha)	Gross returns (Rs./ha)	Benefit cost ratio (BCR)
Pre-period of Project							
Maize	21.00	600	4200	14000	18200	12600	0.90
Jowar	16.00	600	4200	13500	17700	9600	0.71
Groundnut	14.00	1600	4500	19000	23500	22400	1.18
Onion	42.00	400	5000	15000	20000	16800	1.12
Garlic	7.00	2400	5000	16000	21000	16800	1.05
Sunflower	7.00	1800	4000	11500	15500	12600	1.10
Cotton	10.00	1900	5000	17800	22800	19000	1.07
Vegetable	82.00	400	5000	18000	23000	32800	1.82
Pulses	7.00	2200	4500	13000	17500	15400	1.18
Sericulture (Silkworm)	6.00	11000	10000	48600	58600	66000	1.13
Post-period of Project							
Maize	30.0	800	4600	15000	19600	24000	1.22
Jowar	20.0	800	4600	14000	18600	16000	0.86
Groundnut	18.0	2000	5000	20000	25000	36000	1.44
Onion	60.0	600	5200	17000	22200	36000	1.62
Garlic	9.5	3000	5200	13000	18200	28500	1.57
Sunflower	9.0	2200	4500	12000	16500	19800	1.20
Cotton	13.0	2400	5200	18800	24000	31200	1.30
Vegetable	120.0	600	5200	20000	25200	72000	2.86
Pulses	10.0	2500	4700	13700	18400	25000	1.36
Sericulture (Silkworm)	8.0	13000	10000	50200	60200	104000	1.73