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Impact of Soil Rejuvenating Scheme on Income of Cotton Farmers – An Evidence from Kalaburagi District of Karnataka

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Authors' contributions

This work was carried out in collaboration among both authors. Author Sagar designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author MK was the major advisor for author Sagar and he corrected the manuscript. Author MS reviewed and managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Rainfed areas are not only thirsty but also hungry for nutrients and are hotspots of poverty, malnutrition, and degradation of natural resources. Looking into these aspects, the Government of Karnataka has implemented a mission mode project called *"Bhoochetana"* meaning *"reviving the soils"* to benefit dryland farmers for sustainable use of natural resources in Karnataka. This scheme aimed at enhancing the yield level of major dryland crops through integrated crop management (ICM) practices. The study has been conducted in the Kalaburagi District of Karnataka State, where the majority of the area under agriculture is rainfed and cotton is one of the major rainfed crops grown on a large scale. The study revealed that the yield of the main product from cotton production for Bhoochetana beneficiary farmers was higher with 23.18 quintals per hectare compared to non-beneficiary farmers with 21.36 quintals. The results of partial budgeting showed that, a net gain of ₹ 4660 per hectare was obtained by Bhoochetana scheme beneficiaries over non-beneficiary farmers. The study highlighted that, there is a positive significant effect of the scheme on the production of

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cotton. Therefore, the policies must focus on long-term soil, water, and other natural resource conservation practices to achieve sustainability in agriculture.

Keywords: Regression analysis; bhoochetana; soil; micronutrients; yield and income.

HIGHLIGHTS

The application of Bhoochetana inputs have significantly improved the yield and returns from cotton production. The return per rupee of expenditure in cotton cultivation was high for Bhoochetana beneficiary farmers than non-beneficiary farmers.

1. INTRODUCTION

Globally, dry land occupies 40 per cent of the earth's surface and is highly prone to land degradation. About 3.6 billion ha of the dry-land has already degraded and this is threatening the lives of millions of people [1,2]. The task of feeding the global human population estimated at 9.6 billion by 2050 combined with dietary transitions accompanying the change in human socio-economic status, calls for the intensification of farming systems [3]. Achieving this goal entails increasing the quantity and quality of crop production inputs such as water, seed, pesticide, and fertilizer. As a crucial input in modern agriculture, fertilizers make an important contribution to the attainment of high crop yields. Agricultural productivity increased in many of the regions that experienced the Green Revolution through the application of nitrogen, phosphorus, and potassium (NPK) containing fertilizers. Together with NPK, the eight other essential nutrients constitute a distinct group of elements required by plants in very small amounts, described conventionally as micronutrients: namely copper, iron, manganese, molybdenum, nickel, zinc, boron, and chlorine.

India has about 108 million hectares of rain fed area which constitutes nearly 75 per cent of the total 143 million hectares of arable land [4]. These rainfed areas feeds nearly half of country's population and contributes more than 40 per cent of total food grain production [5]. The Productivity of the irrigated area has already reached a plateau and any additional food grain production has to come largely from the rainfed lands only. The current productivity of rainfed agriculture is just 1 to 1.5 tonnes per ha, which are lower by two to five folds of achievable potential yield [6]. Rainfed soils are multi-nutrient deficient and need proper nutrient management strategies to bridge the yield gaps [7]. Wani et al. [8] also reported that rainfed regions have low rain water use efficiency (RWUE). In India, rainfed agriculture accounts for nearly two-thirds of the total cropped area and generates nearly half of the total value of agricultural output. Similarly, Karnataka has 75 to 80 per cent cultivated area under rainfed agriculture. Rainfed areas are not only thirsty but also hungry of nutrients. Millions of hectares of land in India have low availability of micronutrients. In India, micronutrient deficiencies have been reported as one of the main causes for yield plateau or even yield decline [9,10]. The analysis of more than 2.0 lakhs soil samples, collected from 508 districts of the country during 2011-2017 under the leadership of ICAR – Indian Institute of Soil Science, Bhopal, revealed that on an average of 36.50, 12.80, 7.10, 4.20 and 23.20 per cent soils are deficient in Zn, Fe, Mn, Cu and B, respectively [11].

Karnataka occupies 2nd position in the rainfed area after the Rajasthan in India [12]. It was observed that Karnataka soils are also hungry as largely deficient in S (52%), Zn (55%) and B (60%). Similarly, Hyderabad-Karnataka region soils are also largely deficient in S, Zn and B [13] leading to lower yields of dry-land crops. Limited by water scarcity along with micro-nutrient deficiencies, poses difficulty in harnessing the full potential of dry land agriculture. Hence, there is a great need to increase the productivity of rain fed crops and overall net returns to keep the farmers in agriculture. A paradigm shift in rain fed agriculture can be expected through technological thrusts and policy changes.

In order to improve the potential of dry-lands, the Government of Karnataka initiated a novel project under Rashtriya Krishi Vikas Yojana (RKVY) called 'Bhoochetana' to improve the livelihoods of dry-land farmers in all the districts of the State. The project was initiated in the year 2009 to increase the average productivity of major rainfed crops by 20 per cent by analysis of soil samples and preparation of GIS-based soil fertility maps in all the districts. The primary strategy of Bhoochetana is soil testing based nutrient management with a major thrust on micronutrients. Inputs are made available at 50 per cent subsidy at village and cluster level through Raitha Samparka Kendra’s (RSKs).

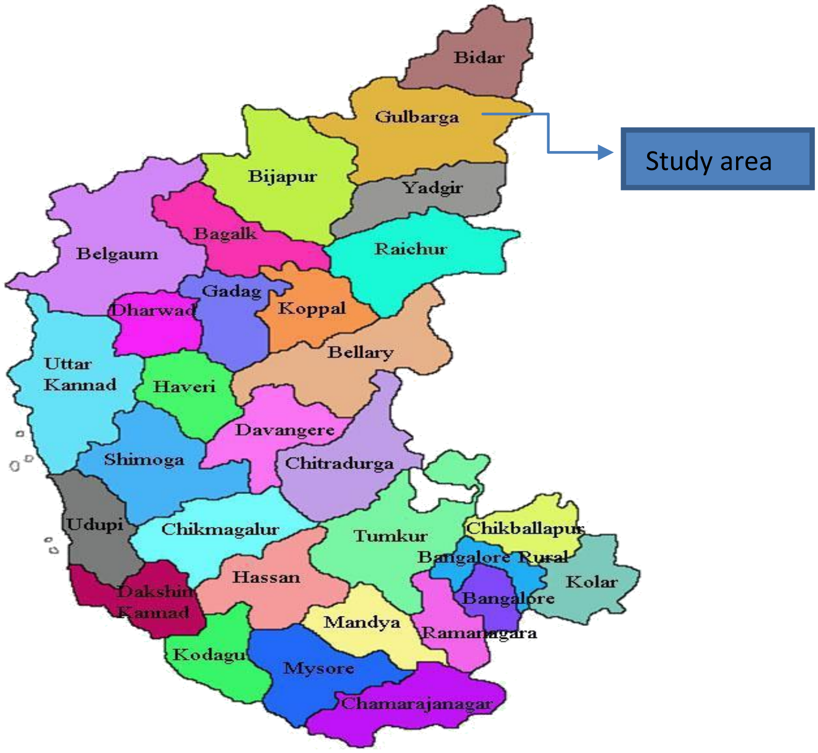

Fig. 1. Map showing the study area

With this backdrop, the present study was taken up with the specific objective to measure the impact of the Bhoochetana scheme on yield level and returns of rainfed crops in Kalaburagi district of Karnataka where, 86.20 per cent of area is under rainfed agriculture [14]. The study focuses on Cotton crop which is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. Cotton is the sixth major dry-land crop grown in terms of area (32,830 ha) in the study area out of which Jewargi taluka alone constitutes about 89.50 percent (29435 ha) of area under cotton [15].

2. DATA AND METHODOLOGY

2.1 Data

The primary data about inputs used, yield, the economics of crop production *etc*. were collected from sample farmers for the agriculture year 2017-18 in Kalaburagi district of Karnataka. The random sampling technique was used in the selection of sample farmers in the study area. The data was collected from 120 sample farmers which constituted 60 Bhoochetana beneficiaries and 60 non-beneficiaries.

2.2 Methodology

2.2.1 Data collection

The primary data about socio-economic characteristics, resources used, yield, economics of crop production *etc*. were collected from sample farmers for the agriculture year 2017-2018 by using a pre-tested, structured interview schedule in Kalaburagi district of Karnataka. 60 Bhoochetana beneficiaries and 60 non-beneficiaries were selected at random.

2.2.2 Data analysis

2.2.2.1 Estimation of costs and returns of cotton production

The cost of cultivation was arrived at by considering both variable and fixed costs as well as explicit and implicit costs. Under the variable costs, labour cost (both family and hired), cost of inputs and interest on working capital were calculated. Under the fixed cost, the rental value of land, depreciation (straight line method was used), interest on fixed capital, land revenue and taxes are computed. Gross returns from cotton production, net returns over total cost, cost of production per quintal and return**s** per rupee of expenditure are calculated.

List 1. Partial budgeting tool

Debit	Credit
Increase in cost due to application of Bhoochetana inputs = A	Decrease in cost due to application of Bhoochetana inputs = C
Decrease in gross returns due to application of Bhoochetana inputs = B	Increase in gross returns due to application of Bhoochetana inputs= D
Total = A+B	Total = C+D
Credit-Debit = Net gain / loss	

2.2.2.2 Partial budgeting

A simple yet powerful tool partial budgeting technique was used to estimate the direct economic benefit (or loss) at farm-level by adoption of the Bhoochetana scheme. It focuses only on the changes in income and expenses that would result from implementing an alternative technology. Thus, all components of farm profits that remain unchanged by the decision were not considered. In this study, the impact of the Bhoochetana scheme on an income of cotton farmers is evaluated by considering the additional costs incurred in application of inputs (micronutrients and bio-fertilizers) and decreasing gross returns (if any) were used under debit. Decrease in cost if any by the adoption of Bhoochetana scheme and incremental returns realized (if any) were taken under credit as shown in Table 1. Sum of credits was subtracted from the sum of debt to arrive at net gain or loss.

2.2.3 Resource Use Efficiency (RUE)

Resource use efficiency in cotton production was estimated among beneficiaries and non-beneficiaries of Bhoochetana by using the Cobb-Douglas type of production function and its empirical form is shown in equation (1).

$$Y = a\prod_{i=1}^{7} X_i^{\beta_i} + e^u, where\ i = 1\ to\ 7 \qquad (1)$$

Where, Y_i is the gross returns (₹) from cotton, β_1 to β_7 parameters to be estimated, X_1= area (acres) under cotton crop, X_2 =Seed quantity (kg), X_3= FYM and fertilizer cost (₹), X_4= Cost of human labour (₹), X_5= Cost of bullock labour (₹), X_6= Cost of machine labour (₹), X_7= Cost of plant protection chemical (₹), 'a' is a Constant and 'u' is a random error.

2.2.3.1 Marginal Value Product (MVP)

The estimated coefficients were used to compute the MVP. We can assess the relative importance of factors of production by studying the marginal value product. Marginal Value Product of X_i, *i.e.* for the i^{th} input, is estimated by the following formula (equation 2)

$$MVP = bi \times \frac{GM(Y)}{GM(Xi)} \times P_y \qquad (2)$$

GM (Y) and GM (Xi) represent the geometric means of output and input respectively, b_i is the regression coefficient of i^{th} input and P_y is the price of output. The model was estimated as in equation 3.

$$r = \frac{MVP}{MFC} \qquad (3)$$

Where, 'r'is the efficiency ratio, MVP is the marginal value product of variable input and MFC is the marginal factor cost (price per unit input).

Based on economic theory, a firm maximizes profits with regards to resource use when the ratio of the marginal return to the opportunity cost is one. The values are interpreted thus, if r is less than 1 indicates that the resource is excessively used (there exist scope for the reduction). If r is greater than 1, indicates that the resource is under used or being underutilized (there is a scope to increase). If r is equal to 1, indicate optimum utilization of resource.

2.4 Bhoochetana Impact on Cotton Production

Cobb-Douglas regression function was used to analyze the impact of the Bhoochetana scheme on cotton production and the functional form is presented in equation (4)

$$Y = aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}D^{b6}e^u \qquad (4)$$

Where, Y is total cotton production (Quintals), X_1 is the area (acre), X_2 is seed (Kg), X_3 is nutrient cost (₹), X_4 is Human labour cost (₹), X_5 is bullock and machine cost (₹), D is a Dummy variable (D=1 for Beneficiary, 0 otherwise) and u is an error term.

3. RESULTS AND DISCUSSION

3.1 Estimation of Costs and Returns

The details of per hectare cost of cultivation for cotton production for Bhoochetana beneficiary and non-beneficiary farmers are given in Table 1.

Proportion of working expenses in cotton cultivation for both the Bhoochetana beneficiary and non-beneficiary farms were 80.34 and 78.75 per cent, respectively and the fixed expenses in cotton cultivation was found to be 19.65 and 21.25 per cent for Bhoochetana beneficiary and non-beneficiary farms, respectively.

Human labour occupied the prominent cost in the total variable cost in case of Bhoochetana beneficiary farms and was found to be ₹ 27,213 per hectare which constituted about 38.63 per cent of total cost followed by fertilizer cost (10.78 %), FYM (7.49 %), bullock labour (5.94 %), seed (5.67 %), plant protection chemicals (2.94 %), machine labour (2.43 %) and the cost of micro nutrient and bio-fertilizer was lowest (1.18 %). Human labour requirement was mainly required for activities such as sowing or transplanting, weeding, fertilizer application, harvesting, and packaging. In case of cotton cultivation by non-beneficiary farms the human labour cost was found highest amounting to ₹ 25213 per hectare (37.42 %) and the cost of plant protection chemicals was lowest with 3.04 per cent of the total cost.

Fixed costs accounted for 19.65 per cent and 21.25 per cent of the total cost of cultivation in cotton cultivation for Bhoochetana beneficiary and non-beneficiary farms, respectively. Among fixed costs, the rental value of land was a major cost for both beneficiary (18.45 %) and non-beneficiary farms (20.03 %) in cotton cultivation. The average fixed cost was found to be ₹ 13836 and ₹ 14325 per ha in cotton cultivation for Bhoochetana beneficiary and non-beneficiary farms, respectively.

The average cost of cultivation of cotton for Bhoochetana beneficiary farmers was ₹ 70436.80 and ₹ 67384.33 for non-beneficiary farmers per hectare. The Cost of cultivation was higher in cotton cultivation by Bhoochetana beneficiary farms compared to non-beneficiary farms, because of higher requirement of labour and also the application of micronutrients and bio-fertilizers.

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Table 1. Per hectare cost of cultivation of cotton in the study area

Sl. No.	**Particulars**	**Bhoochetana beneficiary**			**Non-beneficiary**		
		Quantity	**Total Cost (₹)**	**Per cent**	**Quantity**	**Total Cost (₹)**	**Per cent**
I	**Variable cost**						
	Human labour (Man days)	81.23	27214	38.63	77.58	25214	37.42
	Bullock labour (BP days)	4.40	4188	5.94	3.24	3078	4.57
	Machine labour (hours)	3.23	1713	2.43	4.21	2316	3.44
	Seed (kg)	5.00	4000	5.67	4.30	3225	4.79
	FYM (tractor load)	3.5	5278	7.49	4.11	6576	9.76
	Fertilizer cost		7593	10.78		7137	10.59
	Micro nutrient and Bio fertilizer		837	1.18		0.00	0.00
	Plant protection chemicals		2070	2.94		2048	3.04
	Interest on working capital @ 7 per cent		3702	5.26		3472	5.15
	Total variable cost		56595	80.34		53065	78.75
II	**Fixed cost**						
	Depreciation		740	1.06		730	1.08
	Land revenue		20	0.02		20	0.03
	Interest on fixed capital @ 10 per cent		76	0.10		75	0.11
	Rental value of land		13000	18.45		13500	20.03
	Total fixed cost		13836	19.65		14325	21.25
III	**Total cost of cultivation**		70437	100		67390	100

Human labour occupied the prominent cost in the total variable cost in case of Bhoochetana beneficiary farms and was found to be ₹ 27,213 per hectare which constituted about 38.63 per cent of total cost followed by fertilizer cost (10.78 %), FYM (7.49 %), bullock labour (5.94 %), seed (5.67 %), plant protection chemicals (2.94 %), machine labour (2.43 %) and the cost of micro nutrient and bio-fertilizer was lowest (1.18 %). Human labour requirement was mainly required for activities such as sowing or transplanting, weeding, fertilizer application, harvesting, and packaging. In case of cotton cultivation by non-beneficiary farms the human labour cost was found highest amounting to ₹ 25213 per hectare (37.42 %) and cost of plant protection chemicals was lowest with 3.04 per cent of the total cost.

Fixed costs accounted for 19.65 per cent and 21.25 per cent of the total cost of cultivation in cotton cultivation for Bhoochetana beneficiary and non-beneficiary farms, respectively. Among fixed costs, rental value of land was major cost for both beneficiary (18.45 %) and non-beneficiary farms (20.03 %) in cotton cultivation. The average fixed cost was found to be ₹ 13836 and ₹ 14325 per ha in cotton cultivation for Bhoochetana beneficiary and non-beneficiary farms, respectively.

3.1.1 Yield and returns

The yield of main product from cotton production for Bhoochetana beneficiary farmers was higher with 23.18 quintals per hectare compared to non-beneficiary farmers with 21.36 quintals and the gross return was also high in case of Bhoochetana beneficiary farms (₹ 1,04,310) compared to non-beneficiary farms (₹ 96,120). The higher net returns of ₹ 5137 for Bhoochetana beneficiary farms were observed over and above the non-beneficiary farms. The difference in returns between beneficiary and non-beneficiary can be attributed to the increased yield for beneficiary a farmer (1.82 quintals per hectare) which was due to the application of Bhoochetana inputs like micronutrients and bio-fertilizers (Table 2). Hence the productivity of rainfed crops among Bhoochetana beneficiary farmers is higher than non-beneficiary farmers. The results are also in line with Hamsa et al. [16] which showed that the application of the micronutrients in adopter category of groundnut resulted in an increased yield of 1.23 quintals extra over and above the non-adopters and 2.02 quintals extra over and above the non-adopters in ragi.

Table 2. Per hectare returns from the cotton production

Particulars		**Bhoochetana beneficiary**			**Non-beneficiary**		
I	**Returns**	**Quantity**	**Price/ Unit (₹)**	**Total (₹)**	**Quantity**	**Price/ Unit (₹)**	**Total (₹)**
	Main product (Quintals)	23.18	4500	104310	21.36	4500	96120
	Gross returns (₹)	104310			96120		
	Net returns (₹)	33873			28736		
	Cost of production (₹/Quintal)	3039			3155		
II	**Returns per rupee of expenditure**	1.48			1.42		

Table 3. Relative benefits of Bhoochetana beneficiary farmers over non-beneficiary farmers in cotton cultivation (₹/ha)

Debit		**Amount**	**Credit**		**Amount**
A) Increase in costs			**A) Decrease in cost**		
i)	Human Labour	2000	i)	Machine Labour	602
ii)	Bullock Labour	1109	ii)	FYM	1298
iii)	Seed	775			
iv)	Fertilizer cost	456			
v)	Micro nutrients	836			
vi)	PPC	22			
vii)	Interest on working capital @ 7 per cent	230			
B) Decrease in returns		-	**B) Increase in returns**		8190
Total debits		**5430**	**Total credits**		**10090**
Net gain per hectare (Total Credit-Total Debits) =₹ 4660					

Table 4. Impact of Bhoochetana scheme on yield of cotton in study area

(Dependent Variable: Yield in quintals)

Particulars	Co-efficient	Co-efficient value	t value
Intercept	a	1.566	0.440
Area (ac)	b_1	0.627**	5.289
Seed (Kg)	b_2	0.328*	2.950
Nutrients cost (₹)	b_3	0.099	1.195
Human labour cost (₹)	b_4	0.020	0.333
Bullock labour cost (₹)	b_5	0.003	0.089
Machine labour cost (₹)	b_6	0.009	1.525
PPC (₹)	b_7	0.001	0.248
D (1= Beneficiary, 0 otherwise)	b_8	0.175*	4.463
Coefficient of multiple determination (R^2)		0.88	

*Note: **, * indicates significance at one and five per cent, respectively.*

3.1.2 Returns per rupee of expenditure

Return per rupee of expenditure incurred in cotton cultivation was found to be higher in case of Bhoochetana beneficiary farms (1.48) compared to non-beneficiary farms (1.42).

Partial budgeting technique was used to estimate the relative benefit of Bhoochetana scheme on income level of farmers in cotton cultivation. It is evident from Table 3 that, net gain of ₹ 4660 per hectare was obtained for Bhoochetana scheme beneficiaries over non-beneficiary farmers in cotton cultivation. It clearly shows the relative benefit of the Bhoochetana scheme on returns on farm income. The use of micronutrients and bio-fertilizers has contributed in increase in the yield level of cotton and increase in the income level of farmers. The results of partial budget indicated that it is profitable to apply micronutrients which yield a net gain of ₹ 4660 per hectare.

3.2 Impact of Bhoochetana Scheme on Yield Level of Cotton

To assess the impact of the Bhoochetana scheme on yield level of cotton, dummy was assigned to beneficiary and non-beneficiary farmers (D=1 for beneficiary and 0 otherwise). The coefficient of determination was 0.88 indicating that 88 per cent of the variation in dependent variable was explained by the variables included in the regression model. The threshold output of cotton was 1.56 quintals per farm which is the contribution of other factors which are not included in the regression model. The regression coefficients for area was 0.627 and was statistically significant at one per cent level of significance indicating that for every one-acre increase in area from its geometric mean level, the output increases by 0.627 per cent from its geometric mean level. The regression coefficients for seed (0.328) was statistically significant at five per cent level of significance indicating that for every one per cent increase in the seed from its geometric mean level, the output increases by 0.328 per cent from its geometric mean level.

Because of Bhoochetana scheme the threshold yield level of beneficiary farmers shifted by 0.17 quintal per farm as given by the coefficient of dummy variable (D was significant at one per cent) used for Bhoochetana beneficiary farmers in the study area. Because of use of micronutrients and bio-fertilizers the yield of cotton was more in case of beneficiary farmers compared to non-beneficiary farmers.

4. CONCLUSION

Bhoochetana inputs are being used widely in Kalaburagi district of Karnataka. This scheme has enhanced soil health, increase in crop yields and in turn helped in achieving higher income. It is evident from the study that, the higher yield level of 8.52 per cent by Bhoochetana beneficiary farmers can be attributed to the use of Bhoochetana inputs. Overall, this technology has potential and can play an important role in achieving the target of doubling farmer's income by 2022 in the region, provided it is carefully promoted, implemented and monitored by the Government through adequate and timely supply of micro nutrients and certified bio-fertilizers to all the farmers and only soil test based micro-nutrient application. The government should take measures to implement schemes like Bhoochetana across all states of the country to help farming community to gain from the additional income derived from application of Bhoochetana inputs.

The Productivity of the irrigated area has already reached a plateau and any additional food grain production has to come largely from the rainfed areas only. This gives a clear picture on importance of soil reviving schemes like Bhoochetana in unlocking the potential of rainfed agriculture and enhancing the productivity of rainfed crops through *Science-led interventions* to make rainfed farming a viable livelihood option on a sustainable basis while also protecting the environment, and to help the farming community to stay in agriculture. Since the study was based on the primary data collected from sample farmers, I have considered the socio economic characters which are influencing the adoption of Bhoochetana scheme. It provides an opportunity for other researchers to consider agri-environmental variables such as rainfall, temperature etc.. for future studies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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