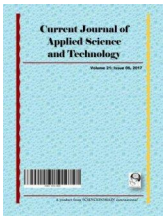

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Economic Surplus Approach for Impact Assessment of Soil Reviving Programme in Karnataka: An Economic Analysis

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Authors' contributions

This work was carried out in collaboration between all authors. Author KRH conducted a study during her Ph.D work and he designed the study, performed the statistical analysis, wrote the protocol, and wrote the complete manuscript. Author KBU is the major advisor/guide for my Ph.D degree, so it is mandatory to add his name and he corrected the manuscript, guided me to how to conduct the study and select the tools for analysis, etc. Author VB helped in framing the suitable methodology, helped in collecting the data and managed the part of the analyses of the study. Author BG helped in framing the suitable methodology and managed the part of the secondary data for analyses of the study. Finally all authors read and approved the final manuscript.

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ABSTRACT

Globally rainfed areas are hotspots of poverty, malnutrition and degradation of natural resources. Government of Karnataka (GoK) has converged all the Government schemes through a mission mode project called as "*Bhoochetana*" meaning "*reviving the soils*" to benefit dryland farmers for sustainable use of natural resources in Karnataka. The study aims to estimate the welfare impact of Bhoochetana programme in holistic manner. Multiple regression analysis was employed to evaluate the marginal effect of soil reviving programme among the adopters and non-adopters. The distributional effects of the programme on consumers and producers were assessed with the application of Economic Surplus (ES) model. Field information was composed from 120 farmers

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covering adopters and non-adopters of the programme. The application of micro nutrients was the major intervention of this programme and it had found to have significant impact on yield and income of selected crops. In groundnut the application of the micronutrients in adopter category resulted in increase in yield of 1.23 quintals extra over and above the non-adopters (5.9 quintals) and the total economic surplus due to adoption of programme was Rs. 2643 million from 2009-10 to 2015-16 with producers (72.56%) benefited relatively more than the consumers (27.43%). Whereas, in case of ragi, the adopters ragi yielded 2.02 quintals extra over and above the non-adopters (6.6 quintals) and distributional effect of consumers (54.93%) profit was relatively more than the producers (45.06%), with total economic surplus of Rs. 1933 million. Therefore, the policy focus must be on creating awareness and adoption of new technologies through developmental programmes in rural areas to reach millions of small farmers.

Keywords: Bhoochetana programme; micro nutrients; regression analysis; economic surplus approach; consumers surplus; producer surplus.

JEL code: Q, Q1, Q16

1. INTRODUCTION

Agriculture is the main stay of Indian economy. India has 25% of the farming population of the world and over 80% of them belong to small and marginal farmers. In India, out of 142 million hectare (mha) of arable lands, 60% (85.2 mha) is under rainfed. Karnataka has the second largest area (5 mha) under rainfed agriculture after Rajasthan in the country [1].

Over 60% of the Karnataka population depends on agriculture for their livelihood, the majority of these are small and marginal farmers with landholding less than two ha, responsible for nearly half the food production in the State [2]. Inappropriate soil, water and crop management practices are depleting soil nutrient reserves and further degrading land resources which results in low crop productivity [3]. Further a wide gap exists in actual yield levels in the farmer's field and yields of field level demonstrations.

The depletion of soil nutrients often leads to low fertility levels that limit production and severely reduce water productivity. Soil health is a pre-requisite to quickly harness the productivity benefits while bringing on board the majority farmers to initiate the process of upgradation of dryland agriculture. Similarly, the use of low yielding cultivars is another stumbling block for enhancing productivity of dryland agriculture. Therefore, an introduction of improved cultivars of crops through participatory evaluation is another potential entry point intervention. The Government of Karnataka has converged all the Government schemes through a mission mode project called *"Bhoochetana"* meaning *"reviving* the soils" to benefit dryland farmers.

In Karnataka, Bhoochetana programme was started in 2009-10 for increasing yield by 20%. Bhoochetana is a technology package comprising of soil test based nutrient management, distribution of inputs (seeds, seed treatment chemicals, micronutrients and bio-fertilisers) at subsidised rates and integrated extension services. Available empirical evidence showed that, the programme has made significant impact on the performance of agriculture in the state [4,1]. Yield of various dryland crops increased remarkably overtime with the balanced application of nutrients on soil test basis, adoption of improved cultivars and integrated pest management.

Initially, Bhoochetana programme was started in six districts of Karnataka state. Based on the success achieved in these districts (0.22 lakh ha) during 2009-10, the scheme was extended to another ten districts (1.2 mha) during 2010-11, later in 30 districts, with area of coverage of 3.1 mha during 2011-12 and further enhancement of area of 5.0 mha during 2012-13. During 2009-10, 2010-11, 2011-12 and 2012-13 about 0.2 million, 0.85 million, 2.2 million and 4.2 million farmers had benefited from the scheme, respectively. The success of the scheme was evident from the increase in average yields of 30-40% during 2009-10, 25-50% during 2010-11, 21-43% during 2011-12 and 11-37 per cent during 2012-13 [5]. In 2013-14, 2014-15 and 2015-16 about 4.87, 5.02 and 6.68 mha were covered in 30 districts with 4.1, 4.1 and 4.42 million farmers, respectively. Karnataka state received a prestigious "Krishi Karman Award" from the Government of India and "Leadership Awards" from agriculture today during the year 2010-11 in that the contribution of Bhoochetana programme was significant.

Since Bhoochetana is a package programme, an ex-post evaluation approach was followed to analyse the impact of intervention of technologies benefiting the farm households who have adopted. Thus the present study aims to analyse the impact of the Bhoochetana programme between adopters and non-adopters in Tumakuru district of Karnataka.

2. DATA AND METHODOLOGY

The present study was conducted in Tumakuru district of Karnataka, India. The district was selected based on extent of deficiency in micro nutrients (Table 1). Two villages were selected from Tumakuru based on micro nutrient deficiency of S, Zn and B. Simple random sampling technique was employed for the selection of 120 sample farmers comprising of 60 adopters and 60 non-adopters of the Bhoochetana technology programme. Post stratification of the sample was done based on the crops grown (Groundnut and Ragi) in adopter's category. The reference period for the collection of data was 2015-16. Data pertaining to adoption of technology and its impact variables were compiled from the beginning of the Bhoochetana programme *i. e.,* 2009-10 to till the end of the reference period. The secondary data regarding area, production and productivity were collected from the district website for the year 2009-10 to 2015-16 [6].

2.1 Analytical Tools

The adoption of micronutrients was considered one of the key component of the Bhoochetana technology package. Farmers who applied any of the micronutrients *viz.,* gypsum, zinc sulphate and borax to the crops during Bhoochetana period (2009-10 to 2012-13 and 2013-14 to 2015-16) were considered as adopters, otherwise non-adopters.

2.2 Rate of Adoption

Rate of adoption of Bhoochetana technologies were calculated using the formula:

$$\text{Rate of adoption } (\%\ of\ farmers) = \frac{X}{Sample\ size} * 100$$

X = Number of farmers adopted micronutrients technology in any year during Bhoochetana period (2009-10 to 2015-16)

2.3 Estimation of Costs and Returns

The costs were classified into variable and fixed costs. Variable cost includes cost of inputs (seed, manure, fertilizers, micronutrients and bio-fertilizers), labour cost and interest on working capital. Fixed cost includes depreciation on farm implements, rental value of land and interest on fixed farm implements.

2.4 Linear Regression Model

Dependent variable: Yield in quintals
Independent variables: X1: Seed (Kg)
X2: Micronutrients (Rs.)
X3: NPK fertilizers (Rs.)
D1: Dummy variable (1-Adopters, 0 - Non-adopters)

2.5 Economic Surplus Approach

The Economic Surplus (ES) approach is widely followed for evaluating the impact of technology on the economic welfare of households [7,8,9]. The economic surplus method measures the aggregate social benefits of research institutions and policy interventions of a research project. With this method, it is possible to estimate the return to interventions by calculating a variation of consumer and producer surplus through change. Later, the economic surplus is

Table 1. Detailed nutrient status of soil samples collected and analysed by ICRISAT from 11609 farmers' fields in 6 district of Karnataka during 2008-2009 crop seasons

Districts	Numbers of fields	% of fields deficient in a nutrient		
		Sulphur(ppm)	Zinc(ppm)	Borax (ppm)
Chikaballapura	2257	80	52	80
Chitradurga	1489	86	80	64
Dharwad	1129	79	44	39
Haveri	1532	85	60	46
Kolar	2161	85	32	87
Tumakuru	3041	92	50	91

Source: [1]

utilized together with the intervention costs to calculate the net present value (NPV), the internal rate of return (IRR), or the benefit-cost ratio (BCR) [8]. The model can be applied to the small/large open/closed economy within the target domain of production environment. The term surplus is used in economics for several related quantities. The consumer surplus is the amount that consumers benefit by being able to purchase a product for a price that is less than they would be willing to pay. The producer surplus is the amount that producers benefit by selling at a market price mechanism that is higher than they would be willing to sell for [10]. In the case of Bhoochetana programme, producers are mainly the farm households who produce the goods using the benefits of the Bhoochetana interventions such as distribution of seeds, seed treatment chemicals, micronutrients and bio-fertilisers and consumers are mainly the other stakeholders in the region, viz. non-farm households representing the labourers, business people and people engaged in non-agricultural activities.

For impact assessment of the Bhoochetana programme, the adopters were compared with non-adopters based on the adoption rate and extent of adoption of Bhoochetana technologies. This is further analysed 'with and without' programme approach as against 'before and after' programme approach for impact assessment [11]. Economic surplus method provides a relatively simple and flexible approach for economic impact assessment of a programme.

2.5.1 Theoretical framework

The Fig. 1 illustrates the impact of a successful programme effort on the supply curve, the equilibrium price, quantity and the economic surplus. The adoption of the programme shifts the original supply curve S_0 down to the right to S_1. This shift in supply moves the equilibrium price from P_0 to a lower level P_1 and a higher quantity from Q_0 to Q_1. For farmers, impact of the programme is reduction in cost of production. This in terms of producer surplus is given by an increase in area between (S_0) and (S_1) supply curves + the area under the new price line P_1 given by ERBF. Further, the programme reduces the price received by farmers and this reduces producer surplus by the extent of area between two price lines above S_0 given by P_1BNP_0.

For consumers, the effect of the programme is that they are always gainers. They receive whatever was lost by producers due to lower prices plus the economic surplus on the increased quantity. Consumers gain because they are able to consume a larger amount (Q_1) at a lower price (P_1). The area P_0NRP_1 (Fig 1) gives the change in consumer surplus (ΔCS). The change in producer surplus (Δ PS) is given by area ERBF.

The impact of the Bhoochetana programme is a gain of the area ERBF and area P_0NRP_1 where the whole economy is concerned [11]. The social gain from the programme is the sum of additional producer surplus and additional consumer surplus.

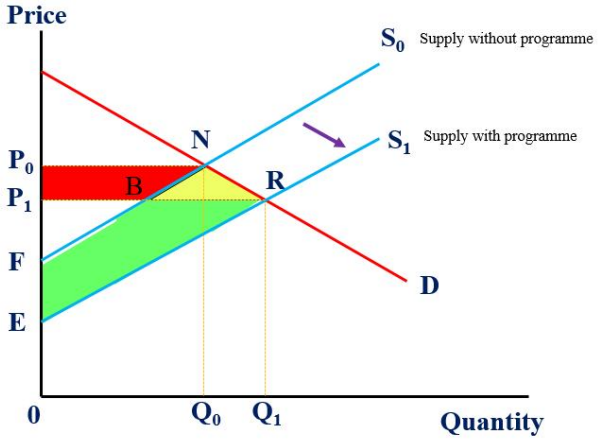

Fig. 1. Impact of Bhoochetana programme using economic surplus approach
Source: [12]

2.5.2 Measurement of social gains

For the present study, the ex-post impact assessment of the Bhoochetana programme is considered. In this situation, the observed price and quantity already included the effects of programme which results in shift in supply, as the technology is adopted. In the Fig. 2 the social gain is measured of area R minus area T. Area R shows the social gain due to the reduction in production costs at the observed level of production (Q_0), while area T represents a correction for the change in quantity caused by the research (Fig. 2). The height of area R is measured in terms of money per unit of output. Specifically, the effects of programme were observed in terms of quantity of output per unit of input, such as an increased crop yield per hectare. For a given cost of inputs, increased quantities represent a horizontal shift of the supply curve. To adopt the programme, it requires additional cost in new inputs. For a given level of output, this increased cost represents vertical shift [11]. Therefore, it is necessary to combine data on increased quantities $\Delta Q = Q_1-Q_0$ (horizontal shift) and increased inputs costs (a vertical shift, k) to obtain a net shift in terms of costs per unit of output.

The Social gain is obtained by the formula Social gain (SG) = $kPQ - \frac{1}{2}kP\Delta Q$ (1)

To compute k, Q, I, J and K parameter

The steps involved in estimation of welfare gain according to [11] are as under:

Step 1: Data on total production (in quintals) of groundnut & ragi and price per quintal (in rupees), for years 2009-10 to 2015-16 were obtained from Tumakuru district profile [6] and the farm harvest Prices for years 2009-10 to 2015-16 were obtained from the website [13]. As the prices obtained are nominal prices, they are deflated to obtain price in real terms by dividing nominal price by wholesale price index [14].

Step 2: The data on yield of groundnut and ragi were collected from the sample farmers pertains to the year 2015-16. The shift in yield (Q) is the difference between the yield of adopters (Ym) and non-adopters (Yc) of the programme.

Step 3: Estimation of J parameter

The J parameter is the total increase in production that is due to adoption of the programme. J is obtained by the change in quantity of output as a share of total output given by

$$j = J/Q \quad (2)$$

This expression gives the estimate of the supply shift in parameter (j) in terms of the increase in yield, rate of adoption (t), extent of adoption (e) and the overall average yield (Y)

Rate of adoption (t) is ratio of total area sown in Tumakuru district for each year and area covered under Bhoochetana programme for each year

Extent of adoption is assumed to be 0.8%

$j = (\Delta Y^* t^* e) / Y$. Here, Y is the overall average yield, *i.e* total production/total area under crop for each year.

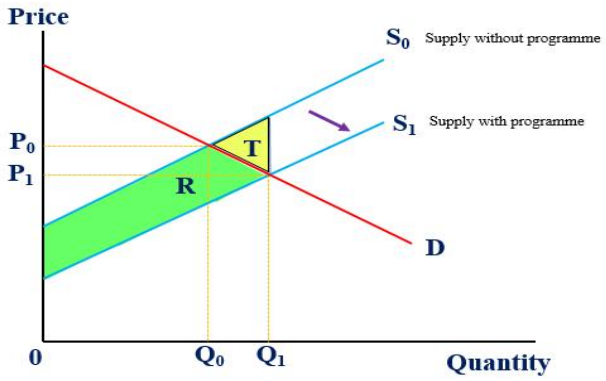

Fig. 2. Ex-post impact of Bhoochetana programme
Source: [11]

Step 4: Computation of adoption costs

The parameter I is the increase in per unit input cost required to obtain the increase in total production or total output J.

Given by $I = [\Delta C * t/Y]$ (3)

Here, ΔC = Cost per ha incurred to adopt the programme. This is obtained as the additional cost involved to adopt the programme.

The proportional cost increase parameter (c) is given by,

$c = I/P = [(\Delta C * t)/Y]*1/P$ (4)

Step 5: K parameter or shift in supply curve to be estimated. The K-parameter is the net reduction in production costs induced by the technology and can be obtained from combining the effects of increased productivity (J) and adoption costs (I). Given J and I, it can be computed using the slope of the supply curve (b_s) as

$K = (J * b_s) – I$ (5)

Step 6: The slope of supply curve (b_s) are associated with units of measurement. Therefore supply elasticity (€), which is independent of units of measurement is computed as follows:

$€ = \% \Delta Q/\%\Delta P$
$= (\Delta Q/Q)/ (\Delta P/P)$
$= (\Delta Q/\Delta P)*(P/Q)$
$= (1/b_s)*(P/Q)$
$b_s = €*Q/P$
$K = J/(€*Q/P) – I ; K = [JP/ €Q] –I$

Again K is used in proportional terms *i.e.* the net-reduction in production cost as a proportion of the production price, the formula used is

$k = K/P = [JP/€QP] - I/P = (j/€)- c.$ (6)

Where,

€ = price elasticity of supply

To estimate social gains, the elasticity of demand (e), price elasticity of supply and demand of groundnut and ragi were obtained from [15] and [16] respectively.

Step 7: Estimate equilibrium output quantity change: ΔQ

The equilibrium situation without programme would be that price and quantity, which satisfy both demand and supply.

$Q_d=Q_s$
$P= (a_s-a_d)/(b_d-b_s)$

Similarly

$P_1=(a_s-a_d+ b_s K)/(b_d-b_s)$
$\Delta P= b_sK/(b_d+b_s)$

the change in quantity is given by

$\Delta Q = b_d\Delta P$ (7)
$= b_db_s K/(b_d +b_s)$

To substitute elasticities for slopes, assume elasticity of demand is e, then

$e = \%\Delta Q/\%\Delta P$
$= (\Delta Q/Q) / (\Delta P/P)$
$= (\Delta Q/\Delta P) (P/Q)$
$= b_d (P/Q)$
$b_d = e (Q/P)$

Thus $\Delta Q = (e* Q/P) \times (€*Q/P) K / [(e* Q/P) + [€* Q/P]$

Here, we use ΔQ in proportional terms, and it is given by the formula

$\Delta Q = Qe €k/ (e+€)$ (8)

Step 8: Estimation of social gains. It is computed using the formula

$SG = (kPQ)\pm½(kP\Delta Q)$ (9)

Step 9: Incorporate the costs of extension (programme), to obtain social benefits for each year. The net social benefits were computed by subtracting extension costs from the total social gains obtained. Data on extension cost was obtained based on the allocation of budget from Government of Karnataka from 2009-10 to 2015-16 to the study area.

Step 10: Net social gain = Social gain-Extension costs

The producer surplus and consumer surplus was computed by decomposing the social gains (SG)/ total surplus given by the equation as follows

$\Delta TS = \Delta CS+ \Delta PS = P_0Q_0k (1+0.5Ze)$ (10)

$$\Delta CS = P_0Q_0Z(1+0.5Ze) \quad (11)$$

$$\Delta PS = P_0Q_0(k-Z)(1+0.5Ze) \quad (12)$$

$$\text{Where } Z = k^* €/e+€ \quad (13)$$

The net social gains obtained from deducting total extension costs and it is used to estimate NPV (Net Present Value).

$$NPV = \sum_{i=1}^{n} \frac{values_i}{(1+rate)^i} \quad (14)$$

Where,

Bi/ values i = Net social gains
r/rate = Discount rate, taken as 7 %
i = year 1 to n.
n = total number of years

3. RESULTS AND DISCUSSION

3.1 Socio-economic Status of Sample Farmers

The socio-economic characteristics of adopters and non-adopters of the Bhoochetana programme sample farmers (Table 2) revealed that, the average age of the adopters and non-adopters was 42 and 47 years, respectively and the pattern of distribution was statistically significant. There was a significant difference in the years of respondent's schooling between adopters and non- adopters. The classification of sample respondents according to their education level revealed that, majority of non-adopters possessed primary education (30.0%). While the majority of adopters had secondary education (67.0%). With respect to land holding, majority of the adopters and non-adopters were small and marginal size holders constituting 66.6% and 90% of land holdings, respectively followed by medium size with 33.3% and 10%, respectively. Overall, the majority of adopters were small and marginal size holders with comparatively young age with higher education status.

Cropping pattern (Fig. 3) of sample farmers indicated that, groundnut, ragi, maize, redgram, arecanut and coconut were the major crops grown by sample farmers in the study area. Inner doughnut of represents for adopters and outer doughnut for non-adopters cropping pattern. It was evident from the results that, groundnut occupied greater share in gross cropped area (GCA) among all crops in both adopters (52%) and non-adopters (48%) category with an area of 62.5 ha and 57.5 ha, respectively as it is a dryland crop and can withstand drought conditions. Whereas, ragi is also a dryland crop and mainly grown for the purpose of subsistence of the family. It occupied 21.25 ha (18% GCA) by adopters and 36.25 ha (30% GCA) by non-adopters in the study area.

3.2 Adoption of Bhoochetana Technology Components by Groundnut and Ragi Farmers

The results pertain to adoption of Bhoochetana technology components (Table 3) indicated that, in case of groundnut, the adoption of micronutrients started in 2009-10 for gypsum and zinc sulphate and in 2011-12 for borax. The number of farmers applying micronutrients has increased between 2009-10 and 2015-16 in groundnut due to the increased awareness of the programme. In case of gypsum, the adoption has increased from 14% in 2009-10 to 100% in 2015-16. The application of zinc sulphate has increased from 14% in 2009-10 to 95% in 2015-2016 and application of borax was low (4%) in 2011-12, later it has increased to 14% during 2015-16. The application of bio-fertilizers such as rhizobium and trichoderma started from 2009-10 and 2012-13, respectively. The percentage of farmer's adopting rhizobium varied from 14% in 2009-10 to 57% during 2015-16. Whereas, application of vermicompost showed a very small increase. Among rainfed technologies, multipurpose machinery, broadbed and furrow; and bunding showed increasing trend. There was an improvement in the adoption of technologies over the years because of trainings extended by the farm facilitators and increased awareness of the programme and this is reflected through yield enhancement.

With respect to ragi, the adoption of micronutrients (Table 4) started in 2009-10 for gypsum, 2010-11 for zinc sulphate and 2013-14 for borax. In case of gypsum, the adoption has increased from 11% in 2009-10 to 44% during 2015-16. The application of zinc sulphate has increased from 33% in 2010-11 to 88% in 2015-2016 and application of borax has increased from 11% in 2011-12 to 55% during 2015-16. No biofertilizer usage was noticed among the ragi growers in the study area. Use of manures to meet the nutrient requirements of the crop has been practiced by most sample farmers.

Table 2. Socio-economic details of the sample farmers in Tumakuru district

Sl. no.	Particulars	Adopters (n=30)	Non- Adopters (n=30)	Test value
I	**Age group (Years)**			
1	Below 35	7.0 (23)	1.0 (3)	
2	35-50	21.0 (70)	19.0 (63)	t = -2.3^{S}
3	Above 50	2.0 (7)	10.0 (34)	
	Average age (Years)	42	47	
II	**Literacy level (No.)**			
1	Primary education	4.0 (13)	9.0 (30)	
2	Secondary education	20.0 (67)	8.0 (27)	t= 3.4^{S}
3	College/higher education	6.0 (20)	5.0 (17)	
4	Illiterates	0.0 (0)	8.0 (26)	
III	**Land holding (Ha)**			
1	Marginal and small (<2 ha)	20.0 (66.6)	27.0 (90)	t = -2^{S}
2	Medium (2-5 ha)	10.0 (33.3)	3.0 (10)	
	Average size of land holding (ha)	1.91	1.50	

Note: Figures in parentheses indicate percentage to total
s- Significance at 5 % level

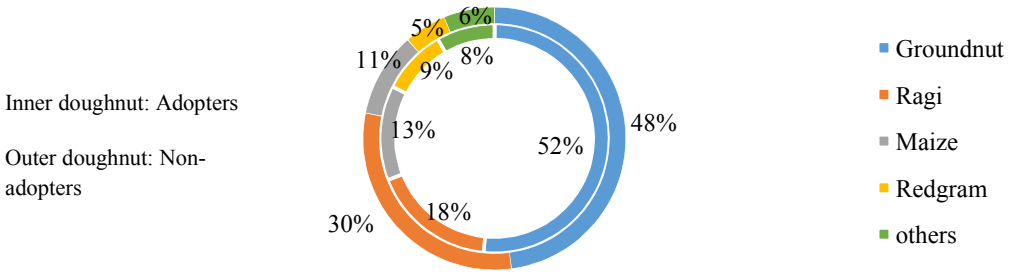

Fig. 3. Cropping pattern followed by sample farmers in Tumakuru district (ha)
Note: Others include coconut and arecanut

3.3 Cost and Returns Analysis

Application of micronutrients along with other technologies showed a positive impact on crop yield. The comparison of the yield and net income of groundnut between adopter and non-adopter categories of improved variety and application of micro-nutrient showed that, the yield was marginally higher among adopter category with 13.75 quintals per ha which is mainly because of the application of micronutrients which enhances the number of pods as well as the oil content. While, per ha net income realized by groundnut adopters was more (Rs. 15555) compared to non-adopters [16] whose yield and net income was 12 quintals per ha and Rs. 11320 per ha, respectively (Table 5). The returns per rupee of expenditure were 1.29 in case of adopters, while it was 1.20 for non-adopters. This implies with the application of micro-nutrients there is an improvement in net returns of adopters through yield compared to non-adopters.

Table 3. Adoption of Bhoochetana technology components by groundnut farmers in Tumakuru district (% of farmers)

Particulars	1st year of adoption	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Gypsum	2009	14.28	14.28	14.28	66.66	90.47	90.47	100.0
Zinc sulphate	2009	14.28	14.28	14.28	52.38	80.95	90.47	95.23
Borax	2010	0.0	0.0	4.76	4.76	14.2	14.20	14.20
Rhizobium	2009	14.28	14.28	14.28	38.09	38.09	42.85	57.14
Trichoderma	2012	0.0	0.0	0.0	14.28	19.04	19.04	23.80
Vermicompost	2009	4.76	4.76	4.76	9.52	4.76	4.76	14.28
Multipurpose machinery	2012	0.0	0.0	0.0	14.28	28.57	38.09	57.14
Broad bed and furrow system	2009	14.28	14.28	14.28	47.61	42.85	42.85	61.90
Contour cultivation /cultivation across slope	2013	0.0	0.0	0.0	0.0	9.52	9.52	19.04
Bunding	2009	4.76	9.52	9.52	9.52	33.33	42.85	42.85

Table 4. Adoption of Bhoochetana technology components by Ragi farmers in Tumakuru district (% of farmers)

Particulars	1st year of adoption	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Gypsum	2009	11.1	33.33	33.33	33.33	33.33	33.33	44.44
Zinc sulphate	2010	-	33.33	33.33	33.33	44.44	88.88	88.88
Borax	2013	-	-	-	-	11.1	55.55	55.55

Table 5. Comparison of cost and returns of groundnut by adopters and non-adopters of Bhoochetana programme (Per ha)

Sl. no.	Particulars	Adopters (n=30)	Non-adopters (n=30)
1	Cost of cultivation (Rs)	53070	50480
2	Yield (q)	13.75	12
3	Market price(Rs.)	3900	3900
4	Net income (Rs.)	15555	11320
5	Cost of production (Rs./q)	3860	4206
6	Returns per rupee of expenditure (Rs.)	**1.29**	**1.20**

The coefficient of determination was 0.70 indicating that the variables included in the regression model explain about 70 per cent of the variation in the output of groundnut. The contribution of other factors which were not included in the regression model was 5.91 quintals per farm. The elasticity of production for the use of micro-nutrients and Bio fertilizers was 0.0093 and it is significant at 5 per cent. It is indicating that for every per cent increase in micro-nutrients and Bio fertilizers from its arithmetic mean level, the output increases by 0.009 per cent from its arithmetic mean level [16]. Because of Bhoochetana scheme the threshold yield level adopter was increased by 1.23 quintals extra over and above the non-adopters (5.9 quintals) (Table 6). The results of [17] aptly supported the findings of this study.

In case of ragi, adopters yield (15.5 quintals/ha) was higher due to the application of micronutrients which induces the grain size, number of grains and quality of the grain (Table 7). The net income obtained by adopters was Rs. 1091 per ha. While, non-adopters obtained yield of 12.75 quintals per ha with a negative net returns of Rs. 3154 per ha. The returns per rupee of expenditure were more (1.03) in case of adopters, while it was 0.90 for non-adopters [16].

In case of ragi, the co-efficient of determination was 0.84 indicating that, the variables included in the regression model explains about 84 per cent of the variation in the output. The elasticity of production for the use of micro-nutrients was 0.001 and it was significant at 5 per cent. The elasticity of production with respect to seed was negative (-0.81) [16] and failed to exert any significant influence on gross returns. The adoption of micronutrients indicated increased yield of 2.02 quintals extra over and above the non-adopters (6.6 quintals) and it was significant (Table 8). The results of [17] fittingly supported the findings of the present study.

3.4 Total Economic Surplus

3.4.1 Total economic surplus of groundnut farmers

The economic benefits of the Bhoochetana programme on yield and income of groundnut in Tumakuru district are presented in Table 9. It is evident from the table that, with the assumption of price elasticity of supply of 0.35 and price elasticity of demand of -1.02 [15], the total economic surplus due to adoption of the Bhoochetana programme was Rs. 2643 millions from 2009-10 to 2015-16. Within total economic surplus, the consumers' surplus formed 27.43%, while producers surplus formed 72.56%. The results are in conformity with the results of [15]. Thus, producers were benefited relatively more than the consumers as groundnut is being grown as cash crop in rainfed areas and mainly for the purpose of oil extraction. The net present value was Rs. 1818 millions at prevailing discount rate. The increase in economic surplus was mainly due to increased productivity of pods in groundnut with the application of micro nutrients.

3.4.2 Total economic surplus of Ragi farmers

The economic benefits of Bhoochetana programme on yield and income of ragi (finger millet) in Tumakuru is presented in Table 10. The results of the model reveal that, with the assumption of price elasticity of supply 0.53 and price elasticity of demand 0.45 [16], the total economic surplus due to adoption of the Bhoochetana programme was Rs. 1933 millions from 2009-10 to 2015-16. The consumers benefited more than the producers as consumers surplus was 54.93%, while the producers

Table 6. Linear regression model to assess the impact of micro-nutrients and bio fertilizers on yield of groundnut (Per farm)

Particulars	Coefficients	Standard error	t Stat	P-value
Intercept	5.9123	3.2546	1.8169	0.6008
Seed(Kg)	0.0159	0.0414	0.3840	0.9057
NPK (Rs.)	0.4322	0.9810	0.4400	0.342
Micro-nutrients and Bio-fertilizers (Rs.)	0.0093	0.0025	3.7200**	0.0041
Dummy (1,0)	1.23	0.39	3.1538**	0.0039
R2	0.708			
F value	9.09			

Note: 1-Adopters, 0 - Non-adopters
*** significance at 5%*

Table 7. Comparison of cost and returns of ragi by adopters and non-adopters of Bhoochetana programme (Per ha)

Sl. no.	Particulars	Adopters (n=30)	Non-adopters (n=30)
1	Cost of cultivation (Rs)	41809	40354
2	Yield (q)	15.5	12.75
3	Market price(Rs.)	1800	1800
4	Net income (Rs.)	1091	-3154
5	Cost of production (Rs./q)	2697	3165
6	Returns per rupee of expenditure (Rs.)	**1.03**	**0.90**

Table 8. Linear regression model to assess the impact of micro-nutrients on yield of Ragi (Per farm)

Particulars	Coefficients	Standard error	t Stat	P-value
Intercept	6.637	1.909	3.4766	0.0005
Seed (Kg.)	-0.8143	0.2169	-3.7531**	0.0019
NPK (Rs.)	0.0026	0.0034	0.7622	0.4577
Micro-nutrients (Rs.)	0.001	0.00021	4.2377**	0.0007
Dummy (1,0)	2.02	0.8916	2.2185**	0.0382
R2	0.84			
F value	20.02			

Note: 1-Adopters, 0 - Non-adopters
*** significance at 5%*

Table 9. Estimated Economic surplus in groundnut due to Bhoochetana programme in Tumakuru district

Sl. no.	Particulars	Supply elasticity (SE)= 0.35 and Demand elasticity (DE)= -1.02	
		Value (in millions)	% share
1	Consumer surplus (Rs.)	725	27.43
2	Producer surplus (Rs.)	1918	72.56
3	Total economic surplus (Rs.)	2643	100.00
4	Net economic surplus (Rs.)	2519	
5	NPV @ 7 % (Rs.)	1818	

Table 10. Estimated economic surplus in ragi due to Bhoochetana programme in Tumakuru district

Sl. no.	Particulars	Supply elasticity (SE)= 0.53 and Demand elasticity (DE)= 0.45	
		Value (millions)	% share
1	Consumer surplus (Rs.)	1062	54.93
2	Producer surplus (Rs.)	870	45.06
3	Total economic surplus (Rs.)	1933	100.00
4	Net economic surplus (Rs.)	1809	
5	NPV @ 7 % (Rs.)	1280	

surplus was 45.06%. Ragi is one of the staple food crop of the South Karnataka and mainly grown for family consumption could be the reason for higher consumer surplus. The results are in conformity with the results of [18]. The net present value was Rs.1280 millions at the prevailing discount rate. The programme has been adopted in more than 50% of the area in Karnataka due to the committed and sustainable extension efforts. The increase in total economic

surplus is mainly due to the increased productivity of grain and fodder yield of ragi with application of micro nutrients.

4. CONCLUSION AND POLICY RECOMMENDATIONS

The findings strongly support the positive impact of the Bhoochetana programme impact assessment and should be given importance in future planning and developmental programmes in rainfed agriculture. The present study has demonstrated that, the economic surplus method captures the impact of the Bhoochetana programme activities in a holistic manner and assesses the distributional effects of producers and consumers. Therefore, it would be a fairly good methodology to assess the impact of the programme. The major intervention of the programme, the application of micro nutrients, has been found significant impact on yield and income of farm households in the study area. Therefore, the policy focus mainly on creating awareness and adoption of new technologies through developmental programmes in rural areas. The Bhoochetana programme has enhanced the soil health, increase in crop yields and in turn acieve higher farm income. In addition to the increased productivity and incomes of the farmers, the important impact of this programme is the development of new farmer-friendly institutional arrangements to reach millions of small farmers, with re-vitalized Department of Agriculture and convergence of various schemes and developmental activities in the state.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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