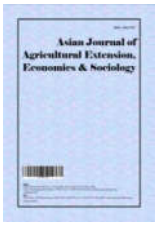

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Economics of Banana Cultivation: A Comparative Study on Adopters and Non-Adopters of Weather Based Crop Insurance Scheme

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An economic analysis of banana cultivation was done to compare the adopters and non-adopters of WBCIS. Firstly, a comparison of farm business analysis was done using cost concepts. At Cost C, insured farmers had incurred more cost (₹ 3,86,021 ha^{-1}) than uninsured farmers (₹3,50,910.06 ha^{-1}). The net returns at Cost C for insured farmers were ₹3,56,261 ha^{-1} and for uninsured farmers, it was 3,24,197 ha^{-1}. Insured farmers had incurred more cost C and more net return at Cost C than uninsured farmers. The BC ratio obtained for insured farmers (2.01) at Cost C were more than that of uninsured farmers (1.92). It was found that the insured farmers were having more economic benefits than uninsured farmers from banana cultivation. The results of Cobb-Douglas production

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function revealed that R^2 value for insured and uninsured farmers was 0.87 and 0.79 respectively, which indicated a good fit. The analysis of allocative efficiency, for insured and uninsured farmers, revealed that quantity of hired labour, family labour and quantity of manures, fertilizers and soil ameliorants were underutilized. Furthermore, quantity of plant protection materials was overutilized by both categories of farmers.

Keywords: WBCIS; cost of cultivation; resource use efficiency; returns; marginal productivity; Cobb-Douglas production function; allocative efficiency.

1. INTRODUCTION

Weather-Based Crop Insurance Scheme (WBCIS) was introduced in India during the Kharif 2007 period to mitigate the hardship of the farmers against adverse weather conditions. The WBCIS uses weather parameters as a proxy for crop yields in compensating the farmers for crop losses. Pay-out structures were developed to compensate for the extent of losses deemed to have been suffered using the weather triggers. Almost all the crops were covered under this scheme and the scheme varies depending upon the different conditions. Banana cultivation is more vulnerable to climate perils and many farmers choose WBCIS as a risk mitigation mechanism.

Birari et al. [1] conducted a study on the crop insurance scheme as a means of livelihood security in the rainfed agriculture areas of western Maharashtra. They observed that the insured farms had between 11-34% more productivity than uninsured farms. Similarly, the gross yield per hectare of the insured was higher between 26-46% compared to the uninsured farmers. They also realized that the crop insurance scheme as an important measure to improve economic conditions, stabilize incomes and provide additional employment for farmers.

Olubiyo et al. [2] evaluated the impact of crop insurance on agricultural practices and crop production. The results of the study revealed that farmers differ in their use of agricultural resources and the level of output produced. Most insured farmers applied better agricultural practices and were more commercially oriented. Insured farmers have ventured into riskier initiatives and put more of their production up for sale. It was discovered that uninsured farmers were more productive and efficient in using the resources than insured farmers.

Kiran [3] studied the impact of crop insurance on resource use efficiency in potato cultivation in the Hassan district of Karnataka. The result of the study revealed that insured farmers used resources more efficiently than uninsured farmers. Insured farmers used 6.25 per cent and 20.89 per cent more seeds and FYM respectively than uninsured farmers, which resulted in a higher yield of 9.08 per cent for them.

Stephy et al. [4] estimated the cost of cultivation of banana for insured and uninsured farmers separately based on the data collected from a total of 80 farmers from four Panchayats of Neyyatinkara taluk in the Thiruvananthapuram district of Kerala. The results of the study found that insured farmers were investing more in input than uninsured farmers. It was also revealed that farmers who adopted crop insurance incurred a higher cultivation cost, obtained a better yield and a higher BC ratio from Nendran banana cultivation and, they also stated crop insurance as a tool to help farmers to mitigate the risk factor by transferring the risk component. to the insurance authority.

Biswas et al. [5] stated that the Weather-Based Crop Insurance Scheme (WBCIS) was a single insurance product designed to provide protection against crop losses due to adverse weather conditions, and provided benefits against adverse weather incidents in both kharif as well as rabi seasons. Also stated that the main limitations of index-based climate insurance were that it covered only a part of the exogenous risks faced by farmers and the main advantage was the low transaction cost compared to traditional crop insurances.

Mirranda and Farrin [6] stated that the conventional insurance, which compensates the insured for verifiable production losses deriving from multiple risks, the index-based insurance compensates the insured based on the observed value of a specific index which is closely related, and highly correlated with losses. Index insurance shows lower transaction costs than conventional insurances, which potentially makes it more accessible to the poor in developing

countries, but it also offers less effective individual protection against risks.

2. MATERIALS AND METHODS

Data was collected from the Palakkad and Wayanad districts of Kerala based on the criteria of districts having maximum production of bananas. Total sample size was 120, among that 60 respondents each selected from both districts, which comprises of 30 each insured and uninsured farmers. Data was collected from farmers through personal interviews using a pre-tested and well-structured schedule, conducted between March and April of 2019.

2.1 Cost of Cultivation

The cost of cultivating bananas was calculated as the total sum of the cost incurred in various inputs that were used in production. In this study, the ABC cost concept was used to calculate the cost of cultivation and returns.

A B C Cost Concept

The **Cost A_1** includes

a) Cost of sucker plant
b) Cost of hired labour
c) Cost of manures, fertilizers and soil ameliorants
d) Cost of plant protection chemicals
e) Cost of propping material and irrigation
f) Land revenue
g) Depreciation
h) Interest on working capital
i) Miscellaneous cost & insurance premium

Cost A_2

Cost A_1 + rent paid for leased-in land.

Cost B

Cost A_2 + rental value of owned land & interest on owned fixed capital excluding land.

Cost C

Cost B + imputed value of family labour. [7]

2.2 Returns

Gross returns

The gross returns were calculated as the total value of the products at the current market price.
Gross returns = Quantity of product * unit price

Net returns

Net returns were obtained by deducting the total cost from gross returns.

Net returns = Gross returns- cost of cultivation

2.3 Benefit-Cost Ratio

It was calculated as the ratio of the total benefits to total expenditure incurred for production of banana.

BC ratio = Gross returns / cost of cultivation

2.4 Resource Use Efficiency

The analysis of resource use efficiency is important to calculate in a production process how efficiently the farmers are using or allocating their scarce farm resources in a judicious manner. To describe the relationship between the output and various inputs used in production, Cobb-Douglas production function was used.

Several production functions can be used as a basis for examining and comparing the economic characteristics between the group of farms. There is no strict rule according to which a given functional form is more appropriate than another. However, for this type of study, the Cobb-Douglas production function has had a wide application and is the functional form used in this comparative analysis [2].

Cobb- Douglas production function in algebraic form can be written as,

$$Y = a \prod_{i=1}^{4} (X_i^{bi}) e$$

The functional form of production function fitted for this study is

$$Y = a. X_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} e$$

In log-log form the above function can be written as

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + \log e$$

Were,

Y = Quantity of output (kg / ha)
X_1 = Quantity of manures and fertilizer (kg/ha)
X_2 = Hired labour / ha
X_3 = Family labour / ha
X_4 = Quantity of plant protection materials/ha
a = Intercept
b_1, b_2 …. b_4 = Regression coefficients of dependent variables.

The Cobb-Douglas production function is estimated using the ordinary least squares method assuming that the error term (e) is distributed in a normal and independent way. The multiple determination coefficient (R2) was tested to determine its significance by applying the F test. The regression coefficients (b_i) were tested to determine their significance by the t-test at the chosen significance level.

2.5 Marginal Productivity Analysis

The ratio between marginal value product (MVP) and marginal factor cost (MFC) calculated for each input to understand the efficiency of input use.

$$MPPi = bi \frac{\overline{Y}}{\overline{X}}$$

Were,

$\overline{Y}$ = Geometric mean of production.
$\overline{X}$ = Geometric mean of the i^{th} independent variable.
b_i = Regression coefficient of the i^{th} independent variable.

The MVP of each resource was calculated by multiplying MPP with the unit price of the product. The formula used for the MVP calculation was:

$$MVP \text{ of } X_i = b_i \times P_v \times \overline{Y}/\overline{X}_i$$

Were,

P_y = Unit price of the product.

Allocative efficiency (K) is calculated using the following formula:

$K_i = MVP_i/MFC_i$

Were,

K_i = Allocative efficiency of i^{th} resource.
MVP_i = Marginal Value Product of i^{th} resource.
MFC_i = Marginal Factor Cost of i^{th} resource.
K> 1, indicating under use or sub-optimal use of resources
K= 1, optimum use of resources (al locative efficiency)
K< 1, indicating excess use of resources

3. RESULTS AND DISCUSSION

3.1 Cost of Cultivation

Cost of cultivation of Banana for insured farmers and uninsured farmers were calculated using ABC cost concepts and presented in Tables 1 and 2 respectively.

In the case of insured farmers Cost A_1 for was ₹ 2,84,939.11 ha^{-1}. Among Cost A_1, cost of manures, fertilizers and soil ameliorants component accounted maximum of 30.39 per cent, followed by cost of propping and irrigation which accounted for 22.37 per cent and then cost of hired labour with 21.73 per cent. Cost incurred on planting material was about 12.97 per cent. The cost on plant protection and interest on working capital each contributed with 3.23 and 4.69 per cent respectively. Cost incurred on depreciation, land revenue, insurance premium and machine labour were very less which was 1.52, 0.61, 1.19 and 1.28 per cent respectively. Cost incurred on miscellaneous were 0.24 per cent. Cost A_2, Cost B and Cost C were ₹ 3,18,410.27, ₹ 3,45,545.67, and ₹ 3,86,021.13 ha^{-1} respectively.

The Cost A_1 for uninsured farmers was ₹ 2,52,041.41 ha^{-1}. Among Cost A_1, cost of manures, fertilizers and soil ameliorants component accounted maximum of 30.58 per cent, followed by, cost of hired labour which accounted for 22.68 per cent and then cost of propping and irrigation with 21.46 per cent. Cost incurred on planting material was 14.51 per cent. The cost on plant protection and interest on working capital each contributed with 2.82 and 4.75 per cent respectively. Cost incurred on depreciation, land revenue and machine labour were contributed with 1.24, 0.08 and 1.54 per cent respectively. Cost incurred on miscellaneous were 0.29 per cent. Cost A_2, Cost B and Cost C were ₹ 2,81,023.5, ₹ 3,12,904.06 and ₹ 3,50,910.06 ha^{-1} respectively.

From this analysis, it was understood that insured farmers incurred more cost than that of the Uninsured farmers at Cost C. Cost of fertilizers, manures and soil ameliorants, hired labour cost and cost of propping and irrigation were the major costs incurred by both insured and uninsured farmers.

3.2 Net Returns

Net returns are a concept of farm business analysis which is used to find out profit and efficiency of farm business. Average yields of banana for insured and uninsured farmers were ₹ 259.7 and ₹ 220.9 q ha^{-1} respectively. Average price (₹/kg) obtained for insured farmers was ₹ 25.74 and for uninsured farmers, it was ₹ 25.28. Using the average yield and unit price, gross returns from banana were worked out.

Gross return from banana was more for insured farmers (₹ 7,42,282.75ha^{-1}) than that of uninsured farmers (₹ 6,75,108.00ha^{-1}). Net returns at cost A_1 was ₹ 4,57,343.64 ha^{-1} for insured farmers and ₹4,23,066.59 ha^{-1} for uninsured farmers. The net returns of insured farmers at Cost A_2, Cost B and Cost C were ₹ 4,23,871.73, ₹ 3,96,737.08 and ₹ 3,56,261.62 respectively. For uninsured farmers the net returns at Cost A_2, Cost B and Cost C were ₹ 3,94,084.50, ₹ 3,62,203.94 and ₹ 3,24,197.94 respectively. At all the costs, net returns of insured famers were more than that of uninsured farmers. It shows that insured were making more economic benefits than uninsured farmers from banana cultivation.

Table 1. Cost of cultivation of insured farmers

Sl. No	Item	Cost (₹/ha)	Percentage
1	Sucker	36,969.33	12.97
2	Cost of manures, fertilizers and soil ameliorants	86,604.70	30.39
3	Cost of hired labour	61,927.91	21.73
4	Cost for plant protection	9,220.37	3.23
5	Cost for machine labour	3,636.50	1.28
6	Cost for propping and irrigation	63,731.60	22.37
7	Depreciation	4,319.80	1.52
8	Land revenue	174.85	0.61
9	Miscellaneous cost	680.98	0.24
10	Interest on working capital	13,385.35	4.69
11	Insurance premium	3,387.73	1.19
12	Cost A1	2,84,939.11	-
13	Rent of leased land	34,371.17	-
14	Cost A2	3,18,410.27	-
15	Rental value of own land and interest on fixed capital	27,135.40	-
16	Cost B	3,45,545.67	-
17	Imputed value of family labour	4,0475.46	-
18	Cost C	3,86,021.13	-

Table 2. Cost of cultivation of uninsured farmers

Sl. No	Item	Cost (₹/ha)	Percentage
1	Sucker	36,582.34	14.51
2	Cost of manures, fertilizers and soil ameliorants	77,093.00	30.58
3	Cost of hired labour	57,184.13	22.68
4	Cost for plant protection	7,115.03	2.82
5	Cost for machine labour	3,892.22	1.54
6	Cost for propping and irrigation	54,105.57	21.46
7	Depreciation	3,134.67	1.24
8	Land revenue	204.19	0.08
9	Miscellaneous cost	742.51	0.29
10	Interest on working capital	11,987.75	4.75
11	Insurance premium	0.00	-
12	Cost A1	2,52,041.41	-
13	Rent of leased in land	28,982.04	-
14	Cost A2	2,81,023.5	-
15	Rental value of own land and interest on fixed capital	31,880.56	-
16	Cost B	3,12,904.06	-
17	Imputed value of family labour	38,006.00	-
18	Cost C	3,50,910.06	-

Table 3. Gross returns and net returns of insured and uninsured banana farmers

Sl. No	Particular	Returns	
		Insured farmers	Uninsured farmers
1	Yield (q/ha)	259.7	220. 9
2	Price (₹ /kg)	25.74	25.28
3	Gross return (₹/ha)	7,42,282.75	6,75,108.00
4	Net returns at cost A_1 (₹ /ha)	4,57,343.64	4,23,066.59
5	Net returns at cost A_2 (₹ /ha)	4,23,871.73	3,94,084.50
6	Net returns at cost B (₹ /ha)	3,96,737.08	3,62,203.94
7	Net returns at cost C (₹ /ha)	3,56,261.62	3,24,197.94

3.3 B C Ratio

Benefit cost ratio indicates rate of the value of output per unit price of input or returns generated per rupee invested. This concept indicates the profitability of a business, higher value indicates more profit and *vice versa*. B-C ratio of insured and uninsured farmers from banana cultivation is presented in Table 4.

From the results, B-C ratio of insured farmers at Cost A_1 is 2.73 and for uninsured farmers, it was 2.66. For insured farmers, B-C ratio at Cost A_2, Cost B and Cost C were 2.44, 2.24 and 2.01 respectively. Whereas in the case of uninsured farmers B-C ratio at Cost A_2, Cost B and Cost C were 2.40, 2.2.16 and 1.92 respectively. The results indicate that insured farmers were getting more profit than uninsured farmers. This can be attributed to higher yield based on the income guarantee due to crop loss.

3.4 Resource Use Efficiency

Results of resource use efficiency for insured farmers are shown in Table 5. R^2 value of the fitted model was 0.86. This means, 86 per cent of the variation in dependent variable was explained by the independent variables included in the model. Quantity of manures, fertilizers and soil ameliorants, number of hired labour days, number of owned labour days were found significant at 1 per cent level of significance with positive coefficients. Quantity of plant protection materials had positive coefficient and statistically insignificant. All the independent variables found to be positively influencing dependent variable. Σb_i, returns to scale value was 1.165, which means, simultaneous increase of all the independent variables by 1 per cent would increase the returns by 1.165 per cent, which is increasing returns to scale. VIF value found to be ranges from 1.16 to 2.82, which indicates that there was negligible multicollinearity among the selected independent variables.

Results of resource use efficiency for uninsured farmers are shown in Table 6. R^2 value of the fitted model was 0.79. This means, 79 per cent of the variation in dependent variable was explained by the independent variables included in the model. Quantity of manures, fertilizers and soil ameliorants, numbers of hired labour days were found significant at 1 per cent level of significance with positive coefficients. Number of family labour was found to be significant at 5 per cent level of significance with positive coefficient. But quantity of plant protection materials had positive coefficient and statistically insignificant. All the independent variables found to be positively influencing dependent variable. Σb_i, returns to scale value was 1.09, which means, simultaneous increase of all the independent variables by 1 per cent would increase the returns by 1.09 per cent, which is increasing returns to scale. VIF value found to be ranges from 1.45 to 3.04, which indicates that there is no serious problem of multicollinearity among the selected independent variables.

Table 4. Benefit cost ratio of insured and uninsured Banana farmers

Cost	Insured farmers	Uninsured farmers
Cost A_1	2.73	2.66
Cost A_2	2.44	2.40
Cost B	2.24	2.16
Cost C	2.01	1.92

3.5 Marginal Productivity Analysis

Marginal Value Product (MVP) and Marginal Factor Cost (MFC) are the two important components used to find out the resource use efficiency. MVP is obtained for each input was calculated using unit price of output and geometric mean of all the component and also regression coefficients. Ratio of the MVP and MFC is known as allocative efficiency.

The allocative efficiency of insured farmers is presented in Table 7. The K value of quantity of manures and fertilizer (3.27), hired labour (5.45) and family labour (6.15) was more than one which indicated the underutilization of resources and it can be increased to enhance the allocative efficiency in production. K value for quantity of plant protection materials (0.11) was less than one, which indicated that the input is overutilized.

The allocative efficiency of uninsured farmers is presented in Table 8. Likewise, for the insured farmers K value of quantity of manures and fertilizer (4.05), hired labour (4.80) and family labour (3.65) was more than one which indicated the underutilization of resources and it can be increased to enhance the allocative efficiency in production. K value for quantity of plant protection materials (0.17) was less than one, which indicated that the input is overutilized.

Table 5. Cobb-Douglas production function for insured farmers

Particulars	Coefficients	Standard Error	P value	VIF
Intercept	3.245	0.481	0.000	-
Quantity of manures and fertilizers and soil ameliorants	0.370***	0.669	0.000	2.24
Hired labour	0.448***	0.701	0.000	2.82
Family labour	0.346***	0.073	0.000	1.16
Quantity of plant protection materials	0.001	0.018	0.950	1.66
R^2	0.87			
$\bar{R}^2$	0.86			
F	92.24			
Σb_i	1.165			
No. of observations	60			

**** significant at 1 per cent level of significance; Note: coefficients were obtained with log values*

Table 6. Estimated production function for uninsured farmers

Particulars	Coefficients	Standard error	P value	VIF
Intercept	3.08	0.662	0.000	-
Quantity of manures and fertilizers and soil ameliorants	0.455***	0.108	0.000	3.04
Hired labour	0.416***	0.106	0.000	2.95
Family labour	0.218**	0.102	0.038	1.45
Quantity of plant protection materials	0.001	0.018	0.000	1.52
R^2	0.79			
$\bar{R}^2$	0.77			
F	51.78			
Σb_i	1.09			
No. of observations	60			

*** significant at 5 per cent level of significance; *** significant at 1 per cent level of significance; Note: coefficients were obtained with log values*

Table 7. MVP and MFC of inputs for insured farmers

Particular	Geometric mean	MVP	MFC	K=MVP/MFC
Yield of Banana (Y)	14632.57	-	-	-
Quantity of manures, fertilizers and soil ameliorants (x_1)	10736.33	12.84	3.92	3.27
Hired labour (x_2)	46.28	3632.25	662.14	5.45
Family labour (x_3)	30.67	4228.43	684.03	6.15
Quantity of plant protection materials (x_4)	3.27	117.20	1070.38	0.11

Table 8. MVP and MFC of inputs for uninsured farmers

Particular	Geometric mean	MVP	MFC	K=MVP/MFC
Yield of Banana (Y)	13180.9	-	-	-
Quantity of manures, fertilizers and soil ameliorants (x_1)	9661.14	15.69	3.87	4.05
Hired labour (x_2)	44.07	3145.31	655	4.80
Family labour (x_3)	29.56	2457.63	67342	3.65
Quantity of plant protection materials (x_4)	2.33	143.27	858.22	0.17

4. CONCLUSIONS

Comparison of farm business analysis was done using ABC cost concept. At Cost C, insured farmers had incurred cost of about ₹ 3,86,021.13 ha^{-1} and uninsured farmers had ₹3,50,910.06 ha^{-1}. Insured farmers had incurred 10 % more cost than uninsured farmers. The net returns at Cost C for inured farmers were ₹ 3,56,261.62 ha^{-1} and for uninsured farmers, it was ₹ 3,24,197.94 ha^{-1}. Insured farmers had 9.89 per cent higher net return at Cost C than uninsured farmers. The BC ratio obtained for insured farmers at Cost C were 2.01 for insured farmers and 1.92 for the uninsured farmers. It was found that the insured farmers were having more economic benefits than uninsured farmers from banana cultivation. Cobb Douglas production function was fitted to know the resource use efficiency of insured and uninsured farmers. In the case of both insured and uninsured farmers quantity of manures and fertilizers, hired labour and family labour were found positively significant, quantity of plant protection chemicals had positive coefficient but insignificant. The returns to scale of insured farmers (1.16) were found higher than uninsured farmers (1.09). All the inputs except quantity of plant protection chemicals were found underutilised for both insured and uninsured farmers, which was found overutilized. The resource utilization of insured farmers except in the case of quantity of manures and fertilizers found less than uninsured farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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