DECOMPOSITION ANALYSIS OF INCOME DIFFERENCE BETWEEN SPRINKLER IRRIGATION AND CONVENTIONAL METHOD OF IRRIGATION IN CULTIVATION OF GROUNDNUT IN NORTHERN KARNATAKA, INDIA

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Abstract: The present study was conducted in two districts of Northern Karnataka namely, Belagavi and Vijaypur. The required data was collected from 60 farmers practicing sprinkler system and 60 farmers practicing conventional method of irrigation in cultivation of groundnut. The data was analysed using the output decomposition model developed by Bisaliah (1977). The study revealed that the adopters of sprinkler irrigation technology produced 37.06 per cent higher income than conventional method of irrigation. The increase in the income was further decomposed into different sources of change such as adoption of sprinkler irrigation technology and changed input levels. The sprinkler irrigation technology alone contributed 67.88 per cent increase in income, while the contribution of change in input levels was found to be negative (-30.81 per cent).

Keywords: Sprinkler Irrigation, Conventional Method of Irrigation, Decomposition Analysis, Groundnut.

Introduction: Water is gradually becoming a scarce resource worldwide especially in developing countries like India. With the increasing need of providing food and water security for an ever increasing population, the availability, usability and affordability of water is becoming a major challenge. Efficient use of this resource is essential. However, this requires innovation and more precision in its utilisation, especially where it is used in abundance like agriculture. In spite of technological advancements in pressurised irrigation techniques, a substantial amount of land worldwide, especially in countries like India is still irrigated by surface irrigation. With agriculture being the most dominant water user, it is essential to develop and improve existing technologies for more efficient use of this precious resource. The application of irrigation water by conventional method causes up to 30 per cent loss of water through deep percolation depending on the soil type. To overcome the problems of conventional methods of irrigation and to improve water use efficiency to achieve more crop yield per drop, the adoption of sprinkler irrigation gains greater attention. In the light of the above and considering the relevance of sprinkler irrigation system in groundnut cultivation in the state, the present paper is proposed to evaluate the profitability of sprinkler irrigation system over the conventional method of irrigation in cultivation of groundnut in the study area.

Materials and Methods:
Sampling Procedure: The purposive multistage random sampling was followed for the selection of districts, taluks, villages and sprinkler irrigation beneficiary farmers. The farmers practicing conventional methods of

irrigation were selected from the selected villages randomly. Belagavi and Vijaypur districts were selected purposively for the detailed study. From each selected district one major taluk in terms of no. of beneficiaries covered (sprinkler irrigation) under the project were selected purposively. The taluks selected were Gokak from Belagavi district and Indi from Vijaypur district.

Three villages from each taluk based on the availability of beneficiaries practicing sprinkler irrigation for raising the groundnut were selected purposively for the study. From each selected village 10 farmers practicing sprinkler irrigation and 10 farmers practicing conventional method of irrigation (furrow) were selected purposively. Thus sample size was 60 in each irrigation method and the total sample size was120.

Analytical Tool Used: ***Decomposition Analysis:***Before going to the decomposition analysis of the income difference from groundnut between the Sprinkler Irrigation Farmers (SIF) and Conventional Irrigation Farmers (CIF) one must ensure whether there is structural break or not in the production relations between SIF and CIF. To identify the structural break, if any, in the production relations with the adoption of sprinkler irrigation system, output elasticities were estimated by ordinary least square method by fitting a log linear regression separately for SIF and CIF. The pooled regression was run in combination with SIF and CIF including dummy variable for farmers practicing sprinkler irrigation system. The dummy variable was quantified as one for farmers practicing sprinkler irrigation system and zero for farmers practicing conventional method of irrigation.

For identifying the structural break in production with the introduction of sprinkler irrigation (new technology) in groundnut, the Cob-Douglas type of production function was used. Production function with technology dummy variable was fitted for identifying structural break in production relations between the SIF and CIF. Production function with one for SIF and zero for CIF was estimated.

The following log linear estimable forms of equations were used for examining the structural break in production relation.

$\ln y_1 = \ln A_1 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + U_i$ ....(1)

$\ln y_2 = \ln A_2 + b'_1 \ln X_1 + b'_2 \ln X_2 + b'_3 \ln X_3 + b'_4 \ln X_4 + b'_5 \ln X_5 + b'_6 \ln X_6 + b'_7 \ln X_7 + U_i$.......(2)

$\ln y_3 = \ln A_3 + b''_1 \ln X_1 + b''_2 \ln X_2 + b''_3 \ln X_3 + b''_4 \ln X_4 + b''_5 \ln X_5 + b''_6 \ln X_6 + b''_7 \ln X_7 + e3d + U_i$ ...(3)

Where,

Y = Gross return in rupees/hectare
a = Intercept
x_1 = Seed cost/ hectare
x_2 = FYM cost/ hectare
x_3 = Fertiliser cost/ hectare
x_4 = Human labour cost/ hectare
x_5 = Bullock and Machine labour cost/ hectare
x_6 = Plant protection chemicals cost/ha
x_7 = irrigation water applied in ha cm
e_i = Error term
b_i = Elasticity coefficients of respective inputs and summation of these gives returns to scale

Equations 1, 2 and 3 represent farmers following conventional method of irrigation, farmers following sprinkler irrigation system and pooled regression function with farmers following sprinkler irrigation systems as dummy variables, respectively.

$b_1, b_2, b_3, b_4, b_5, b_6, b_7, b'_1, b'_2, b'_3, b'_4, b'_5, b'_6, b'_7, b''_1, b''_2, b''_3, b''_4, b''_5, b''_6, b''_7$
represent individual output/income elasticity of respective input variable in equation (1), (2) and (3). 'd' in equation (3) represents dummy variable. If the regression coefficient of dummy variables is significant, then there is structural break in production relations with the adoption sprinkler irrigation system.

Output Decomposition Model: For any production function, the total change in income is affected by the change in the factors of production and in the parameters that define the function. This total change in per hectare output/income is decomposed to reflect on adoption of sprinkler irrigation system. The output decomposition model developed by Bisaliah (1977) is used in the study, which is depicted below.

The output decomposition equation used in this study can be written as

$$\ln Y\,SIF - \ln Y\,CIF = [\text{intercept } SIF - \text{intercept } CIF] +$$
$$[(b_1' - b_1) \times \ln X_1\,CIF + \ldots\ldots\ldots + (b_7' - b_7) \times \ln X_7\,CIF] +$$
$$[\{(b_1' (\ln X_1\,SIF - \ln X_1\,CIF + \ldots\ldots + (b_7' (\ln X_7\,SIF - \ln X_7 CIF)\}] \;\ldots\; (4)$$

The decomposition equation (4) is approximately a measure of percentage change in income with the adoption of sprinkler irrigation system. The first bracketed expression of the right hand side is the measure of percentage change in income due to shift in scale parameter (A) of the production function. The second bracketed expression is the difference between output elasticities each weighted by natural logarithms of the volume of that input used under non adopter category, a measure of change in output/income due to shift in slope parameters (output elasticities) of the production function. The third bracketed expression is the sum of the natural logarithms of the ratio of each input of adopters to non-adopters, each weighted by the output elasticity of that input. This expression is a measure of change in output due to change in the per hectare cost of seeds, FYM, fertilizers, human labour, bullock and machine labour and water applied (ha cm).

Results and Discussion:

Structural Break in the Production Relation of Groundnut under Sprinkler and Conventional Method of Irrigation: To identify the structural break in groundnut production relation with the introduction of sprinkler irrigation as new technology, direct estimates of Cobb-Douglas type of production function presented in Table 1 indicates that in case of new technology (sprinkler irrigation), the calculated 'F' value 66.94 was greater than the 'F' critical value (12.20) at one per cent for 7 and 52 degrees of freedom, the R^2 value 0.900 was statistically significant. The intercept value was 1.062. The regression coefficients for fertiliser (0.219) and human labour (0.779) were statistically significant at 1 per level of significance where as the regression coefficients for farmyard manure (0.215) and plant protection chemicals (0.227) were found to be significant at five per cent level of significance. The regression coefficients for bullock and machine labour (0.268) was statistically significant at five per cent level of significance and the regression coefficients for remaining variables namely seed (0.206) and irrigation water applied (0.108) were found to be non significant.

In case of conventional method of irrigation, the calculated 'F' value 278.13 was greater than the 'F' critical value (12.20) at one per cent for 7 and 52 degrees of freedom, the R^2 value 0.974 was statistically significant. The intercept value was -3.114. The regression coefficients for seed (0.618), fertiliser (0.201) plant protection chemicals (-0.184) were significant at one per cent level of significance where as the regression coefficient for human labour (0.755) was significant at five per cent level of significance. The regression coefficients for remaining variables namely farmyard manure (-0.065), bullock and machine labour (0.059) and irrigation water applied (0.068) were found to be non significant.

In case of pooled groundnut production function with sprinkler irrigation as dummy variable was used for identifying structural break if any in production relation with the introduction of sprinkler irrigation as a new technology. The regression coefficient for dummy variable (0.268) was significant at one per cent level of significance and calculated 'F' value (391.55) was greater than 'F' critical value (9.53) and is significant at one per cent for 8 and 111 degrees of freedom so R^2 value 0.966 was statistically significant. The regression coefficients for seed (0.486), human labour (0.527) and dummy variable (0.268) were significant at one per cent level of significance where as regression coefficient for bullock and machine labour (0.152) and plant protection chemicals (-0.083) were significant at five per cent level of significance and the regression coefficient for irrigation water applied (0.104) was found to be significant at ten per cent level of significance. The regression coefficients of remaining variables such as farmyard manure (-0.007) and fertiliser (-0.066) were found to be non significant [1], [2], [3],[4].

Geometric Mean Levels of Returns and Cost Involved In Groundnut Production under Sprinkler Irrigation and Conventional Method of Irrigation: The per hectare geometric mean levels of gross returns and inputs in groundnut production are presented in Table 2.

It is clear from the table that the gross returns under sprinkler irrigation (Rs. 1,34,392.66) were more compared to conventional method of irrigation (Rs. 88,309.25). With respect to inputs, the sprinkler irrigation involves about 5.92 per cent less seed cost, 17.80 per cent less farmyard manure cost, 34.64 per cent less fertiliser cost, 6.70 per cent less plant protection chemicals cost and 42.78 less irrigation water.

Decomposition Analysis of Total Change In Per Hectare Income between Sprinkler Irrigation and Conventional Method of Irrigation in Cultivation of Groundnut: The total change in income received from groundnut production due to adoption of sprinkler irrigation technology was decomposed using decomposition equation (4) developed by Dr. Bisaliah provided in chapter III, using the production function parameters (estimates) from Table 1 and geometric mean levels of returns and cost of inputs from Table 2. The results of output decomposition analysis are presented in Table 3.

A perusal of Table 3 indicates that the adopters of sprinkler irrigation technology produced 37.06 per cent higher income from groundnut production than the conventional method of irrigation. The increase in income was further decomposed into different sources of change such as adoption of sprinkler irrigation technology and all other inputs. The sprinkler irrigation technology contributed positively to the income (67.88 %) and the contribution of change in input levels was found to be negative (-30.81%). Amongst the various inputs, fertiliser (-9.30 %), human labour (-23.59 %), bullock and machine labour (-7.87 %) and plant protection chemicals (-1.57 %) contributed negatively to the income [4],[5], [6], [7].

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Table 1: Production Function Estimates In Groundnut Production under Sprinkler Irrigation and Conventional Method of Irrigation in the Study Area (Per Ha)

Sl. No.	Particulars	Parameter	Conventional Method of Irrigation	Sprinkler Irrigation	Pooled
1	No. of observations	N	60	60	120
2	Intercept	A	-3.114 (2.707)	1.062 (2.086)	1.245 (1.449)
3	Seed (Rs.)	X_1	0.618*** (0.106)	0.206 (0.141)	0.486*** (0.089)
4	FYM (Rs.)	X_2	-0.065 (0.043)	0.215* (0.110)	-0.007 (0.039)
5	Fertiliser (Rs.)	X_3	0.201*** (0.056)	0.219*** (0.062)	-0.066 (0.044)
6	Human labour (Rs.)	X_4	0.755** (0.311)	0.779*** (0.278)	0.527*** (0.184)
7	Bullock and Machine labour (Rs.)	X_5	0.059 (0.087)	0.268** (0.123)	0.152** (0.076)

8	Plant protection chemicals (Rs.)	X_6	-0.184*** (0.036)	-0.227* (0.134)	-0.083** (0.037)
9	Irrigation water applied (ha cm)	X_7	0.068 (0.098)	0.108 (0.101)	0.104* (0.059)
10	Dummy for sprinkler irrigation	-	-	-	0.268*** (0.078)
11	Coefficient of multiple determination	R^2	0.974	0.900	0.966
12	Adjusted R	R^2	0.970	0.887	0.963
13	F Value	F	278.13	66.94	391.55

Note: *** Significant at 1% level, ** Significant at 5% level,* Significant at 10% level
Figures in parentheses indicate standard errors of coefficients

Table 2: Geometric Mean Levels Of Returns and Cost Involved In the Production of Groundnut under Sprinkler Irrigation and Conventional Method of Irrigation in the Study Area (Per Ha)

Sl. No	Particulars	Conventional method of irrigation	Sprinkler irrigation	Difference (%)
1	No of observation	60	60	
2	Seed (Rs.)	13809.48	12991.98	-5.92
3	FYM (Rs.)	5948.72	4889.66	-17.80
4	Fertiliser (Rs.)	4845.11	3166.63	-34.64
5	Human labour (Rs.)	16635.68	22522.96	35.39
6	Bullock and Machine labour (Rs.)	5522.10	7409.24	34.17
7	Plant protection chemicals (Rs.)	665.74	621.16	-6.70
8	Irrigation water applied (ha cm)	10.60	6.06	-42.78
9	Gross returns (Rs.)	88309.25	134392.66	52.18

Table 3: Decomposition Analysis of Total Change in Per Hectare Income between Sprinkler Irrigation and Conventional Method of Irrigation in Cultivation of Groundnut in the Study Area

(Per ha)

Sl. No.	Particulars	Per Cent Contribution
	Total change in measured income	**37.06**
1	**Sprinkler irrigation**	**67.88**
	a. Neutral component	**417.68**
	b. Non neutral component	**-349.81**
	Seed (Rs.)	-390.98
	FYM (Rs.)	237.81
	Fertiliser (Rs.)	-337.88
	Human labour (Rs.)	24.08
	Bullock and Machine labour (Rs.)	186.26
	Plant protection chemicals (Rs.)	-27.42
	Irrigation water applied (ha cm)	-41.69
2	**Input contribution**	**-30.81**
	Seed (Rs.)	1.26
	FYM (Rs.)	4.22
	Fertiliser (Rs.)	-9.30
	Human labour (Rs.)	-23.59
	Bullock and Machine labour (Rs.)	-7.87
	Plant protection chemicals (Rs.)	-1.57
	Irrigation water applied (ha cm)	6.05
	Total estimated difference in the income	**37.06**

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