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RESEARCH PAPER

Decomposition analysis of income difference between flood and border strip method of irrigation in cultivation of wheat in the Malaprabha command area of Karnataka

SHREESHAIL RUDRAPUR, B.L. PATIL AND M.T.SHARMA

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ABSTRACT

The present study was conducted in the Malaprabha command area as many scientific irrigation methods were implemented by the RKVY project. The required data were collected from the 35 farmers each practicing border strip method of irrigation (scientific) and flood method of irrigation (traditional) in the cultivation of wheat. The data was analysed using the output decomposition model developed by Bisaliah (1977). The study revealed that the adopters of scientific irrigation technology produced 29.39 per cent higher income from border strip method of irrigation than flood irrigation. The increase in the income was further decomposed into different sources of change such as adoption of scientific irrigation technology and changed input levels. The scientific irrigation technology alone could contribute 31.74 per cent increase in income, while the contribution of change in input levels was found to be negative (-2.35 %). Amongst the various inputs, seed (-0.18 %), fertiliser (-1.36 %) and cost of irrigation (-3.07 %) contributed negatively whereas human labour (0.1.38 %), bullock and machine labour (0.76 %) and FYM (0.11) contributed positively to the income.

KEY WORDS : Border strip irrigation, Decomposition analysis, Flood irrigation, Wheat

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Wheat is a world's number one cereal in area. Wheat is a crop which highly responds to irrigation. Hence the water should be applied optimally through scientific irrigation methods. The water use should aim at securing the maximum crop production per unit of water and sustaining soil health.

MEMBERS OF THE RESEARCH FORUM

Correspondence to:
SHREESHAIL RUDRAPUR, Department of Agricultural Economics, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA
Email: shree4476@gmail.com

Authors' affiliations:
B.L. PATIL AND M.T. SHARMA, Department of Agricultural Economics, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA

There are two different water management practices being practiced by peasants in cultivation of wheat in the Malaprabha command area, such as flood and border strip methods of irrigation. Out of these two, first one is traditional and other one is scientific. Flood irrigation is an ancient method of irrigation, where generally half water is lost through evaporation, run off, infiltration in uncultivated areas, transpiration through the leaves of weeds, anaerobic conditions in the soil and around root zone, and deep percolation below the root zone that is unavailable to the plants. Thus, to overcome the problems of flood irrigation, the adoption of scientific water management (border strip method of irrigation) practice assumes greater attention.

Malaprabha command comprises the area of a dam across the river Malaprabha, near Navilutheertha in Belgaum district with a irrigation potential of 2,20,028 hectares in the areas of Belgaum, Bagalkot, Gadag, and Dharwad districts. Cumulative financial and physical progress upto the end of march 2011 were Rs. 1172.36 crores and 2, 13,537 ha, respectively.

Water is the elixir of life. Every drop of water needs to be used optimally. The water use should aim at securing the maximum crop production per unit of water and sustaining soil health. Thus the present paper aims to analyse the income difference between border strip method of irrigation and flood method of irrigation in cultivation of wheat.

METHODOLOGY

The present study was conducted in Malaprabha Command Area of Karnataka. All the villages covered by the project entitled under RKVY were purposively selected for the study. The seven villages selected were Hebsur, Kumargoppa, Kanakikoppa, Guralikatti, Hunasikatti, Mugnur and Naragund.

The major traditional irrigation method followed by the farmers in the cultivation of wheat in the study area was flood method whereas, scientific method was border strip method of irrigation which was recommended by the project officials. From each village five farmers practicing each methods were selected randomly, thus the total sample size was 70 and irrigation method wise sample size was 35.

Output decomposition model :

Before going to the decomposition analysis of the income difference of wheat crop between the border strip method of irrigation and flood irrigation one must ensure whether there is structural break or not in the production relations between border strip method of irrigation and flood method of irrigation. To identify the structural break, if any, in the production relations with the adoption of scientific irrigation method, output elasticities were estimated by ordinary least square method by fitting a log linear regression separately for farmers following the scientific irrigation method and traditional irrigation method. The pooled regression was run in combination with farmers following the scientific and traditional irrigation methods including dummy variable for farmers following the scientific irrigation method. The dummy variable was quantified as one for farmers following scientific irrigation method and zero for farmers following traditional irrigation method.

For identifying the structural break in production of wheat with the introduction of border strip method of irrigation (new technology), the Cob-Douglas type of production function was used. Production function with technology dummy variable was fitted for identifying the structural break in production relations between the scientific method (border strip method of irrigation) and traditional method (flood). Production function with one for scientific method of irrigation and zero for traditional method (flood) was estimated.

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

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

$$\ln y_2 = \ln A_2 + b'_1 \ln X_1 + b'_2 \ln X_2 + b'_3 \ln X_3 + b'_4 \ln X_4 + b'_5 \ln X_5 + b'_6 \ln X_6 + U_{i....} \quad (2)$$

$$\ln y_3 = \ln A_3 + b''_1 \ln X_1 + b''_2 \ln X_2 + b''_3 \ln X_3 + b''_4 \ln X_4 + b''_5 \ln X_5 + b''_6 \ln X_6 + e_3 d + U_i \quad (3)$$

where,

Y = Gross return in rupees/hectare

a = Intercept

x_1 = Seed cost/ hectare

x_2 = Fertilizer cost/ hectare

x_3 = Human labour cost/ hectare

x_4 = Bullock labour and Machine labour cost/ hectare

x_5 = Cost of irrigation/ hectare

x_6 = FYM cost/ha

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 the traditional irrigation method, farmers following scientific irrigation method and pooled regression function with farmers following the scientific irrigation method as dummy variables, respectively.

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

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 scientific irrigation method. The output decomposition model developed by Bisaliah (1977) was used in the study, which is depicted below :

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

$$\ln Y\ SIM - \ln Y\ TIM = [\text{intercept SIM} - \text{intercept TIM}] + [(b_1' - b_1) \times \ln X_1\ TIM + \ldots\ldots + (b_6' - b_6) \times \ln X_6\ TIM] + [\{(b_1' (\ln X_1\ SIM - \ln X_1\ TIM + \ldots\ldots + (b_6' (\ln X_6\ SIM - \ln X_6\ TIM)\}] \quad (4)$$

The decomposition equation (4) is approximately a measure of percentage change in output/income with the adoption of scientific irrigation method. The first bracketed expression of the right hand side is the measure of percentage change in output/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 quantities of seed, fertilisers, human labour, bullock and machine labour, cost of irrigation and cost of farm yard manure.

ANALYSIS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Structural break in the production relation of wheat under flood and border strip method of irrigation :

To identify the structural break in wheat production relation with the introduction of border strip method of irrigation (BSI) method as new technology, direct estimates of Cobb-Douglas (1928) type of production function presented in the Table 1 were used.

In case of new technology (BSI), the calculated 'F' value 466.01 was greater than the 'F' critical value (3.528) at one per cent for 6 and 28 degrees of freedom, the R^2 value 0.990 was statistically significant. The intercept value was -2.825. The regression co-efficient for seed (0.070) and cost of irrigation (0.064) were significant at ten per cent level of significance, fertilizer (0.936) was significant at one per cent level of significance, bullock and machine labour (0.295) and FYM (0.035) were significant at five per cent level of significance, whereas human labour (0.213) was found to be non significant.

In case of traditional technology (flood method of irrigation), the calculated 'F' value 24.08 was greater than the 'F' critical value (3.528) at one per cent for 6 and 28 degrees of freedom, the R^2 value 0.837 was statistically significant. The intercept value was 1.453. The regression co-efficient for seed (0.693) was found to be significant at five per cent level of significance whereas fertilizer (-0.108), human labour (0.348), bullock and machine labour (0.182), cost of irrigation (0.001) and farm yard manure (-0.025) were found to be non-

Table 1 : production function estimates in wheat production under flood and border strip method of irrigation (Per ha)

Sr. No.	Particulars	Parameter	Flood	BSI	Pooled
1.	No. of observations	N	35	35	70
2.	Intercept	a	1.453 (3.228)	-2.825 (0.830)	4.391 (1.825)
3.	Seed (Rs.)	X_1	0.693** (0.288)	0.070* (0.036)	-0.030 (0.079)
4.	Fertilizer (Rs.)	X_2	-0.108 (0.497)	0.936*** (0.115)	0.261 (0.250)
5.	Human labour (Rs.)	X_3	0.348 (0.336)	0.213 (0.126)	0.359* (0.181)
6.	Bullock and Machine labour (Rs.)	X_4	0.182 (0.223)	0.295** (0.118)	0.098*** (0.133)
7.	Cost of irrigation (Rs.)	X_5	0.001 (0.114)	0.064* (0.037)	0.238*** (0.032)
8.	FYM (Rs.)	X_6	-0.025 (0.090)	0.035** (0.013)	0.048** (0.018)
9.	Dummy for BSI method		-	-	0.110*** (0.015)
10.	Co-efficient of multiple determination	R^2	0.837	0.990	0.986
11.	Adjusted R	R^2	0.802	0.980	0.985
12.	F Value	F	24.08	466.01	649.73

***, ** and * indicates significance of values at P = 0.01, P=0.05 and P=0.1, respectively; Figures in parentheses indicate standard errors of co-efficients
BSI-Border strip irrigation

Table 2 : Geometric mean levels of returns and cost involved in the production of wheat under flood and border strip method of irrigation (Per ha)

Sr. No.	Particulars	Flood	BSI	Difference (%)
1.	No. of observations	35	35	
2.	Seed (Rs.)	1937.62	1888.76	-2.52
3.	Fertilizer (Rs.)	3825.38	3770.32	-1.44
4.	Human labour (Rs.)	11523.26	12295.22	6.70
5.	Bullock and machine labour (Rs.)	14916.31	15304.21	2.60
6.	Cost of irrigation (Rs.)	2854.85	1778.59	-37.70
7.	FYM (Rs.)	414.43	428.22	3.33
8.	Gross returns (Rs.)	43322.05	58125.17	34.17

Note: BSI- Border Strip Irrigation

Table 3 : Decomposition analysis of total change in per hectare income between flood and border strip method of irrigation in cultivation of wheat (Per ha)

Sr. No.	Particulars	Flood+ BSI
	Total change in measured income	**34.17**
1.	Technology component	31.74
a.	Neutral component	-427.85
b.	Non neutral	459.59
	Seed (Rs.)	-472.07
	Fertilisers (Rs.)	861.85
	Human labour (Rs.)	-126.58
	Bullock and machine labour (Rs.)	109.06
	Cost of irrigation (Rs.)	50.76
	FYM (Rs.)	36.58
2.	Input contribution	-2.35
	Seed (Rs.)	-0.18
	Fertilisers (Rs.)	-1.36
	Human labour (Rs.)	1.38
	Bullock and Machine labour (Rs.)	0.76
	Cost of irrigation (Rs.)	-3.07
	FYM (Rs.)	0.11
	Total estimated difference in the income	29.39

Note: BSI- Border Strip Irrigation

significant.

In case of pooled wheat production function with border strip method of irrigation as dummy variable was used for identifying structural break if any in production relation with the introduction of border strip method of irrigation as a new technology. The regression co-efficient for dummy variable (0.110) was significant at one per cent level of significance and also calculated 'F' value (649.73) was greater than 'F' critical value (2.953) at one per cent for 7 and 62 degrees of freedom, so R^2 value 0.986 was statistically significant. The regression co-efficients for dummy variable (0.350), cost of irrigation (0.238) and bullock and machine labour (0.098) were significant at one per cent level of significance, regression co-efficient for farm yard manure was significant at five per cent level of significance and regression co-efficient for human labour (0.359) was significant at one per cent level of significance, whereas the regression co-efficients for seed (-0.030) and fertilizer (0.261) were found to be non-significant. The results are in conformity with the study conducted by Kumar (2001); Kunnal *et al.* (2004) and Radha and Chowdry (2005).

Geometric mean levels of returns and cost involved in Wheat production under border strip and flood method of irrigation:

The per hectare geometric mean levels of gross returns and input costs in the wheat production are presented in the Table 2. It is clear from the table that the gross returns under border strip method of irrigation (Rs. 58125.17) were more compared to flood method of irrigation (Rs. 43322.05). With regard to input costs, the border strip method of irrigation involved about 2.52 per cent less seed cost, 1.44 per cent less fertilizer cost and 37.70 per cent less irrigation cost.

Decomposition analysis of total change in per hectare income between flood and border strip method of irrigation in cultivation of wheat :

The total change in income received from wheat production due to adoption of border strip method of irrigation technology was decomposed using decomposition equation (4) developed by Dr. S. Bisaliah provided in methodology, 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. The study is also in confirmity with the studies of Ravichandran *et al.* (2006) and Naik (2010).

A perusal of Table 3 revealed that the adopters of border strip method of irrigation technology produced 29.39 per cent higher income from wheat production than the flood method of irrigation. The increase in the income was further decomposed into different sources of change such as adoption of border strip method of irrigation technology and all other inputs. The border strip method of irrigation technology alone could contribute 31.74 per cent increase in income, while the contribution of change in input levels was found to be negative (-2.35%). Amongst the various inputs, seed (-0.18 %), fertilizer (-1.36%) and cost of irrigation (-3.07%)

contributed negatively to the income. Gaddi *et al*. (2002) and Mohan have made some observations related to the present investigation.

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