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AN ANALYSIS OF RESOURCE USE EFFICIENCY OF DRIP AND CONVENTIONAL CHILLI FARM IN MIDDLE GUJARAT

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ABSTRACT

Chilli is one of the important spices cum vegetable crop of India. More than 400 different varieties of chilli are found all over the world. It is also called as hot pepper, cayenne pepper, sweet pepper, bell pepper etc., The present study was carried out in middle Gujarat region of Gujarat state during 2012-13. The input-output coefficients were generated with personal surveys from 60 drip and 60 conventional chilli farmers selected from four talukas of Anand and Vadodara districts in middle Gujarat region, thus the total 160 famers were selected for the stud. The study revealed that cob-douglass production function was found to be better fit in case of chilli production, as it was judge by the explanatory power of the function (R^2). Cost of planting materials and chemical fertilizers were positive and highly significant at 1 per cent and 10 per cent level of significance respectively in drip irrigated chilli farmers. MVP-MFC ratio was more than one for inputs like labour cost, planting materials, chemical fertilizers and irrigations but negative one for inputs like plant protection in drip chilli cultivation. While in the conventional chilli cultivation the ratio was found to be more than one for inputs like labour cost, chemical fertilizers, irrigations and plant protection but less than one for inputs like planting materials.

KEYWORDS: Resource Use Efficiency in Chilly Cultivation, MVP-MFC Ratio Analysis in Drip & Non Drip Methods of Irrigation

INTRODUCTION

Chilli (*Capsicum annuum* L.) is an important spice cum vegetable crop of India. More than 400 different varieties of chilli are found all over the world. It is also called as hot pepper, cayenne pepper, sweet pepper, bell pepper *etc*., (Anon., 2009). Chilli is believed to be originated in the tropical America and known from pre-historic times in Peru. Columbus carried chilli seeds to Spain in 1493. The cultivation of chilli and capsicum spread rapidly from Spain to Europe (Raju and Luckose, 1991). Among all varieties of chilli, some varieties are famous for red colour because of the pigment '*capsanthin*' and others are known for biting pungency attributed to '*capsaicin*'. India is the only country which is rich in many varieties with different quality factors. Chillies are rich in vitamins especially in vitamins A and C. They are also packed with potassium, magnesium and iron. It has long been used for pain relief as they are known to inhibit pain

messengers, extracts of chilli peppers are used for alleviating the pain of arthritis, headaches, burns and neuralgia. It is also claimed that they have the power to boost immune system and decrease the cholesterol (Anon., 2009).

Micro irrigation concept date back to as early as 1917. Development of micro irrigation takes place in England, Denmark, Germany, New Zealand and America. The pioneers of drip irrigation technology were Mr. Hansen in Denmark, Mr. Blass in Israel and Mr. Chapin in the United States (Chapin, 2000). Drip irrigation systems indicated the higher B:C ratio with net extra income in 30 to 40 per cent saving in water in high value crops *viz.*, chilli, tomato and turmeric (Taley and Mayande, 2011).

The result of the study would be important for procedure in allocation of resources for minimizing the costs and raising the net returns and helpful to a greater extent in planning of their production economically. This study is examining the resource use efficiency of drip chilli farmers and conventional chilli farmers in Middle Gujarat region.

METHODOLOGY

The present study was carried out in middle Gujarat region of Gujarat state during 2012-13. The input-output coefficients were generated with personal surveys drip and conventional sample farmers selected from four talukas of Anand and Vadodara district in middle Gujarat region. From each talukas three villages are selected randomly. Thus, in all 12 villages from the four selected talukas were picked up for the study. From each selected village, 5 drip and 5 conventional farmers are selected thus, 60 drip and 60 conventional farmers were selected total 120 respondents for the study.

METHOD OF ANALYSIS

Production Function Analysis

To capture the ability of the farmer to achieve the maximum realizable crop output with given level of inputs under the existing situation and given technology, careful examination of farm specific resource use efficiency farms is necessary. Cobb-Douglas production function was used to study.

$Y = aX_i^{bi}$

Where, 'X_i' is the variable resource measure,

'Y' is the output,

'a' is a constant and

'bi' estimates the extent of relationship between X_i and Y

When, X_i is at different magnitudes.

The Cobb-Douglas production function is the most widely used form of production functions for fitting agricultural production data, because of its mathematical properties like easy of interpretation and computational simplicity. In the present study the Cobb-Douglas production function in the log form was defined as follows.

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + e^u$$

Where,

Y = Gross income of chilli, (`/ha)

A = Intercept

X_1 = Cost of labour (human+ bullock), (`)

X_2 = Value of planting materials, (`)

X_3 = Cost of Irrigation, (`)

X_4 = Cost of fertilizers, (`)

X_5 = Cost of plant protection chemicals, (`)

$b_1, b_2, \ldots, b_5$ = Regression co-efficient (output elasticity of respective inputs (X_i's),

$\sum_{i=1}^{n} bi$ = Returns to scale (sum of regression co-efficients)

e^u = Error term with usual assumptions

The Chow's-F Test: Comparing Two Regressions

The Chow's-F test was applied for testing the equality between coefficients obtained from different regressions *i.e.* for drip and conventional chilli cultivator groups of farmers. Symbolically, it can be expressed as follows:

$$F = \frac{\{\sum e_p^{\,2} - (\sum e_1^{\,2} + \sum e_2^{\,2})\}/k}{(\sum e_1^{\,2} + \sum e_2^{\,2}) \,/\, (n_1 + n_2 - 2k)}$$

Where,

$\Sigma e_p^{\,2}$ = Regression sum of square for over all analysis (both drip and conventionally irrigated chilli growers as a whole)

$\Sigma e_1^{\,2}$ = Regression sum of square for drip chilli growers

$\Sigma e_2^{\,2}$ = Regression sum of square for conventional chilli growers

K = Number of explanatory variables plus intercept

n_1 = Number of observation for drip chilli growers

n_2 = Number of observation for conventional chilli growers

If calculated 'F' > table $'F'_{0.05\ \{k,\,(n1+n2-2k)\}}$ degrees of freedom, then it can be concluded that two estimated functions differ significantly.

Marginal Value Productivity (MVP)

The regression coefficients of inputs obtained were used to calculate marginal value products (MVP) at their geometric mean.

$$MVPxi = \frac{bi\,\bar{Y}}{\bar{X}}$$

Where

$\overline{Y}$ = Geometric mean of output (Y),

$\overline{X}$ = Geometric mean of respective inputs (x_i) and

b_i = Regression coefficient associated with the x_i input.

MVP in Relation to Marginal Factor Costs

The basic criterion of an efficient resource use is that the MVP of the input just covers the marginal factor cost, which is $\mathbf{MVP_{Xi} = P_{Xi}}$. Hence, for evaluating the efficiency of resource use the ratio of marginal value product for different factors to their respective factor cost was estimated.

If the marginal contribution of one unit of input is greater than the price of the input, then the farmers is said to be allocating the resources efficiently and as such there is further scope for allocating more unit of that particular input. If the marginal contribution is negative, then the farmers are said to be using the input excessively so that the fixed resources are no longer responsive to the variable input applied.

The criterion for determining optimality of resource use was,

MVP/MFC > 1 under utilization of resource

MVP/MFC = 1 optimal use of resource

MVP/MFC < 1 excess use of resources

RESULTS AND DISCUSSIONS

The co-efficient of multiple determination (R^2) values were 0.854, 0.941 and 0.929 on drip, conventional and overall chilli crop, respectively, it indicates that about 85 per cent, 94 per cent and 93 per cent variations in the gross return was explained by the modal using explanatory variables (X_1 to X_5).

The regression coefficient of labour (X_1) turned out to be positive but statistically non-significant, indicating that at the current level they were applied at optimum level in case of drip adopter farms, while it was highly significant on conventional farms and on overall basis *i.e.*, 0.388 and 0.260 respectively. It indicates that one per cent increase in the labour cost would bring 0.388 and 0.260 per cent increase in the gross income from chilli on conventionally irrigated farms and on chilli growers as a whole, respectively.

Table 1: Production Elasticity of Drip and Conventional Chilli Crop as Estimated from Cobb-Douglas Production Function

Sr. No	Variables	Production Elasticity (Bi)		
		Drip Farm	Conventional Farm	Overall
1	n - Number of farms	60	60	120
2	a – Intercept	1.282	1.216	1.260
3	X_1 - Cost of labour (human+ bullock) (`/ha)	0.099 (0.201)	0.388*** (0.131)	0.260*** (0.087)
4	X_2 - Value of planting materials (`/ha)	0.698*** (0.258)	0.338*** (0.165)	0.527*** (0.052)
5	X_3 - Cost of irrigation (`/ha)	0.114 (0.182)	0.065 (0.091)	0.098 (0.089)
6	X_4 - Cost of fertilizers (`/ha)	0.141* (0.081)	0.102 (0.078)	0.134** (0.054)
7	X_5 - Cost of plant protection (`/ha)	-0.028 (0.094)	0.145 (0.133)	0.011 (0.068)
8	R^2 - Co-efficient of multiple determination	**0.854**	**0.941**	**0.929**
9	Σbi's - Returns to scale	1.024	1.038	1.030
10	Chow's F	**25.06**		

Source: Field Survey
Figures in parentheses indicate standard error of corresponding elasticity
*Significant at 10% level of significance
**Significant at 5% level of significance
***Significant at 1% level of significance

The planting materials (X_2) one of the important inputs was found to be exerting significance on the yield of chilli. Its production elasticity was found highly significant at 1 per cent level of significance, on drip, non-drip and on the farms chilli growers as a whole and the value of elasticity on drip farm was 0.698, on conventional farm it was 0.388 while on overall basis it was 0.527. The results indicated that, increase the investment one per cent for seedlings would increase the gross return by 0.698 per cent, 0.338 per cent and 0.527 per cent on drip irrigated, conventionally irrigated and on overall chilli growers farms, respectively.

The explanatory variable fertilizer (X_4) had positive and significant impacts at 10 per cent level of significance on drip as well as on over all basis, while on conventional farm it was found non significant. It means, each additional investment on fertilizer would add 0.141 per cent on drip adopted farm and 0.134 per cent on overall estimation. It was found non significant on conventional farm, indicating that at the current level they were applied at optimum level.

The results of the study are in corroboration with earlier findings of Singh and Vashit (1999), Singh and Kumar (2004), Rathod (2008) and Jadav (2008).

Returns to Scale

The regression coefficients in Cobb-Douglas production function framework are the production elasticities of the respective resource variable and their sum indicates the type of returns to scale. The returns to scale are increasing, constant and decreasing accordingly the sum of regression coefficients is greater equal or less than unity. The sum of elasticities of production were observed to be 1.024, 1.038 and 1.030 for drip, conventional and overall this was indicated increasing returns to scale, respectively. It means that gross value of chilli increases proportionately with an increase in the variable factors.

Chow's F Test: Comparing Two Regressions

The presence of structural break in the gross income for chilli was identified with the help of Chow's 'F' values (Table 1). The Chow's F ratio was worked out to know that whether there exist any significant difference between the two production function of drip irrigated chilli and conventional irrigated chilli in terms of their parameters. The Chow's 'F' ratio was found significant at 1 per cent level, which indicated that the existence of significant difference in parameters between drip and conventional irrigation system production function. This implied that the only irrigation method not a caused the structural break in the production relations and shifted the production functions upward, but the other factors such as labour, planting materials and fertilizer also shifted the production functions in upper side. Similar type of results was obtained by Kotwal in cotton crop (2010).

Ratios of Marginal Value Product to Marginal Factor Cost in Drip and Conventional Chilli Production

To analyse the scope for intensification of resources in drip and conventional chilli farm, the marginal value products (MVP) of resources are compared with the respective marginal factor cost (MFC). The MVP and MFC ratios for different resources for both irrigation methods were presented in Table 2.

Table 2: Ratio of MVP to MFC in Drip and Conventional Chilli Farms

Particular	MVP/MFC Ratio		Resource Use Efficiency	
	Drip	Conventional	Drip	Conventional
Labour cost	2.213	5.403	Under Utilization	Under Utilization
Planting materials	15.603	0.012	Under Utilization	Over Utilization
Irrigation	8.411	3.403	Under Utilization	Under Utilization
Fertilizers	4.837	2.592	Under Utilization	Under Utilization
Plant protection	-1.396	5.799	Over Utilization	Under Utilization

Moreover, on conventionally irrigated chilli farms, the MVP/FC ratios were more than unity of plant protection, labour, irrigation and fertilizer indicating under utilization of resources. Planting material was the only input excessively used as the MVP – Factor Cost ratio was very low (0.01) and as such any further addition of this variable may result into contraction of return from chilli cultivation under conventional method of irrigation.

Results of resource use efficiency analysis showed that ratio of MVP to MFC of labour, irrigation and fertilizer were found greater than unity in both systems *i.e.,* drips as well as conventional. It implies that the resources were being underutilized and there is need to use more of these inputs to increase profit by equating MVP to MFC. Therefore, farmers have an opportunity to increase their profit by using more of these inputs in their fields.

The ratio of MVP to MFC was less than unity implied the resource was being used excessively. Both the ratios were less than unity which clearly indicated the excessive use of plant protection and planting materials, respectively. This was due to the lacuna of knowledge and importance about application of these inputs among chilli cultivators. Hence it is to be inferred that the farmers can increase their profit by reducing these resources.

CONCLUSIONS

- It is concluded that the cost of labour applied at optimum level in case of drip adopter farms; where as one per cent increase in the labour cost would bring 0.388 per cent increase in the gross income from chilli on conventionally irrigated farms.

- Looking to the significant result of seedlings it conclude that, increase the investment one per cent for seedlings would increase the gross return by 0.698 per cent, 0.338 per cent and 0.527 per cent on drip irrigated, conventionally irrigated and on overall chilli growers as a whole, respectively
- The explanatory variable fertilizer (X4) had positive and significant impacts at 10 per cent level of significance on drip as well as on over all basis, it means, each additional investment on fertilizer would add 0.141 per cent on drip adopted farm and 0.134 per cent on chilli growers as a whole farms.
- The results of the returns to scale indicating that the gross value of chilli increases proportionately with an increase in the variable factors.
- The results of Chow's 'F' ratio indicating that, only irrigation method not a caused the structural break in the production relations and shifted the production functions upward.
- Results of MVP to MFC of labour, irrigation and fertilizer were found greater than unity in both systems i.e., drips as well as conventional may implies that the resources were being underutilized and there is need to use more of these inputs to increase gross income.

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