Economic Affairs: 58(4): 349-355 December, 2013 **DOI Number** 10.5958/J.0976-4666.58.4.018

Crop Production in Rainfed Agrarian Environment: A Study on Resource use, Costs and Returns and Constraints in Chilli Production in Ramanathapuram District of Tamil Nadu

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Paper no: 86 **Received:** 12 September, 2013 **Revised:** 20 October, 2013 **Accepted:** 15 November, 2013

Abstract

Resource endowments specific to a given agrarian region determine pattern of input use and efficiency, thereby costs and returns involved in crop production. Scarcity of water is the foremost factor that critically limits the economic potential and restricts a farmer from maximising his output; thereby profit, despite the role of other factors like seeds, manures, fertilizers etc. Using Cobb-Douglas production function, we examined the influence of such factors on output of chilli in two different production conditions, namely irrigated and rainfed, within a dry land agricultural system by using primary data. Results revealed that number of irrigation significantly increased chilli output. Factors like seeds, manures, fertilizers and plant protection chemicals also had significant positive impact, with varying degrees under irrigated and rainfed conditions. Still, inefficiency was observed in resource use, particularly in labour (in both conditions) and seed-rate (in rainfed condition). Costs and prices realised were higher in irrigation crop production, which ultimately resulted in increased returns. Shortage of agricultural labourers, high wage rates, excess rain during harvest but paucity of water at seed germination and early growth stages followed by pest and disease incidences were critical constraints in chilli production.

Keywords: Chilli production, rainfed farming, resource use efficiency, surplus labour, Tamil Nadu.

Introduction

Indian agriculture continues to be dominated by rainfed agriculture with nearly 55 per cent of the net cultivated area not having access to irrigation. It accounts for 40 per cent of country's food production and supports 40 per cent of human and 60 per cent of livestock population. Even after full irrigation potential of the country is realised, half of the cultivated area will continue under rainfed farming. Scope to improve agricultural productivity in a rainfed ecosystem is limited, as they suffer from a number of biophysical and socio-economic constraints. These include low and erratic rainfall, land degradation and poor productivity (Sharma *et al*., 1999), low level of input use and technology adoption, low draft power availability (Mayande and Katyal 1996), inadequate fodder availability, low productive livestock, poor mechanisation (Jagtap *et al*., 2012), excess labour use (Rajur *et al*., 2008), resource poor farmers, greater livelihood vulnerability (Ashok and Sasikala 2012), inadequate credit availability and outmigration (Murali *et al*., 2012). Irrespective of states, drought and extreme rainfall affect crop yield in rainfed regions and effect of drought is severe than rainfall variations (Auffhammer *et al*., 2011).

Despite various institutional interventions that aim to improve prevailing farming practices and productivity, thereby relative socio-economic status, little improvement had been observed in past. Between TE 1998-99 and TE 2008-09, productivity of coarse cereals had significantly increased (30%) followed by oilseeds (13%). Productivity growth was stagnant in pulses (3%) in comparison to coarse cereals and oilseeds. Productivity of food grains excluding rice and wheat (coarse cereals + pulses) recorded a rise of 20% during the period, where as growth in productivity of wheat was as low as 9% and rice showed 14% increase in productivity. Coarse cereals, pulses and oilseeds together recorded 18% rise in productivity (Raju *et al.*, 2010). Given the limited resource base, achieving farmers' goal *viz.* profit maximisation would be influenced not only by resource endowments, but also by efficiency in use of resources. Existence of vast yield gaps across all states (Aggarwal *et al*., 2008) along with variance in input use and efficiency differentials could impact crop production environment adversely.

This necessitates studying such factors in specific to their pattern of use, efficiency in use and scope of improvement. In this context, the study was undertaken in Ramanathapuram district of Tamil Nadu, well known for its poor resource base and weak socio-economic development. The district is characterised predominantly by rainfed agriculture, with rainfed rice, chilli, oilseeds and cotton as major crops. Absence of major industrial and service sector developments in the district reserves most of the rural population in agriculture and allied activities. Chilli, the major crop next to rice, was selected for the study, which occupies around 21,000 ha per annum. It is cultivated both under irrigated and rainfed conditions in different parts of the district. Moreover, Ramanathapuram district stands first in area, production as well as yield in chilli among all districts. In this background, the study was conducted with following objectives. 1) To estimate costs and returns associated with chilli production in rainfed and irrigated regions, 2) To analyse and compare resource use efficiency in chilli production and 3) To identify and rank the constraints in chilli production.

Materials and Methods

Among the 31 districts of Tamil Nadu, Ramanathapuram and Tuticorin are two major chilli producers. Statistics shows that, in recent past, these two districts together occupied more than 60 per cent of the total area under chilli and only 36 per cent was occupied by the remaining districts. Ramanathapuram was selected purposively for the study, which had highest area under chilli cultivation. The district also stands first in production and yield. Two among the seven Taluks namely, Kadaladi and Paramakudi were selected in specific, considering maximum area under chilli cultivation. While the former was selected to study rainfed farming, latter was chosen to study irrigated farming, for the same criterion mentioned earlier. Two villages from each Taluk and 30 farmers from each village were selected at random, and in total, 120 farmers were selected for the study. Farmers were contacted individually and collected data pertains to the agriculture year 2010-11.

Production function analysis was deployed to evaluate the factors influencing output in chilli and to examine their relative efficiencies. Average products are simple measure between output and inputs. But to know the efficiency of resources used in production, it is necessary to know marginal products rather than average products. Marginal products could be known only if the technical relationship between output and inputs are estimated. Cobb-Douglas function in the following form was used to analyse efficiency in use of resources.

$Y = Ax_1^{b_1} x_2^{b_2} ... x_n^{b_n} e$, where $b_i > 0$, for all i = 0, 1, … , n. Y and x_i denote output and inputs respectively. It can be alternatively written as $\ln(y) = a_0 + b_1 \ln(x_1) + b_2 \ln(x_2) + … + b_n \ln(x_n)$, where $a_0 = \ln(A)$. *A* and b_i are co-efficients to be estimated, and e is the error. The error term represents all other (omitted) variables which may affect output. Since the production function is linear in parameters after logarithmic transformation, method of Ordinary Least Squares (OLS) can be applied to estimate co-efficients, which directly measure elasticities of production *i.e.* per cent change in output that would result from one per cent change in input. Sum of these coefficients indicate degree of homogeneity that indicates whether the production function is constant, increasing, or decreasing returns to scale. Three possibilities exist:

1. If $\Sigma b_i = 1$, there are constant returns to scale.
2. If $\Sigma b_i < 1$, there are decreasing returns to scale.
3. If $\Sigma b_i > 1$, there are increasing returns to scale.

Variables considered under the study are shown in Table 1. Production functions were estimated using Ordinary Least Square (OLS) method and estimated values of the regression co-efficients and R^2 were tested for statistical significance. Regression estimates were obtained separately for rainfed and irrigated conditions.

Table 1: Variables considered for analysing resource use efficiency

Rainfed farming	Irrigated farming
Y = Yield of chilli (Kg/ha)	Y = Yield of chilli (Kg/ha)
X_1 = Seed cost (Rs/ha)	X_1 = Seed cost (Rs/ha)
X_2 = Labour (Man days/ha)	X_2 = Labour (Man days/ha)
X_3 = Organic manures (Tonnes/ha)	X_3 = Organic manures (Tonnes/ha)
X_4 = Inorganic fertilizers (Kg/ha)	X_4 = Inorganic fertilizers (Kg/ha)
X_5 = Cost of weeding (Rs/ha)	X_5 = Cost of weeding (Rs/ha)
X_6 = Plant Protection Chemicals (Rs/ha)	X_6 = Plant Protection Chemicals (Rs/ha)
U_t = Error term	X_7 = Number of irrigation (No)
a, b_1, b_2, …….., b_6=Parameters to be estimated	U_t = Error terma, b_1, b_2, …….., b_6=Parameters to be estimated

Note: For irrigated chilli farming, the variable X7 (number of irrigation) was considered in addition to the variables considered for rainfed farming.

Traditional cost items i.e. fixed cost, variable cost and total cost were calculated separately for rainfed and irrigated regions. To understand the constraints faced by the farmers in chilli production, respondents were asked to prioritise their problems and the identified constraints were ranked using Garrett's Ranking Technique. These ranks were then converted into per cent positions by using the formula,

$$\text{Per cent position} = \frac{100 \text{ X } (R_{ij} - 0.5)}{N_j}$$

Where,

R_{ij} = Ranking given to the i^{th} attribute by the j^{th} individual

N_j = Number of attributes ranked by the j^{th} individual.

By referring to the Garrett's table, the per cent positions estimated were converted into scores. Thus, for each

Print ISSN: 0424-2513 Online ISSN: 0976-4666

factor, scores of various respondents were added and mean values were estimated. Once they were arranged in descending order, the attribute with the highest mean value was considered as most important constraint and others were followed in that order.

Results and Discussion

Efficiency in resource use

Seed had significant positive influence on crop output under rainfed condition, than it had under irrigated condition signalling, one per cent increase in seed use will improve the crop output by 0.30 per cent. Though the regression results suggest for increased seed use, relatively higher seed use was observed among rainfed chilli growers beyond the recommended level of State Agricultural Departments. It is arguable on the ground that inequality in rainfall distributions or monsoon failure associated with seed germination and early growth stages could have forced the farmers to prefer high seed rates. Then, what really needed is not increasing the seed rate, rather, it is assured irrigation, at least in critical growth stages. Construction of farm ponds and other water harvesting structures would improve the condition.

Table 2: Estimates of OLS regressions

S.No	Explanatory variables	Rainfed farming	Irrigated farming
1.	Constant	2.06 (0.98)	4.63 (0.64)
2.	Seed (Rs/ha)	0.30^{***} (0.12)	0.12^{*} (0.09)
3.	Labour (Man days/ha)	0.06 (0.09)	-0.13 (0.11)
4.	Manures (Tonnes/ha)	0.50^{***} (0.08)	0.17^{***} (0.03)
5.	Fertilizers (Rs/ha)	0.22^{***} (0.07)	0.19^{***} (0.06)
6.	Cost of weeding(Rs/ha)	-0.04 (0.06)	-0.04 (0.06)
7.	PPC (Rs/ha)	0.01^{*} (0.01)	0.08^{**} (0.04)
8.	No. of irrigation (No./ha)	NA	0.20^{**} (0.11)
	R^2	0.72	0.83
	Adjusted R^2	0.69	0.81
	F	22.37	37.32

Note: *** Significant at one per cent level, ** Significant at five per cent level, * Significant at ten per cent level; Figures in parentheses indicate standard errors; PPC refers for 'Plant Protection Chemicals'; NA refers 'Not Applicable'

Labour use had almost no effect in rainfed crop and it had negative impact in irrigated crop (the co-efficient in rainfed farming was 0.06 whereas it was -0.13 in irrigated farming). Similar relation was observed in cost spent on weeding, which got a negative co-efficient of -0.04 in both regions. It indicates use of excess labour in chilli production *i.e.* there was *disguised unemployment*, where part of the labor force was either left without work or was working in a redundant manner with zero *marginal labour productivity*. Main reason for such condition could be employing excess labour in fields, in particular, the family labour. Lack of alternate employment opportunities like off-farm and non-farm activities induce the farm families to spend more time in fields rather than to be idle. Manures, fertilizers and plant protection chemicals had significant positive impact on crop output, as one could expect in common. Irrigation significantly increased the output than any other input (in irrigated condition), which indicated a one per cent increase in number of irrigation supplied will increase the output by 0.20 times. As tank irrigation was observed as the major source of irrigation, efficiency in water use could be improved through collective participation by forming water user groups.

Costs, Returns and Constraints

Labour cost accounted major share both in irrigated and rainfed regions. Labour use was relatively higher in irrigated condition, grasping more than half of the total cost and nearly 60 per cent of total variable cost incurred, whereas the same under rainfed condition was nearly 40 per cent and 44 per cent of total cost and total variable cost respectively (Table 3). As noted earlier, excess use of labour should be the prime reason for this. Lack of other income generating sources, along with rising demand for agricultural labourers (as a result of engagement of rural masses in employment generation programmes like Mahatma Gandhi National Rural Employment Guarantee Scheme) had restricted timely availability of labour to essential crop management activities, which had resulted in increased costs. Labour shortage and rising wages were two most pressing problems for the farmers in this region (Table 5). Inefficiency in seed use could also be observed in cost terms. Seed rate used under rainfed condition was much beyond the recommended level. It could be observed from Table 3 that per cent share of seeds to total cost was just 2.5 per cent in irrigated farming whereas it was around 15 per cent in rainfed farming. Seed germination is a critical stage in chilli cultivation where absence or scarcity of water could adversely affect seed germination. One could note in Table 6 that monsoon during the time of harvest and scarcity of water at crop germination stages were important constraints next to labour shortage and higher wage rates in chilli production.

Table 3: Cost of Cultivation of Chilli under Rainfed and Irrigated conditions (Rs/ha)

S.No	Items	Rainfed farming	Irrigated farming
1.	Labour (including family labour)	18,630.94 (39.41)	27,718.59 (51.31)
2.	Machine power	5,654.18 (11.96)	5,076.20 (9.40)
3.	Seed	6,851.69 (14.49)	1,326.39 (2.45)
4.	Organic manures	6,747.43 (14.27)	6,262.37 (11.59)
5.	Inorganic fertilizers	2,718.85 (5.75)	3,857.21 (7.14)
6.	Plant protection chemicals	379.33 (0.80)	528.99 (0.98)
7.	Irrigation	NA	1,227.32 (2.27)
8.	Interest on working capital	1,320.65 (2.79)	1,457.77 (2.70)
	Total variable cost	42,303.07 (89.47)	47,454.84 (87.85)
9.	Depreciation on fixed capital	1,260.56 (2.67)	1,771.60 (3.28)
10.	Land revenue	60.00 (0.13)	60.00 (0.11)
11.	Interest on fixed capital	1,153.16 (2.44)	1,735.57 (3.21)
12.	Rental value of owned land	2,500.00 (5.29)	3,000.00 (5.55)
	Total fixed cost	4,973.72 (10.53)	6,567.17 (12.15)
	Total cost	47,276.79 (100.00)	54,022.01 (100.00)

Note: Figures in parentheses indicate percentages to total cost; NA=Not Applicable.

Cost of labour, along with seed cost accounted for 53 to 55 per cent of total cost and more than 60 per cent of total variable cost in chilli production. Provided that high cost is involved, inefficiency in use of these inputs would further worsen the profits attainable and the same scenario is reflected in Table 4. Cost of producing a Kg of chilli in rainfed condition was Rs. 4 higher than in irrigated condition whereas the price realised was less by Rs.7 per Kg. Low yield rate along with inefficiency induced cost increase had pushed the benefit-cost ratio down. One could clearly notice vast income differentials between two regions. Gross return earned by rainfed farmers was less than Rs. 60,000 whereas it was more than Rs. 82,000 to the irrigated farmers. In terms of net returns, irrigated farmers got nearly Rs. 16,000/ha more than water scarce rainfed farmers. Low productivity and poor market prices were responsible for such income gap.

 Print ISSN: 0424-2513 Online ISSN: 0976-4666

Table 4: Output, Costs and Returns in chilli production

S. No	Items	Rainfed farming	Irrigated farming
1.	Average yield (Kg/ha)	1,084.14	1,256.38
2.	Average price (Rs/kg)	58.01	65.43
3.	Cost of production (Rs/kg)	51.07	47.29
4.	Benefit-Cost Ratio	1.14	1.38
5.	Gross Return (Rs/ha)	59,062.30	82,204.94
6.	Net Return (Rs/ha)	7,065.32	22,790.27

Table 5: Problems faced in Chilli production

S.No	Constraints	Score	Ran
1.	Labour shortage	55.19	I
2.	High wage rate	54.53	II
3.	Rain during harvest season	51.00	III
4.	Water scarcity	47.24	IV
5.	Pests and Diseases problem	39.32	V

Increased prices realised by irrigated chilli farmers was partly due to the *distance* factor. Direct transport of commodities to the market was possible to the irrigated farmers whose farms were located less than 12 km to the market destination. Rainfed lands were relatively far, demanding more labour use on one side for disposal of commodity and hesitation in labour supply because of the distance of fields on the other side. Moreover, quality of produce was relatively good in irrigated farming because of lesser pests and diseases infestation, when compared to rainfed farming. While the former is being exogenous i.e. distance, the later could be minimised by efficient resource use and improved agronomic practices.

To conclude, under the limited possibilities of employment diversification within agricultural sector, or towards off-farm and non-farm sectors, agrarian society in the study area largely depends farming alone. The common features of rainfed regions like poor resource base, uneven distribution of rainfall, low crop productivity are also features of the study area. Provision of irrigation significantly increases chilli output. Along with the commonly observed hurdles like uneven rainfall, labour shortage and increasing agricultural labour wages, there exists inefficiency in labour use, particularly in use of family labour in both rainfed and irrigated chilli growing regions. Lack of other income generating activities has possibly caused disguised unemployment among the farm families who spend their idle labour time in own farms. Higher agricultural wages is yet the other reason for such increased involvement of family labour in own farm operations. Inefficiency also exists in seed in the form of excess use than the recommended levels. Not by ignorance, farmers' own experiences on undue weather conditions in this region guide them to opt for increased seed rates. Still, there exist potentials for creation of water harvesting structures that could address this problem by reducing vulnerability of seed germination process to rainfall distributional inequalities. Costs and returns, in general, are higher in irrigated chilli cultivation. Differential profits can be narrowed down by increasing the efficiency in use of resources in short-run and by creating water harvesting structures and by forming water user groups in long-run. Shortage in agricultural labour supply, rising wages, excess rain during harvest but paucity at other stages and pests and diseases are pressing issues for the chilli producers. Higher prices realised by irrigated chilli growers are mainly due to the *distant* factor and ability to produce relatively higher quality produce.

References

Aggarwal, P.K., Hebbar, K.B., Venugopalan, M.V., Rani, S., Bala, A., Biswal, A. and Wani, S.P. 2008. Quantification of Yield Gaps in Rain-fed Rice, Wheat, Cotton and Mustard in India. Global Theme on Agroecosystems, Report no. 43. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Ashok, K.R. and Sasikala, C. 2012. Farmers' Vulnerability to Rainfall Variability and Technology Adoption in Rain-fed Tank Irrigated Agriculture. *Agricultural Economics Research Review* **25**(2): 267-278.

Auffhammer, A., Ramanathan, V. and Jeffrey R Vincent. 2011. Climate change, the monsoon, and rice yield in India. *Climatic Change* **111**:411-424.

Jagtap, P.P., Shingane, U.S. and Kulkarni, K.P. 2012. Economics of Chilli Production in India. *African Journal of Basic & Applied Sciences* **4**(5): 161-164.

Mayande, V.M. and Katyal, J.C. 1996. Low Cost Improved Seeding Implements for Rainfed Agriculture. Technical Bulletin-3, CRIDA, Hyderabad: 26

Murali, Janakaraj and Tamer Afifi. 2012. "Where the Rain Falls" project. Case study: India. Results from Janjgir-Champa District, Chhattisgarh State. Report No. 4. Bonn: United Nations University-Institute for Environment and Human Security (UNU-EHS).

Raju, B.M.K., Rama Rao, C.A. and Venkateswarlu, B. 2010. Growth Performance of Major Rainfed Crops in India. *Indian Journal of Dryland Agricultural Research and Development* **25**(1): 17-22.

Rajur, B.C., Patil, B.L. and Basavraj. 2008. Economics of Chilli Production in Karnataka. *Karnataka Journal of Agricultural Sciences* **21**(2): 237-240.

Sharma, K.L., Vittal, K.P.R., Srinivas, K., Venkateswarlu, B. and Neelaveni, K. 1999. Prospects of organic farming in dryland agriculture. In Fifty Years of Dryland Agricultural Research in India (Eds. H.P. Singh, Y.S. Ramakrishna, K.L. Sharma and B. Venkateswarlu) Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad: 369-378.

 Print ISSN: 0424-2513 Online ISSN: 0976-4666