An analysis of resource use efficiency and allocative efficiency in IPM and non-IPM chilli production

K UMA and S PRAVEENA

Department of Agricultural and Rural Management
Tamil Nadu Agricultural University Coimbatore 641003 Tamil Nadu, India
Email for correspondence: umatnau@gmail.com

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ABSTRACT

Chilli is one of the most important and the largest produced spices. India is one of the largest producers, consumers and exporters of spices in the world. Indian chillies are known for their pungency and colour particularly grown in Guntur district of Andhra Pradesh state. The present study was focussed on the assessment and comparing the resource use efficiency of chilli cultivation for IPM and non-IPM farmers in Andhra Pradesh. The results indicated that there was a positive relationship between IPM technology and the productivity of chilli. In case of IPM farmers the marginal value product to marginal factor cost ratio was observed to be more than one for organic manure, machine labour and chemical fertilizers which indicated that these inputs were underutilized.

Keywords: Allocative efficiency; resource use efficiency; partial budgeting; chilli; IPM

INTRODUCTION

Chilli is one of the most important and the largest produced spices in India. India is one of the largest producers, consumers and exporters of spices in the world. Indian chillies are known for their pungency and colour particularly grown in Guntur district of Andhra Pradesh state. It is estimated that around 25-30 per cent of the chilli crop is used for powder preparation.

India is not only the largest producer but also the largest consumer of chilli in the world. Chillies are the most common spice cultivated in India. It is a universal spice of the country. It is cultivated in all the states and union territories of the country. India contributes about 36 per cent to the total world production. In India chillies are grown in almost all the states throughout the country. Andhra Pradesh is the largest producer of chilli in India and contributes about 26 per cent to the total area under chilli followed by Maharashtra (15%), Karnataka (11%), Orissa (11%), Madhya Pradesh (7%) and other states contributing nearly 22 per cent to the total area under chilli (https://agmarknet.gov.in/Others/preface-chhilli.pdf).

In Andhra Pradesh as on 26 September 2018, about 1,16,578 hectares was reported under red chilli. The chilli area coverage in Guntur, Kurnool and Krishna regions was reported as 65,259, 15,584 and 12,816 hectares respectively (https://pjtsau.edu.in/files/AgriMkt/2019/Ol_Chilli _Jan_ 2019.pdf).

The study was conducted to assess and compare the resource use efficiency in chilli cultivation for IPM and non-IPM farmers and assess the extent of adoption and reasons for non-adoption of IPM practices in Kurnool district of Andhra Pradesh.

METHODOLOGY

Kurnool district is one of the major chilli producing areas of Andhra Pradesh. Here the case firm recommends the IPM package of practices for chilli and buy the produce from the farmers who are following the recommended practices advocated by the firm. Four Mandals from Kurnool district and from each Mandal three villages were selected based on the maximum area under chilli cultivation and purposively recommended by the case firm. From each village five IPM and five non-IPM farmers were selected using simple random technique. It comprised 60 farmers who had adopted IPM and 60 who had not followed IPM.

A well-structured interview schedule was designed for the farm level survey and the same was pre-tested in the field and modified accordingly. The personal interview method was used for data collection. Cobb-Douglas production function (Cobb and Douglas 1928), partial budgeting technique (https://www.extension.iastate.edu/AGDm/wholefarm/html/c1-50.html) and Garrett's ranking technique (Garrett and Woodworth 1969) were used for the analysis of the data.

Functional analysis

Cobb-Douglas type of production function was fitted to study resource productivity and allocative efficiency in case of IPM and non-IPM farmers. This was done with a view to determine the extent to which the important resources that have been quantified, explain the variability in the gross returns of the IPM and non-IPM farmers and to determine whether the resources were optimally used by the farmers.

Heady and Dillon (1963) indicated that the Cobb-Douglas type of function was the most popular of all possible algebraic forms in the farm firm analysis as it provided comparison, adequate fit, computational feasibility and sufficient degrees of freedom. They further indicated that Cobb-Douglas type of function had the greatest use in diagnostic analysis reflecting the marginal productivities at mean levels of returns.

The general form of the function is:

$$y = a x_i^{b_i}$$

where x_i= Variable resource measure, y= Output, a= Constant, b_i= Extent of relationship between x_i and y when x_i is at different magnitudes

This type of function allows for either constant or increasing or decreasing returns to scale. It does not allow for total product curve embracing all the three phases simultaneously. Test was conducted to see if the sum of regression coefficients was significantly different from unity. Functions of the following form were fitted for IPM and non-IPM farmers separately:

$$Y = a x_1^{b_1} a x_2^{b_2} a x_3^{b_3} \ldots\ldots\ldots\ldots\ldots\ldots . a x_n^{b_n}$$

On linearization it becomes:

$$\log Y = \log a + b_1 \log x_1 + b_2 \log x_2 + b_3 \log x_3 + \cdots b_n \log x_n$$

Production function employed for IPM and non-IPM farmers as a whole was:

$$\text{Log}(Y) = \log(a) + b_1 \log(x_1) + b_2 \log(x_2) + b_3 \log(x_3) + b_4 \log(x_4) + b_5 \log(x_5) + b_6 \log(x_6) + b_7 \log(x_7) + b_8 \log(x_8) + e_i$$

where Y= Yield (kg/ha), a= Intercept, x_1= Seeds (kg/ha), x_2= Organic manures (kg/ha), x_3= Human labour (man days/ha), x_4= Number of traps/ha, x_5= Chemical fertilizers (kg/ha), x_6= Plant protection chemicals (kg/ha), x_7= Machine labour (h/ha), x_8= Dummy variable (1 for IPM, 0 for non-IPM), e_i= Error term, b_i= Elasticity

Allocative efficiency

The ratios of the marginal value product (MVP) to marginal factor cost (MFC) of individual resources were computed to judge the allocative efficiencies (AEs). The computed MVP was compared with the MFC or opportunity cost of the resource to draw inferences. A resource is said to be optimally allocated when MVP= MFC.

$$AE = MVP/MFC, \quad MVP_i = MPP_i \times P_y$$

where MVP= Marginal value product, MPP_i= Marginal physical product of the i^{th} input, P_y= Price of output

$$MPP_i = b_i \frac{\bar{y}}{x_i}$$

where b_i= Regression coefficient or elasticity of production of i^{th} independent variable, $\bar{y}$ = Geometric mean of gross returns between IPM/non-IPM farmers, X_i= Geometric mean of the i^{th} input

This analysis was carried out in order to identify the possibilities of increasing gross returns under IPM and non-IPM farmers.

Partial budgeting

Partial budgeting analysis was done to measure the economic aspects of adopting the IPM in chilli to find out whether adopting IPM in chilli was economically feasible to a farmer or otherwise. Partial budgeting analysis, a rough form of marginal analysis, looks at the changes that would occur in cost and receipts as a result of a (marginal) change in the cultivation practices. The net increment in the adoption of IPM was calculated by using the following method:

Change in method of plant protection ie adopting IPM or otherwise

Debit (A)	Credit (B)
Added cost	Added returns
——Rs——	——Rs——
——Rs——	——Rs——
Reduced revenue	Reduced cost
——Rs——	——Rs——
——Rs——	——Rs——
Total added cost and reduced return	Total added returns and reduced cost
(A) Rs——	(B) Rs——

Net gain= B – A

The above partial budgeting technique was used to estimate the changes in cost reduction and income for IPM and non-IPM chilli farmers.

RESULTS and DISCUSSION

Resource use efficiency in the production of chilli by IPM and non-IPM farmers

Production functions were fitted to the IPM and non-IPM farmer's data to assess the degree of influence of the inputs on the chilli output. It was noticed that human labour, organic manure, seeds, number of traps and chemical fertilizers were the significant variables while studying the economics of chilli cultivation for IPM and non-IPM farmers.

In addition to these variables, a dummy variable ('1' for adopters, '0' for non-adopters) which was also included to capture the impact of the technology namely IPM, was also found to be significant. The details of the production function estimates are given in Table 1.

It was observed that the R^2 value was 0.799 indicating that 79 per cent of the variation in the chilli yield was explained by the included variables. The regression coefficient for seed used per hectare indicated that there was a strong positive relationship between the seed and chilli yield. A one per cent increase in seed usage, organic manures and human labour ceteris paribus would increase the per hectare chilli yield by 0.21, 0.17 and 0.41 per cent respectively from their mean levels.

Inclusion of dummy variable indicated that there existed a positive relationship between IPM technology and the productivity of chilli. This had happened due to the efficient and continuous adoption of the IPM components in chilli crop during the pest management activities.

Estimation of allocative efficiency for IPM and non-IPM chilli farmers

The ratios of the MVP to MFC of individual resources were computed to judge the allocative efficiency (AE). The computed MVP was compared with the MFC or opportunity cost of the resource to draw inferences. A resource is said to be optimally allocated when its MVP= MFC. The details are presented in Table 2.

The ratios of MVP to MFC indicate that most of the inputs were either overutilized or underutilized by both the categories of farmers. For the non-IPM farmers these ratios were less than one for seed rate (0.66), human labour (0.08) and chemical fertilizers (0.95) which have indicated that they should not increase the usage of these inputs.

In case of IPM farmers the MVP to MFC ratio was observed to be more than one for organic manure, machine labour and chemical fertilizers which indicated that these inputs were underutilized. As a result of this there existed a scope to increase the chilli yield by the use of increased level of these inputs for IPM farmers.

Different IPM components and their extent of adoption by IPM farmers

In the context of IPM practices the major items included cultural, mechanical, biological and chemical components. This information was mainly collected to know the extent of adoption of the recommended IPM components and the same has been presented in the Table 3.

It was observed (Table 4) that within the cultural components 7.97 per cent of the cost was

Table 1. Resource use efficiency in the production of chilli by IPM and non-IPM farmers

Variable	Regression coefficient		t-ratio	Mean value
	IPM	Non-IPM		
Seed	0.218**	0.218	4.051	5439.45
Organic manures	0.171**	0.171	7.438	266.44
Human labour	0.419**	0.419	5.161	3501.02
Number of traps	-0.014*	-0.014	-2.346	462.06
Chemical fertilizers	0.061*	0.061	2.932	14.19
PP chemicals	0.041 NS	0.041	1.389	394.08
Machine labour	0.038 NS	0.038	1.536	16.38
Dummy	0.027**	-	3.338	-
R^2	-	-	-	0.799**

*Significant at 5% level, **Significant at 1% level, NS: Non-significant, PP: Plant protection

Table 2. Estimation of allocative efficiency for IPM and non-IPM chilli farmers

MVP/MFC	IPM	Non-IPM
Seed	0.72	0.66
Organic manures	22.33	-66.7
human labour	0.18	0.08
Chemical fertilizers	7.48	0.95
Plant protection chemicals	0.78	0.5
Machine labour	3.52	-0.06

MVP: Marginal value product, MFC: Marginal factor cost

involved in doing the summer ploughing in order to expose the larvae, pupae and eggs of the previous crop. Within the mechanical components major cost was involved in pheromone traps (1.21%) which helped the farmers in reducing the lepidopteron population followed by bird perches (1.08%). In biological components 3.29 per cent was spent on botanicals like neem cake and neem oil. In the chemical components farmers were spending lesser amounts on insecticides than fungicides due to the incorporation of IPM components in chilli.

It was observed that to implement all these components in the process of chilli cultivation the IPM farmers had incurred Rs 36,536 per hectare as total plant protection cost. In order to restrict the expenditure made on the purchases of synthetic chemicals to 81.96 per cent of the total cost, the farmers had introduced cultural and mechanical components along with the bio-agents and botanicals as plant protection components.

Therefore it can be concluded that by introducing the cultural, mechanical and biological components in chilli IPM module farmers could reduce the usage of synthetic chemicals by 18.04 per cent to the total cost.

All the farmers had conveniently adopted cultural practices which was followed by the use of mechanical, biological and chemical components in that order to achieve the IPM goals. The maximum number of non-IPM farmers (mean score 41.30) (Table 5) indicated that there was no separate market for the IPM products and that was the major reason for non-adoption of IPM practices in the study area. The neighbourhood farmers did not support was the reason ranked second by the respondents (36.15%) followed by difficulty in controlling the pests through IPM practices (31.59%).

Among the different opinions about the impact of IPM practices (Table 6), premium price (mean score 42.46) occupied the first rank and this premium price was mainly due to the better quality of the produce produced by the farmers. The second rank was given to the higher income (mean score 38.82) as the farmers had succeeded in reducing the cost of cultivation followed by better quality products (mean score 29.96). Hence it could be concluded that the premium price for the produce was the major opinion about the impact of IPM practices.

CONCLUSION

An effective pest control requires community participation; social cohesiveness is an important pre-requisite but still farmers take independent pest control decisions. Lack of social cohesiveness is deterrent to any individual's participation in community pest management. Case firm can try to implement a collective participation for IPM (a village as unit).

Nearly 50 per cent of the non-IPM farmers had the opinion that by adopting the IPM technology the yield would reduce drastically and pests couldn't be controlled easily. The case firm could conduct the meetings in which the successful IPM farmers share their own experiences for such farmers. Even IPM farmers were of the opinion that the availability of biological agents and good quality botanicals were

Table 3. Extent of adoption of different IPM components by IPM farmers

Components	Farmers	
	Number	Percentage
Cultural components		
Summer ploughing	60	100.00
Trap crops	60	100.00
Mechanical components		
Bird perches	55	91.66
Pheromone traps	50	83.33
Sticky traps	52	86.66
Biological components		
Bio-control agents	49	81.66
Botanicals	53	88.33
Chemical components		
Insecticides	60	100.00
Fungicides	60	100.00
Herbicides	3	5.00

Table 4. Cost incurred by IPM farmers on IPM module components

Components	Cost in (Rs/ha)	Percentage to the total
Cultural components		
Summer ploughing	2,911	7.97
Trap crops	258	0.70
Sub-total	3,169	8.67
Mechanical components		
Bird perches	395	1.08
Pheromone traps	444	1.21
Sticky traps	248	0.68
Sub-total	1,087	2.97
Biological components		
Biological agents	1,130	3.09
Botanicals	1,202	3.29
Sub-total	2,332	6.38
Chemical components		
Insecticides	14,240	38.97
Fungicides	15,708	42.99
Sub-total	29,948	81.96
Total	36,536	100.00

lacking in the market. So the case firm should take the initiative to identify the dealers where good quality IPM components can be made available and accessible to the farmers. The extent of adoption of bio-agents and botanicals was found to be low but had a positive impact on yield and ecosystem. Hence an extensive training on IPM technology was needed to be arranged. These inputs could be supplied at subsidized prices in the local market.

Table 5. Reasons for non-adoption of IPM practices by non-IPM farmers

Aspect	Mean score	Rank
No separate markets	41.30	I
Neighbourers not supporting	36.15	II
Difficult to control pests	31.59	III
Low yield	28.98	IV
Non-availability of quality bio-inputs	25.72	V

Table 6. Farmers' opinion about the impact of IPM practices

Aspect	Mean score	Rank
Premium price	42.46	I
Higher income	38.82	II
Better quality products	29.96	III
Less cost of cultivation	29.88	IV
Reduced labour use	27.25	V
Reduction in cost of pesticides	25.52	VI
Low level of pesticide use	25.06	VII
Reduced damage to beneficial insects	22.55	VIII

REFERENCES

Cobb CW and Douglas PH 1928. A theory of production. American Economic Review **18 (Supplement):** 139-165.

Garrett HE and Woodworth RS 1969. Statistics in psychology and education. Vakils, Feffer and Simons Pvt Ltd, Bombay, Maharashtra, India, 329p.

Heady EO and Dillon JL 1963. Agricultural production functions. Iowa State University Press, Ames, Iowa, 667p.

https://agmarknet.gov.in/Others/preface-chhilli.pdf

https://pjtsau.edu.in/files/AgriMkt/2019/Ol_Chilli_Jan_2019.pdf

https://www.extension.iastate.edu/AGDm/wholefarm/html/c1-50.html