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RESEARCH ARTICLE :

Resource use efficiency in cultivation of major crops of Dharwad district

LAXMI N. TIRLAPUR* AND S.M. MUNDINAMANI

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SUMMARY : Agriculture in India is one of the most important sectors of its economy. Though, the share of Indian agriculture in the GDP has been steadily declining over the years. Main reason for deceleration in agricultural growth is declining investment in agriculture research and development and irrigation, inefficiency of rural credit and extension. One more the most important factor is; inefficient use of resources is the reason for declined growth of agriculture sector. So the present study was under taken in Dharwad district to analyse the resource use efficiency of major crops. Major crops grown in the district such as chickpea, cotton, paddy, soybean, maize and chilli were selected for the study. Multistage random sampling was adopted for selection of sample respondents. Cobb-Douglas production technique was employed. Results of the study revealed that seed, fertilizers, PPC and machine labour were over utilized and human labour and bullock labour were underutilized by the chickpea farmers. Cobb-Douglas production function for cotton under rainfed condition revealed that seed, PPC, human labour and bullock labour were over utilized and FYM, fertilizer and machine labour were underutilized. During production of paddy seed, fertilizers, FYM, bullock labour and machine labour were over utilized and human labour and PPC were underutilized by the farmers. FYM and PPC were underutilized and seed, fertilizers, human labour, bullock labour and machine labour were underutilized by farmers in cultivation of soybean. Resource use efficiency under rainfed chilli production revealed that seed, PPC, bullock labour and machine labour were over utilized and FYM, fertilizer and human labour were under utilized by the farmers.

KEY WORDS :
Resource use efficiency, Marginal value cost, Marginal fixed cost

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Author for correspondence :
LAXMI N. TIRLAPUR
Department of Agricultural Economics, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA
Email: laxmint4424@gmail.com
See end of the article for authors' affiliations

BACKGROUND AND OBJECTIVES

Agriculture in India is one of the most important sectors of its economy. Agriculture accounts for 15 per cent of India's GDP (2012). Though, the share of Indian agriculture in the GDP has been steadily declining over the years. About 52 per cent of the total workforce is still employed in the farm sector which makes more than half of the Indian population dependant on agriculture for sustenance (NSS 66th Round).

Since agriculture forms the resource base for a number of agro-based industries and agro-services, it would be more meaningful to view agriculture not as farming alone but as a holistic value chain, which includes farming, wholesaling, warehousing, processing, and retailing Raja(1992).

At present Indian agriculture is at crossroads and one of the major challenges is the reverse deceleration in agricultural growth. Main reason for deceleration in agricultural growth is declining investment particularly public investment in agriculture research and development and irrigation, combined with inefficiency of institutions providing inputs and services including rural credit and extension, post-harvest losses of food grains at 10 per cent of the total production or about 20 MT Rangappa *et al.*(2005) and Gaddi *et al.*(2002). One more the most important is inefficient use of resources is the reason for declined growth of agriculture sector. Farmers were not using the resources as per the recommendation; this leads to increased in overhead cost Fare and Grosskopf (1994). Since the study was undertaken to analyse the resource use efficiency (RUE) in cultivation of important crops of Dharwad district.

RESOURCES AND METHODS

The study was conducted in Dharwad district. Multistage random sampling technique was used for the selection of sample farmers. Major crop in each taluk was selected for analysis of cost of cultivation. From Dharwad taluk, chickpea was selected as it was cultivated an area of 19456 ha which accounted for 24.48 per cent of the total cultivable area in Dharwad. Similarly, cotton (19166 ha) accounting for 21.45 per cent from Hubli, soybean (14636 ha) and rice (14355 ha) accounting for 23.79 and 23.3 per cent from Kalaghatagi taluk, chilli (30222 ha) accounting for 25.10 per cent and maize (24691 ha) accounting for 16.46 per cent from Kundagol were selected for the study. Multistage random sampling technique was followed for selection of sample respondents.

Analytical tool used :

The resource-use efficiencies were studied by fitting the Cobb-Douglas type production function (Monetary values) to the farm level data.

$$Y = a X_1^{b1} X_2^{b2} X_3^{b3} X4^{b4} X_5^{b5} X_6^{b6} X7^{b7} Eu \quad .....(1)$$

In logarithmic form, it assumed a log-linear equation as under:

$$\text{Log } Y = \text{Log } a + b_1 \log x1 + b_2 \log x2 + b_3 \log x3 + b_4 \log x4 + b_5 \log x5 + b_6 \log x6 + b_7 \log x7 + u \log e \quad .....(2)$$

where,

Y = Gross returns in Rs.

X_1 = Value of seeds in Rs.

X_2 = Value of FYM in Rs.

X_3 = Value of fertilizers in Rs.

X_4 = Value of plant protection chemicals in Rs.

X_5 = human labour charge in Rs.

X_6 = bullock labour charge in Rs.

X_7= machine labour in Rs.

a = Constant/intercept term

u = Random variable

e = 2.718

b1 to b7 represented production elasticities of respective inputs.

The regression co-efficients (bi) were tested for the significance using't' test :

$$t = \frac{b_i}{\text{Standard error of bi}} \quad .....(3)$$

The co-efficient of multiple determination (R^2) was also worked out to test the goodness of fit of the model.

While calculating resource use efficiency for chickpea, the variable input FYM was not included because it is *Rabi* crop farmers were not applying FYM. Similarly for maize crop plant protection chemicals were not applied by the sample farmers, so it is not included while calculating resource use efficiency for maize production.

OBSERVATIONS AND ANALYSIS

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

Resource use efficiency in cultivation of major crops:

Regression equations under rainfed situation were estimated separately using total gross output as the dependent variable and the quantity of seeds, organic manure, chemical fertilizers, human labour, bullock and machine labour, plant protection chemicals as independent variables in chickpea, paddy, soybean, cotton, chilli and maize production. The regression equation was estimated in order to capture the nature and magnitude of the effects of the independent variables on the productivity of selected crops. The co-efficients were estimated by employing the Cobb-Douglas production function. The efficiency in resource allocation in respect of selected inputs in selected crop production has been explained based on the ratios of the marginal value product (MVP) to marginal factor cost (MFC).

Chickpea :

The output elasticity co-efficients for seed, fertilizers and plant protection chemicals were negative and found to be significant (Table 1). This showed that thus there is need to reduce the expenditure on these inputs would contribute significantly towards gross returns. Elasticity co-efficients for human labour, bullock labour and machine labour were positive but non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. The sum of elasticity co-efficients with 1.12 showed increasing returns to scale. The increasing returns to scale indicated that a one per cent increase in all the factors of production simultaneously would result in an average increase of gross returns by 1.12 per cent. Co-efficient of multiple determination explained 97 per cent of total variation in gross returns was explained by the variables included in the model. The results showed that the MVP to MFC ratios for human labour and bullock labour were more than one indicating that still there is scope to use these inputs and increase the gross returns of chickpea production. On the other hand, the MVP to MFC ratios seed, fertilizers, plant protection chemicals and machine labour were less than one, indicating the expenditure on this input was more than the optimum level. Hence, withdrawal of some units of these resources which were overused is profitable in the short run.

Cotton :

The output elasticity co-efficients for seed and bullock labour were negative and found to be significant (Table 2). This showed that decrease in the use of these inputs would result in increase in efficiency of cotton production, contributing significantly towards gross returns. Co-efficient for machine labour was positive and significant so increasing use of these inputs results

Table 1 : Resource use efficiency in the production of rainfed chickpea

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	3.48 (1.16)		
Seed	b_1	-0.23** (0.05)	-3.87	-3.87
Fertilizers	b_2	-20.55** (4.62)	-193.70	-193.70
PPC	b_3	-1.64** (0.37)	-191.95	-191.95
Human labour	b_4	23.44 (4.98)	204.40	204.40
Bullock labour	b_5	0.03 (0.01)	1.33	1.33
Machine labour	b_6	0.06 (0.03)	0.27	0.27
R^2			0.976	
F value			161.46	
Standard error			0.009	
Returns to scale (Σbi)			1.12	

** indicate significance of value at P=0.01

Table 2 : Resource use efficiency in the production of rainfed cotton

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	12.65 (1.86)		
Seed	b_1	-0.01** (0.021)	-0.36	-0.36
FYM	b_2	0.37 (0.108)	13.42	13.42
Fertilizers	b_3	0.42 (0.071)	13.78	13.78
PPC	b_4	-0.05 (0.235)	-300.96	-300.96
Human labour	b_5	0.06 (0.088)	0.492	0.492
Bullock labour	b_6	-0.50** (0.208)	-49.86	-49.86
Machine labour	b_7	0.76* (0.119)	8.38	8.38
R^2			0.956	
F value			69.06	
Standard error			0.035	
Returns to scale (Σbi)			1.06	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

increasing efficiency of cotton production. FYM, fertilizer and human labour were positive but non-significant Kiresur and Manjunath (2011). Hence, it would not be profitable to further increase in the expenses on these resources. The elasticity co-efficient for plant protection chemical was negative and found to be non-significant indicating that the material was over used. It could be observed from the table that the marginal productivity of the fertilizer (13.78) was the highest followed by FYM (13.42) and human labour (0.49). Profitability ratio analysis showed that MVP:MFC ratio was less than unity for all the inputs except seed, PPC and bullock labour indicating they are over utilized thus there is a need to reduce expenditure on these inputs. These results are in line with results obtained from Hugar *et al.* (2009).

Paddy :

The output elasticity co-efficients for FYM, human labour and bullock labour were positive and found to be significant (Table 3). This showed that increase in the use of these inputs would result in increase in efficiency of paddy production, which contributing significantly towards gross returns. Elasticity co-efficient of machine labour was negative and significant indicates decreasing use of this input would result in increase in efficiency of paddy production. Elasticity co-efficients for seeds, fertilizers and plant protection chemicals were positive but non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. These results are in line with results obtained from Hosamani *et al.* (2010). The sum of elasticity co-efficients with 0.34 showed decreasing returns to scale. The decreasing returns to scale indicated that a one per cent increase in all the factors of production simultaneously would result in an average increase of gross returns by 0.34 per cent. These results are in line

Table 3 : Resource use efficiency in the production of drill sown paddy

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	8.66 (0.560)		
Seed	b_1	0.019 (0.021)	0.453	0.453
FYM	b_2	0.03* (0.012)	0.439	0.439
Fertilizers	b_3	0.04 (0.023)	0.380	0.380
PPC	b_4	0.01 (0.010)	4.243	4.243
Human labour	b_5	0.41* (0.115)	3.768	3.768
Bullock labour	b_6	0.05** (0.021)	0.731	0.731
Machine labour	b_7	-0.26* (0.117)	-1.838	-1.838
R^2			0.9813	
F value			165.34	
Standard error			0.007	
Returns to scale (Σbi)			0.324	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Resource use efficiency in the production of rainfed soybean

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	6.580 (1.78)		
Seed	b_1	0.030 (0.11)	0.52	0.52
FYM	b_2	0.780** (0.06)	8.47	8.47
Fertilizers	b_3	-0.05 (0.04)	-0.93	-0.93
PPC	b_4	0.400** (0.09)	36.94	36.94
Human labour	b_5	-0.080 (0.27)	-0.81	-0.81
Bullock labour	b_6	-0.006 (0.05)	-0.36	-0.36
Machine labour	b_7	0.086 (0.03)	0.69	0.69
R^2			0.966	
F value			100.81	
Standard error			0.01	
Returns to scale (Σbi)			1.15	

** indicate significance of value at P=0.01

with results obtained from Reddy *et al*. (2004). The value of co-efficient of multiple determination (R^2) was 0.98 which implied that 98 per cent of total variation in gross returns was explained by the variables included in the model Suresh and Keshavareddy (2006).

The analysis of marginal value products of various inputs indicated that it was negative for machine labour (-1.84) which was due to over use of this inputs. Plant protection chemical (4.24) showed the highest marginal value product followed by human labour (3.76), bullock labour (0.73), seeds (0.45), FYM (0.44) and fertilizers (0.38). These results are in accordance to the results obtained from Sunandini *et al*. (1993) and Sharif and Dar (1996). Thus, there is scope to increase area under paddy production in combination with increased use of these inputs.

Soybean :

The output elasticity co-efficients for FYM and plant protection chemicals were positive and found to be significant (Table 4). This showed that increase in the use of these inputs would result in increase in efficiency of soybean production, contributing significantly towards gross returns. Elasticity co-efficients of seed and machine labour were positive but non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. Fertilizer, human labour and bullock labour were negative and non-significant indicating that they are over-used. These results are in line with results obtained from Jaiswal and Hugar (2011). The sum of elasticity co-efficients was 1.15 showed increasing returns to scale. The increasing returns to scale indicated that a one per cent increase in all the factors

Table 5 : Resource use efficiency in the production of rainfed chilli

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	7.851 (2.90)		
Seed	b_1	-0.140 (0.13)	-53.20	-53.20
FYM	b_2	0.401 (0.22)	16.74	16.74
Fertilizers	b_3	2.770 (0.43)	169.84	169.84
PPC	b_4	-1.420** (0.43)	-120.7	-120.7
Human labour	b_5	-0.200 (0.20)	1.71	1.71
Bullock labour	b_6	-0.322* (0.34)	-9.99	-9.99
Machine labour	b_7	0.107 (0.460)	-2.65	-2.65
R^2			0.932	
F value			43.44	
Standard error			0.077	
Returns to scale (Σbi)			1.18	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 6 : Resource use efficiency in the production of rainfed maize

Particulars	Parameters	Regression co-efficient	Marginal value product (MVP)	MVP/MFC
Intercept	b_0	4.23 (0.947)		
Seed	b_1	1.23 (0.142)	36.24	36.24
FYM	b_2	0.14 (0.090)	2.86	2.86
Fertilizers	b_3	0.002 (0.119)	0.03	0.03
Human labour	b_4	-0.17 (0.150)	-1.58	-1.58
Bullock labour	b_5	-0.374** (0.106)	-8.36	-8.36
Machine labour	b_6	0.091 (0.083)	1.12	1.12
R^2			0.96	
F value			85.39	
Standard error			0.03	
Returns to scale (Σbi)			0.92	

Note: Figures in parentheses indicate standard error of respective regression co-efficients
* and ** indicate significance of values at P=0.05 and 0.01, respectively
MVP= Marginal Value Product; MFC=Marginal Factor Cost

of production simultaneously would result in an average increase of gross returns by 1.15 per cent. Co-efficient of multiple determination (R^2) implied that 97 per cent of total variation in gross returns was explained by the variables included in the model. The analysis of marginal value products of various inputs indicated that it was negative for human labour (-0.81), bullock labour (-0.36) and fertilizer (-0.93), which was due to over use of these inputs. Plant protection chemical showed the highest marginal value product followed by farm yard manure (8.47), machine labour (0.69) and seeds (0.52). By optimum utilization of these resources, the profits can be increased.

Chilli :

The output elasticity co-efficients for plant protection chemicals and bullock labour were negative and found to be significant (Table 5). This showed that increase in the use of these inputs would result in decreasing in efficiency of chilli production, contributing significantly towards gross returns. Seed and human labour were negative and non-significant indicating that they were over utilized. Elasticity co-efficients of FYM, fertilizers and machine labour were positive and non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. The sum of elasticity co-efficients with 1.18 showed increasing returns to scale. The increasing returns to scale indicated that a one per cent increase in all the factors of production simultaneously would result in an average increase of gross returns by 1.18 per cent. Co-efficient of multiple determination (R^2) implied that 93 per cent of total variation in gross returns was explained by these inputs included in the model Nagaraj *et al.* (1998). Seeds, plant protection chemicals, machine labour and bullock labour were over utilized in the production of chilli where as FYM, fertilizer and human labour were underutilized. By optimum utilization of these resources the profits can be increased.

Maize :

Elasticity co-efficient of bullock labour was negative and significant (Table 6). This showed that increase in the use of this inputs would result in decreasing in efficiency of maize production, contributing significantly towards gross returns. Elasticity co-efficient of seed, FYM, fertilizer and machine labour were positive and non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. The sum of elasticity co-efficients with 0.91 showed decreasing returns to scale. The decreasing returns to scale indicated that a one per cent increase in all the factors of production simultaneously would result in an average increase of gross returns by 0.91 per cent. The value of co-efficient of multiple determination (R^2) was 0.95 which implied that 95 per cent of total variation in gross returns was explained by the variables included in the model. These results are according to results obtained by Sharma and Kachroo (2009). The results showed that the MVP to MFC ratios for seeds, FYM and machine labour were more than one indicating that still there is scope to use these inputs and increase the gross returns of maize production. On the other hand, the MVP to MFC ratios for human labour and bullock labour were less than one and negative, indicating the expenditure on this input was more than the optimum level, Senthil kumar and Alagumani(2005).

Conclusion :

Resource use efficiency analysis for the major crops of Dharwad district revealed that farmers were using seed rate more than the recommendation which unnecessarily adds to the total cost of production. Farmers using fertilizers and FYM less than the recommendation leads to low nutrients availability to the crops. So creating awareness is among the farmers to use the inputs as per recommendation which leads to decrease in cost of cultivation and increase in output levels. Farmers were using the FYM, 50 per cent less than that of the recommended. So farmers must be encouraged to rare the livestock's which gives supplementary income and FYM, which reduces the cost on fertilizers and fertility of the soil can be maintained.

Authors' affiliations :

S.M. MUNDINAMANI, Department of Agricultural Economics, College of Agriculture, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA
Email: smundinamani@rediffmail.com

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