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Resource Use Efficiency in Farming Systems in North *Konkan* Coastal Zone Region of Maharashtra

S.C. Phuge[1]*, A.C. Deorukhakar[2], A.V. Meshram[3], V.A. Thorat[2], J.S. Dhekale[2] and S.S. Wadkar[2]

[1]Department of Agril. Economics, Lokmangal College of Agriculture, Wadala, Solapur, [3]Department of Agril. Economics, College of Agriculture, Konghara, Yevatmal, [2]Department of Agricultural Economics, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, India

*Corresponding author

ABSTRACT

The study was conducted to estimate resource use efficiency in major farming systems in North Konkan coastal zone region of Maharashtra. For this study 251 farmers from Palghar, Thane and Raigad district were selected. The analysis revealed that, the source use efficiency in crop based farming systems indicated that, human labour, fertilizers and plant protection chemicals were positive and influencing factors on production. The sum of regression coefficients indicated decreasing returns to scale. In horticulture based farming systems the results of resource use efficiency indicated that, human labour, fertilizers and irrigation were positive and influencing factors on production. The sum of regression coefficients indicated decreasing returns to scale. The results of resource use efficiency in livestock based farming systems indicated that, human labour, irrigation and veterinary aid were positive and influencing factors on production. The sum of regression coefficients indicated constant returns to scale. It is indicated that, there is great scope for reallocation or rearrangement of the existing resources and also it is possible to increase the net income supported by proper allocation at increased resource level and adoption of package of practices with recommended technology.

Keywords

Resource use efficiency, Farming enterprises etc.

Introduction

Agricultural productivity growth is important for food security. So long, this has attracted considerable attention of policy makers and academicians were concentrated on poverty, hunger and mall nutrition. United Nations initiated Sustainable Development Goals program, is global call to acts towards ending poverty, hunger and mall nutrition and bringing peace and prosperity to all by 2030. (Chandrashekhara Rao *et al.*, 2018). As the major policy response to SDG, Government has announced ‘Doubling of farm income’ by 2020. Expansion of irrigation, market reforms for better prices and diversification of income sources is important for doubling farmers income.

In this context resource use efficiency plays important role in achieving maximum yield and returns. Resource use efficiency includes the concepts of technical efficiency, allocative efficiency and environmental efficiency. An efficient farmer allocates his limited resources in the form of land, labour, water and other resources in an optimal manner. However, past studies showed that farmers often use their resources sub optimally. The natural resource base of the country is being eroded by modern methods of farming must be protected from irreversible degradation. In this context adoption of appropriate farming system deserves special emphases. It is a holistic approach advocating enterprise diversification. Farming system refers to crop combination or enterprises mix in which the products and or the by-product of one enterprise are used as inputs for the production of other enterprises (Maji, 1991). The present paper attempts to examine the prevailing farming systems in the north *Konkan* coastal zone of Maharashtra for their resource use efficiency.

Materials and Methods

For the present study three districts namely Palghar, Thane and Raigad were selected purposively. From each district three tehsils were selected by dividing each district into three zones *viz.* East, central and west. From each tehsil three villages and from each village ten farmers were selected randomly. Thus data were collected from 270 growers. The data was collected by survey method through personal interviews from the farmers, with the help of pre-tested comprehensive schedule specially designed for the purpose.

Identification of farming system

Farming systems were identified on the basis of gross income obtained, by the farmer. The farming systems in the study area were classified as crop base, horticulture base and livestock base. The crop based farming system, consist of the farmers where major income was derived from agronomical crops *viz.* paddy, others cereals and pulses etc. was considered. In case horticulture base farming system major income derived from horticultural crops *viz.* vegetables, orchards and flowers crops etc. was considered. In livestock base farming system major income derived from livestock rearing *viz.* dairy, poultry and goats etc. was considered.

Production function analysis

Production function technique was used to examine the effect of different factors *viz*. human labour, bullock labour, machine charges, seed, manure (FYM), fertilizers, irrigation charges, plant protection chemicals (PPC), on crop production. Cobb-Douglas type of production function of the following form was fitted to the data.

Resource use efficiency

To calculate resource use efficiency in different farming systems it was observed that there were potential yield, resources and price received. Therefore crop equivalent yields were obtained and the returns received from all the crops were converted in to only one crop or animal head.

In case of Crop based farming systems (CFS) as regards resources required for growing different crops and livestock enterprises were also estimated to rice equivalent yield. As regards resources required for growing different crops in Horticulture based farming systems (HFS) were also estimated to *rabi* ridge gourd equivalent yield. In case of Livestock based farming systems (LFS) as regards resources required for growing different crops were also estimated to the one head of milch animal equivalent yield.

Rice Equivalent Yield (REY)

Yield comparison between existing cropping pattern and improved cropping pattern was by performed computing rice equivalent yield outcome from other crop yield into rice yield by prevailing market price of individual crops (Verma and Modgal, 1983). Rice equivalent yield (REY) was computed as yield of individual crop multiplied by market price of that crop divided by market price of rice (Verma and Modgal, 1983)

$$\text{Rice Equivalent Yield (t ha)} = \frac{\text{(Yield of individual crop X Market price of that crop)}}{\text{Market price of rice}}$$

(Hossain *et al*.,2016)

Crops enterprises

$$Y = a.\ x_1^{b1}\ x_2^{b2} x_3^{b3}\ x_4^{b4}\ x_5^{b5} x_6^{b6} x_7^{b7} x_8^{b8}.u$$

Where,
Y = Yield (q/ha)
x_1 = Human labour (Rs./ha.)
x_2 = Bullock labour (Rs./ha.)
x_3 = Machine charges (Rs./ha.)
x_4 = Seed (Rs./ha.)
x_5 = Manure (Rs./ha.)
x_6 = Fertilizers (Rs./ha.)
x_7= Irrigation(Rs./ha.)
x_8 = Plant protection chemicals (Rs./ha.)
u = Random error term
a = Intercept
b1, b2, b3 ……. b8 = Regression coefficient or production elasticity.

Livestock enterprises

Production function technique was used to examine the effect of different factors namely dry fodder, green fodder, concentrates, human labour, veterinary expenditure, etc. on income. Cobb-Douglas type of production function of the following form was fitted to the data.

$$Y_2 = a.\ x_1^{b1}\ x_2^{b2} x_3^{b3}\ x_4^{b4}\ x_5^{b\,5}.\ u$$

Where,
Y_2 = Total income (Rs./animal)
x_1 = Human labour (Rs./animal)
x_2 = Dry fodder (Rs./animal)
x_3 = Feed (Rs./animal)
x_4 = Veterinary expenditure (Rs./animal)
x_5 = Green fodder (Rs./animal)
u = Random error term
a = Intercept
b1, b2, b3 ……. b5 = Regression coefficients or production elasticity

Estimation of marginal physical product

Marginal product of respective farm inputs was calculated by taking first order partial derivatives of output Y with respect to concern input appearing in estimated production function.

$$Y= ax_1^{b1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{6}x_7^{b7}e^{u}$$

$$\frac{dy}{dx} = ab_1x_1^{b1-1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}x_6^{6}x_7^{b7}e^{u}$$

$$\frac{\bar{Y}}{\bar{X}} b_i$$

Where,
b_i= Production elasticity of X_i
$\bar{Y}$ = Geometric mean of Y_i
$\bar{X}$ = Geometric mean of X_i

Estimation of marginal value product

1. Marginal value product (MVP)
   MVP = MPP × Price per unit of output
2. Marginal cost
   MC = Price per unit of input
3. Input use efficiency

I. MVP/FC = 1 Optimum use of input
II. MVP/FC < 1 *Excess utilization of input*
III. MVP/FC > 1 *Underutilization of input*

These forms of the Cobb-Douglas type of production functions were used in general for assessing resource use efficiency of crops as well as other enterprises followed in major farming systems. However, only those inputs were used for particular enterprise was retained in particular function. Inputs which were not used by majority of farmers in particular enterprise were removed from the production function model fitted to the data.

Allocative efficiency

The ratio of the MVP to MFC of individual resources was used to judge the allocative efficiencies. The computed Marginal Value Product (MVP) will compared with the Marginal Factor Cost (MFC) or opportunity cost of the resource to draw inferences. A resource is said to be optimally allocated when its MVP = MFC. The marginal value products (MVP's) will be calculated using the geometric mean levels of the variables using the formula.

$$\text{MVP of xi th resource} = bi\,\frac{\bar{Y}}{\bar{X_i}}$$

Where,

$\bar{y}$ = geometric mean of gross returns in different farming systems

$\bar{x_i}$ = geometric mean of i^{th} independent variable

bi = regression coefficient or elasticity of production i^{th} independent variable

Results and Discussions

Resource use efficiency in major farming systems

Resource use efficiency of various crop as well as other (non-crop farm enterprises) was studied in different farming systems followed by farmers in study area. A Cobb-Douglas of type production function was fitted to data to study the resource productivity and allocative efficiency in farming systems, by comparing marginal value product (MVP) and marginal factor cost (MFC) or opportunity cost of respective resources. The results are presented from Table 1 to Table 3.

Resource use efficiency in Crop Based Farming Systems (CFS)

The efficiency in the use and allocation of resources for crop based farming system are presented separately for different farming systems in Table 1.

It could be observed from Table 1 that, the Cobb-Douglas production function used to study the resource use efficiency was found to be good fit to the data. To study the resource use efficiency in the crop based farming system, monetary values of the independent such as human labour, bullock labour, machine charges, seeds, manures, fertilizers, Irrigation charges, plant protection chemicals, dry fodder, feed, veterinary aid and green fodder were included in production function.

The production function estimates are presented in Table 1. It was observed from table that, the coefficient of multiple determination (R^2) was 0.8359, indicating 84 per cent of variation in dependent variables was explained by independent variables included in the function. Similar observation were also recorded by Nikam (2006) and Pawar (2006)

It was observed that, human labour, fertilizers, and plant protection chemicals were found to be positively influencing inputs on income. The regression coefficients of these inputs were 0.27, 0.37 and 0.08, respectively. The human labour and fertilizer were significant at 1 per cent while plant protection chemicals were significant at 5 per cent level. The influence of other variables was not significant. MVP to MFC ratio in case of human labour, fertilizers, irrigation, plant protection and green fodder were higher than unity. Sum of output elasticity was 0.91 indicating decreasing returns to scale.

Resource use efficiency in horticulture based farming systems

The efficiency in the use and allocation of resources for horticulture based farming system are presented separately for different farming systems in Table 2.

It could be observed from Table 2 that, the Cobb-Douglas production function used to study the resource use efficiency was found to be good fit to the data. To study the resource use efficiency in the crop based farming system, monetary values of the independent such as human labour, bullock labour, machine charges, seeds, manures, fertilizers, Irrigation charges, plant protection chemicals, dry fodder, feed, veterinary aid and green fodder were included in production function.

The production function estimates are presented in Table 2. It was observed from table that, the coefficient of multiple determination (R^2) was 0.6039, indicating 60 per cent of variation in dependent variables was explained by independent variables included in the function. Similar observation were also recorded by Nikam (2006) and Pawar (2006)

It was observed that, human labour, fertilizers, and irrigation were found to be positively influencing inputs on income. The regression coefficients of these inputs were 0.33, 0.45 and 0.26, respectively.

The human labour, fertilizer and irrigation were significant at 1 per cent level. The influence of other variables was not significant. MVP to MFC ratio in case of human labour, fertilizers, irrigation, feed and veterinary were higher than unity. Sum of output elasticity was 0.77 indicating decreasing returns to scale.

Resource use efficiency in livestock based farming systems

The efficiency in the use and allocation of resources for livestock based farming system are presented separately for different farming systems in Table 3.

It could be observed from Table 3 that, the Cobb-Douglas production function used to study the resource use efficiency was found to be good fit to the data. To study the resource use efficiency in the crop based farming system, monetary values of the independent such as human labour, bullock labour, machine charges, seeds, manures, fertilizers, Irrigation charges, plant protection chemicals, dry fodder, feed, veterinary aid and green fodder were included in production function.

The production function estimates are presented in Table 3. It was observed from table that, the coefficient of multiple determination (R^2) was 0.6606, indicating 66 per cent of variation in dependent variables was explained by independent variables included in the function.

It was observed that, human labour, irrigation and veterinary aid were found to be positively influencing inputs on income. The regression coefficients of these inputs were 0.28, 0.48 and 0.15 respectively. The irrigation was significant at 1 per cent while human labour and veterinary aid were significant at 5 per cent level. The influence of other variables was not significant. MVP to MFC ratio in case of human labour, seed, manures, fertilizers, irrigation and veterinary were higher than unity. Sum of output elasticity was 1.02 indicating increasing returns to scale.

In conclusions, the Cobb-Douglas production function analysis in different farming systems has shown that more than 60 per cent variation in gross returns were contributed by input resources. The results of resource use efficiency in crop based farming system indicated that, human labour, fertilizers and plant protection chemicals were positive and influencing factors on production. The sum of regression coefficients indicated decreasing returns to scale. In horticulture based farming system the results of resource use efficiency indicated that, human labour, fertilizers and irrigation were positive and influencing factors on production. The sum of regression coefficients indicated decreasing returns to scale. The results of resource use efficiency in livestock based farming system indicated that, human labour, irrigation and veterinary aid were positive and influencing factors on production. The sum of regression coefficients indicated constant returns to scale.

Table.1 Production function estimates for crops based farming systems

Sr. No.	Input variables	Coefficients	MVP/ MFC	Resource use efficiency
1.	Constant (Intercept)	7.0980	----	----
2.	Human labour in Rs.	0.2710** (0.0615)	1.39	Under Utilized
3.	Bullock labour in Rs.	0.0612 (0.0799)	0.17	Excess Utilized
4.	Machine charges in Rs.	0.0414 (0.0397)	0.11	Excess Utilized
5.	Seed in Rs.	-0.0145 (0.0528)	-0.18	Excess Utilized
6.	Manure in Rs.	-0.1245 (0.0847)	-0.14	Excess Utilized
7.	Fertilizers in Rs.	0.3683** (0.0697)	47.19	Under Utilized
8.	Irrigation in Rs.	0.0229 (0.0206)	2.52	Under Utilized
9.	Plant Protection in Rs.	0.0791* (0.0339)	1.55	Under Utilized
10.	Dry fodder in Rs.	-0.4153 (0.3873)	-208.00	Excess Utilized
11.	Feed in Rs.	-0.0509 (0.0101)	-0.31	Excess Utilized
12.	Veterinary aid in Rs.	0.6665 (0.6135)	407.59	Under Utilized
13.	Green fodder in Rs.	----	----	----
	Returns to scale	0.9053		
	No. of observations	106		
	R Square	0.8359		

(Figures in the parentheses indicate standard errors of respective variable)
**, * significant at 1%, and 5% levels of probability, respectively

Table.2 Production function estimates for horticulture based farming systems

Sr. No.	Input variables	Coefficients	MVP/ MFC	Resource use efficiency
1.	Constant (Intercept)	7.0980	----	----
2.	Human labour in Rs.	0.3306** (0.0967)	4.56	Under Utilized
3.	Bullock labour in Rs.	0.0172 (0.0679)	0.13	Excess Utilized
4.	Machine charges in Rs.	0.0672 (0.0482)	0.43	Excess Utilized
5.	Seed in Rs.	0.0176 (0.0612)	0.002	Excess Utilized
6.	Manures in Rs.	0.1341 (0.0811)	0.31	Excess Utilized
7.	Fertilizers in Rs.	0.4470** (0.1100)	169.26	Under Utilized
8.	Irrigation in Rs.	0.2633** (0.0990)	2.50	Under Utilized
9.	Plant Protection in Rs.	-0.2492 (0.1041)	-1.52	Excess Utilized
10.	Dry fodder in Rs.	-1.1291 (0.7156)	-1722.8	Excess Utilized
11.	Feed in Rs.	0.8006 (0.5329)	164.18	Under Utilized
12.	Veterinary aid in Rs.	0.0680 (0.0921)	66.80	Under Utilized
13.	Green fodder in Rs.	----	----	----
	Returns to scale	0.7675		
	No. of observations	80		
	R Square	0.6039		

(Figures in the parentheses indicate standard errors of respective variable)
**, * significant at 1%, and 5% levels of probability, respectively

Table.3 Production function estimates for livestock based farming systems

Sr. No.	Input variables	Coefficients	MVP/MFC	Resource use efficiency
1.	Constant (Intercept)	2.6127	----	----
2.	Human labour in Rs.	0.2815* (0.1341)	78.99	Under Utilized
3.	Bullock labour in Rs.	-0.0290 (0.1139)	-4.30	Excess Utilized
4.	Machine charges in Rs.	-0.0594 (0.0446)	-11.73	Excess Utilized
5.	Seed in Rs.	0.0245 (0.1096)	26.60	Under Utilized
6.	Manures in Rs.	0.1468 (0.1038)	11.80	Under Utilized
7.	Fertilizers in Rs.	0.0867 (0.0551)	774.73	Under Utilized
8.	Irrigation in Rs.	0.4791** (0.1336)	86.17	Under Utilized
9.	Plant Protection in Rs.	-0.0035 (0.0725)	-6.03	Excess Utilized
10.	Dry fodder in Rs.	-0.0420 (0.0485)	-33.48	Excess Utilized
11.	Feed in Rs.	0.0010 (0.0350)	0.05	Excess Utilized
12.	Veterinary aid in Rs.	0.1460* (0.0715)	35.33	Under Utilized
13.	Green fodder in Rs.	-0.0076 (0.0214)	-16.89	Excess Utilized
	Returns to scale	1.02		
	No. of observations	65		
	R Square	0.6606		

(Figures in the parentheses indicate standard errors of respective variable)
**, *, significant at 1%, and 5% levels of probability, respectively

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