International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 2358-2362

Received: 04-07-2019
Accepted: 06-08-2019

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Resource use efficiency of major rabi crops in Belagavi district of Karnataka

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Abstract
Agriculture in India is one of the most important primary sectors of its economy. Though, the proportion of Indian agriculture domestic the GDP has been steadily declining over the years. Main cause for deceleration in agricultural increase is declining investment in agriculture research and improvement and irrigation, inefficiency of rural credit score and extension. One greater the maximum vital component is; inefficient use of assets is the purpose for declined boom of agriculture quarter. So the existing examine become below taken in Belagavi district to analyse the useful resource use efficiency of principal rabi crops. Major plants grown in the district consisting of wheat, jowar, chickpea and sunflower 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 the farmers were using human labour, plant protection chemicals and irrigation more than the recommendation which unnecessarily adds to the total cost of production. Farmers using seeds, fertilizers and FYM less than the recommendation leads to low nutrients availability to the crops. Farmers were using the FYM 50 per cent less than that of the recommended. The sum of elasticity coefficients with 0.27, -0.03 and 0.29 for wheat, jowar and chickpea respectively, showed decreasing returns to scale. While, sunflower crop shows increasing returns to scale *i.e.* 1.11. The value of coefficient of multiple determination (R2) were 0.86, 0.95, 0.81 and 0.90 for wheat, jowar, chickpea and sunflower respectively.

Keywords: Resource use efficiency, coefficient of determination, returns to scale, marginal value product and marginal factor cost

Introduction
Agriculture in India remains the most important primary sectors of the economy. Agriculture accounting for 13.45 per cent of Indian GDP during 2018. However, its proportion has been steadily declining over the years. Main purpose for deceleration in agricultural increase is declining investment mainly public funding in agricultural studies and development, irrigation mixed with inefficiency of institutions that provide inputs and offerings including rural credit and extension and post-harvest losses of food grains at 10 per cent of the overall production. Other factors together with land fragmentation, current tenancy laws, lack of contemporary market place, rural infrastructure and irrelevant input pricing policies, and so on. had been responsible for agrarian and ecological crisis within the united states. The crux of the problem in agricultural production now's to growth the output in step with unit of enters applied in agricultural production.

The cost of cultivation is an important financial indicator being taken into consideration for framing the economic regulations with the aid of Government of India. Cost of cultivation of a commodity is the full expenditure incurred on various inputs which might be utilized in the production of the commodity. Traditionally agriculture turned into performed with the aid of the conventional practices, the use of farm produced inputs. But modern-day agriculture is characterized with the aid of new practices and current implements and machinery that require huge parched inputs. Till 1970's, there was less use of parched inputs in cultivation of plants. Indigenous sorts of seeds had been used which had been purchased from the market place. It turned into after 1970 with the advent of green revolution, agriculture practices became greater capital intensive and pricey due to usage of all inputs crucial for the increase of agricultural production in India. The cumulative impact of the input intensive technology and the domestic reforms in agriculture has been visible in the shape of an boom inside the value of cultivation of plants. The withdrawal, of subsidies from important spheres and multinationals participation to manufacture and distribute inputs has in addition multiplied enlargement of the farming community. The ploughing, coaching for seed bed, irrigation, intake of seed, hoeing and weeding, fertilizer, pesticides and pesticides were the major input prices that have affected the income of the farmers. These huge costs on inputs and different overhead charges have adversely affected the earnings of the farmers.

The Kharif crop is the summer crop or monsoon crop in India. Kharif crops are usually sown with the beginning of the first rains in July, The Rabi crop is the spring harvest or winter crop in India. It is sown in October last and harvested in March April every year. Major Rabi crops in India include Wheat, Barley, Mustard, Sesame, Peas etc.

Rice is predominantly a Kharif or crop. It covers one third of total cultivated area of India. It provides food to more than half of the Indian population. Rice is produced in almost all states. Top three producer states are West Bengal, Punjab and Uttar Pradesh. Other rice growing states include Tamilnadu, Andhra Pradesh, Bihar, Jharkhand, Uttarakhand, Chhattisgarh, Odisha, Uttar Pradesh, Karnataka, Assam and Maharashtra. It is also grown in Haryana, Madhya Pradesh, Kerala, Gujarat and Kashmir Valley.

Wheat is the second most important crop of India after Rice. It's a Rabi Crop. It is the staple food in north and north western India. It is the staple food in north and north western India. It's a winter crop and needs low temperature. Ideal temperature for wheat cultivation is between 10-15 °C at the time of sowing and 21-26 °C at the time of harvesting. Wheat thrives well in less than 100 cm and more than 75 cm rainfall. The most suitable soil for cultivation of wheat is well drained fertile loamy soil and clayey soil. Plain areas are most suitable. The wheat crop is highly mechanization oriented and may need less labour. Top three states producing Wheat are Uttar Pradesh, Punjab and Haryana.

Coarse Cereals and Millets are the short duration warm weather (Kharif) crops used both as food and fodder. Important millets are Jawar, Bajra, Ragi etc. The areas under these crops have fallen drastically in recent years in India. The coarse cereals and millets are grown in areas with high temperature and are called dryland crops because can be grown in areas with 50-100 cm rainfall. The coarse cereal crops are less sensitive to soil deficiencies. They can be grown in inferior alluvial or loamy soil. Top three states with maximum production of total coarse cereals are Maharashtra, Karnataka, and Rajasthan.

Maize, being an American crop, is a relatively new entrant and is gaining popularity because of its high yields and its easy adaptability to various soils and climatic conditions. It is rich in protein and requires moderate rainfall.

Sugarcane belongs to bamboo family of plants and is indigenous to South Asia. In India, it is one of the most important Kharif crops. India is known as the original land of sugarcane. It is sown before kharif season and harvested in winter. It requires about 100 cm of rain. Many new varieties of sugar such as gur and khandsari are produced from sugarcane.

India is one of the leading producers of oilseeds in the world. They are the main source of edible oils. Some of them are used for preparing paints, varnishes, perfumes, medicines, soap etc.

The main oilseeds are groundnut (kharif crop in peninsular India), rapeseed and mustard (*rabi* crops in wheat belt). Other oilseeds are seasamum (Orissa, Rajasthan, West Bengal, Tamil Nadu, Maharashtra), Linseed (Madhya Pradesh, Uttar Pradesh and Maharashtra), Castor-seed (Gujarat) and Cotton Seed (Gujarat, Maharashtra and Punjab).

Groundnut is most important oil seeds of India. Grown as both as kharif and Rabi crop but 90-95 per cent of the total area is devoted to kharif crop. Groundnut thrives best in the tropical climate and requires 20 °C to 30 °C temperature. 50-75 cm rainfall is favourable for groundnut cultivation. Ground nit accounts for half of the major oilseeds produced in India. India is the second largest producer of groundnut (After China). Top three states producing ground nut are Gujarat, Andhra Pradesh and Tamil Nadu.

Resource use efficiency in agriculture plays an important role in determining the farm production income. Manures and fertilizers, irrigation facilities, manpower, seeds, bullock labour, hired human labour, working capital, farm implements and machinery and crop protection measures are the major crucial inputs in agriculture. The size of farm income depends on the efficiency with which farmers are able to utilize these resources. With higher efficiency in the use of scare resources, farmers can augment their income and savings. This study is aimed at exploring the profitability of crops in Karnataka in general and in Belagavi district of Karnataka in particular through estimation of the extent of resource use allocation and efficiency as reflected by production function analysis.

Material and Methods

The study was conducted in Belagavi district. Multistage random sampling technique was used for the selection of sample farmers. In the first stage, Belagavi district was purposively selected. In the second stage, all the 2 taluks were involved in order to study the cost of cultivation of major crops of the district. In the third stage, from each taluk, two villages were selected based on highest area under cultivation of the selected crops. At the final stage, 15 farmers from each village were selected making the total sample size to 60 farmers. The sample farmers were interviewed personally with help of pre-tested schedule and tabular analysis method was used to work out the resource use efficiency of major crops in Belagavi district.

Analytical tools

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

The model specified was as follows

$$Y = a\, X_1^{bl} X_2^{b2} X_3^{b3} X_4^{b4} X_5^{b5} X_6^{b6} X_7^{b7} eu \qquad \ldots(1)$$

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

$$\text{Log } Y = \text{Log } a + b1 \log x1 + b2 \log x2 + b3 \log x3 + b4 \log x4 + b5 \log x5 + b6 \log x6 + b7\log x7 + u \log e \qquad .....(2)$$

Where,

Y = Gross returns in Rs.

Where, Yt = Output (Gross returns),

a = Constant

u = Random variable

e = Error term

bi= elasticity coefficient of i^{th} input and X1 to X7 are independent variables

The independent variables [inputs] included were seeds (Kg.), human labour (mandays), bullock labour (pair days), machine labour (hour), fertilizers (Kg.), FYM (tons), PPC (litters) and irrigation cost (Rs.). In the case of jowar [6 variables] *viz*, seeds (Kg.), human labour (Mandays), bullock labour (pair days), machine labour (hour), fertilizers (Kg.), FYM (tons) and irrigation cost (Rs.), plant protection chemicals for jowar is not used by the sample farmers in the stud area.
The regression co-efficients (bi) were tested for the significance using 't' test:

$$t = \frac{bi}{\text{Standard error of bi}} \qquad -(3)$$

The co-efficient of multiple determination (R2) was also worked out to test the goodness of fit of the model. While calculating resource use efficiency for jowar, the variable input plant protection chemicals were not applied by the sample farmers.

Results and Discussion

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 *rabi* 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 and irrigation as independent variables in wheat, jowar, chickpea and sunflower 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 coefficients 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).

Wheat

The output elasticity coefficients for seed, machine labour and plant protection chemicals were negative and found to be significant (Table 2). This showed that thus there is need to reduce the expenditure on these inputs would contribute significantly towards gross returns. Elasticity co-efficient for bullock labour and fertilizer were positive but non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. Elasticity coefficient for human labour and irrigation charges was positive and significant hence there is need to increase the use of these resource. The sum of elasticity coefficients with 0.27 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 0.27 per cent. These results are in line with results obtained from Reddy *et al*. (2004). The value of coefficient of multiple determinations (R2) was 0.86 which implied that 86 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 seed (-1.73), machine labour (-9.52) and PPC (-0.35) which was due to over use of this inputs. Irrigation charges (32.13) showed the highest marginal value product followed by FYM (24.77), fertilizer (2.47) and human labour (1.34). Thus, there is scope to increase area under wheat production in combination with increased use of these inputs.

Jowar

The output elasticity coefficient for seed was 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 iowar production, contributing significantly towards gross returns. To further increase Elasticity coefficient of irrigation charges was positive but non-significant. Hence, it would not be profitable in the expenses on these resources. Human labour and machine labour, fertilizer and PPC were negative and significant indicating that they are over-used. These results are in line with results obtained from Jaiswal and Hugar (2011) [6]. The sum of elasticity coefficients was -0.03 showed decreasing returns to scale. The decreasing returns to scale indicated that a one per cent decrease in all the factors of production simultaneously would result in an average decrease of gross returns by -0.03 per cent. The analysis of marginal value products of various inputs indicated that it was negative for seed (-0.75), human labour (-0.95), machine labour (-5.93) and fertilizer (-1.36) which was due to over use of this inputs. PPC (32.72) showed the highest marginal value product. Thus, there is scope to increase area under jowar production in combination with increased use of these inputs.

Chickpea

The output elasticity coefficient for fertilizer was negative and found to be significant (Table 4). This showed that increase in the use of this inputs would result in decreasing in efficiency of chickpea production, contributing significantly towards gross returns. Machine labour and PPC was negative and nonsignificant indicating that they were over utilized. Elasticity coefficients of seed, human labour were positive and non-significant. Hence, it would not be profitable to further increase in the expenses on these resources. The output elasticity coefficients for bullock labour, FYM and irrigation were positive and found to be significant. This showed that increase in the use of these inputs would result in increase in efficiency of chickpea production, contributing significantly towards gross returns. The analysis of marginal value products of various inputs indicated that it was negative for fertilizer (-12.90), machine labour (-0.62) and irrigation (-0.88). FYM (100.67) showed the highest marginal value product followed by irrigation costs (26.61) and bullock labour (2.72). Thus, there is scope to increase area under chickpea production in combination with increased use of these inputs.

Sunflower

The output elasticity coefficients for human labour, bullock labour and FYM were positive and found to be significant (Table 5). This showed that increase in the use of these inputs would result in increase in efficiency of sunflower production, contributing significantly towards gross returns. Elasticity coefficients of seed, machine labour, fertilizers and PPC were positive but non-significant. Hence, it would not be profitable in the expenses on these resources. Irrigation charges were negative and significant indicating that they are over-used. The sum of elasticity coefficients was 1.11 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 decrease of gross returns by 1.11 per cent. The analysis of marginal value products of various inputs indicated that it was negative for irrigation charge (-10.32) which was due to over use of this inputs. Bullock labour (17.28) showed the highest marginal value product followed by FYM (6.80), PPC (1.30) and seeds (1.18). Thus, there is scope to increase area under sunflower production in combination with increased use of these inputs.

Table 1: Input utilization pattern of the major identified rabi crops in Belagavi district of Karnataka (ha)

Sl. No	Particulars	Units	Wheat	Jowar	Chickpea	Sunflower
1	Seed	Kg	60.85	10.58	80.45	6.12
2	Human labour	Mandays	47.58	19.61	32.77	32.45
3	Bullock labour	Bullock pair	4.77	7.04	4.43	5.67
4	Machine labour	Hour	2.89	2.46	3.39	1.51
5	Fertiliser	Kg	78.89	36.45	27.89	28.65
6	Manure	Tonnes	1.56	0.56	0.15	0.98
7	PPC	Litter	1.78	0.00	2.94	1.44
8	Irrigation charges	Rs.	757	561.32	642	504

Table 2: Resource use efficiency of wheat in Belagavi district (Per ha)

Sl. No.	Explanatory variables	Parameters	Regression coefficient	Standard Error	MVP/MFC ratio
1	Intercept	a	8.83	0.386092	
2	Seeds (Rs)	b_1	-0.09	0.057508	-1.74
3	Human labour (Rs)	b_2	0.34*	0.135652	1.34
4	Bullock labour (Rs)	b_3	0.01	0.014209	0.01
5	Machine labour (Rs)	b_4	-0.54**	0.101718	-9.52
6	Fertilizers (Rs)	b_5	0.22	0.189	2.47
7	FYM (Rs)	b_6	0.08*	0.060	24.77
8	PPC (Rs)	b_7	-0.01	0.021147	-0.35
9	Irrigation charge (Rs)	b_8	0.28**	0.035365	32.13
10	Coefficient of multiple determination	R^2	0.86		
11	Returns to Scale	Σb_i	0.27		

Note: Figures in the parentheses indicates their respective standard errors
**- Significant at one per cent probability level,
*- Significant at five per cent probability level

Table 3: Resource use efficiency of jowar in Belagavi district (Per ha)

Sl. No.	Explanatory variables	Parameters	Regression coefficient	Standard Error	MVP/MFC ratio
1	Intercept	a	13.46	1.385	32.72
2	Seeds (Rs)	b_1	0.41**	0.072	-0.75
3	Human labour (Rs)	b_2	-0.12**	0.045	-0.95
4	Bullock labour (Rs)	b_3	-0.07	0.090	-4.51
5	Machine labour (Rs)	b_4	-0.29**	0.083	-5.93
6	Fertilizers (Rs)	b_5	-0.22*	0.087	-1.36
7	PPC (Rs)	b_7	-0.02*	0.097	32.72
8	Irrigation charge (Rs)	b_8	13.46	1.385	-0.75
9	Coefficient of multiple determination	R^2	0.95		
10	Returns to Scale	Σb_i	-0.03		

Note: Figures in the parentheses indicates their respective standard errors
**- Significant at one per cent probability level
*- Significant at five per cent probability level

Table 4: Resource use efficiency of chickpea in Belagavi district (Per ha)

Sl. No.	Explanatory variables	Parameters	Regression coefficient	Standard Error	MVP/MFC ratio
1	Intercept	a	8.74	1.109	
2	Seeds (Rs)	b_1	0.06	0.030	0.63
3	Human labour (Rs)	b_2	0.05	0.085	0.21
4	Bullock labour (Rs)	b_3	0.11**	0.051	2.72
5	Machine labour (Rs)	b_4	-0.05	0.088	-0.62
6	Fertilizers (Rs)	b_5	-0.28*	0.284	-12.90
7	FYM (Rs)	b_6	0.06*	0.072	100.67
8	PPC (Rs)	b_7	-0.03	0.033	-0.88
9	Irrigation charge (Rs)	b_8	0.38**	0.080	26.61
10	Coefficient of multiple determination	R^2	0.81		
11	Returns to Scale	Σb_i	0.29		

Note: Figures in the parentheses indicates their respective standard errors
**- Significant at one per cent probability level,
*- Significant at five per cent probability level

Table 5: Resource use efficiency of sunflower in Belagavi district (Per ha)

Sl. No.	Explanatory variables	Parameters	Regression coefficient	Standard Error	MVP/MFC ratio
1	Intercept	a	2.03	0.713	
2	Seeds (Rs)	b_1	0.05	0.164	1.18
3	Human labour (Rs)	b_2	0.14*	0.065	0.56
4	Bullock labour (Rs)	b_3	0.98**	0.138	17.28
5	Machine labour (Rs)	b_4	0.01	0.025	0.28
6	Fertilizers (Rs)	b_5	0.02	0.024	0.79
7	FYM (Rs)	b_6	0.03*	0.029	6.80
8	PPC (Rs)	b_7	0.02	0.016	1.30
9	Irrigation charge (Rs)	b_8	-0.13**	0.039	-10.32
10	Coefficient of multiple determination	R^2	0.90		
11	Returns to Scale	Σb_i	1.11		

Note: Figures in the parentheses indicates their respective standard errors
**- Significant at one per cent probability level
*- Significant at five per cent probability level

Conclusions: Resource use efficiency analysis for the major rabi crops of Belagavi district revealed that resources are not optimally utilized in most of the crops, there is need for reallocation of the resources as the MVP to MFC ratio was more than one for most of the inputs. Farmers were using human labour, plant protection chemicals and irrigation more than the recommendation which unnecessarily adds to the total cost of production. Farmers using seeds, 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.

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