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Resource use efficiency in rice cultivation in Manipur

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ABSTRACT

The present attempt is to examine the variation in resource use efficiency of rice in the two regions, namely hill and valley regions of Manipur resulting differential yield, using Cobb-Douglas production function approach during 2014-15. It reveals that the value of summation of coefficients is 0.91 implying constant return to scale in case of farmers of valley region *whereas in case of hill region, the elasticities value is 0.65 indication decreasing return to scale.The ratios of marginal value products (MVP) to their respective marginal factor cost (MFC) discerns that there is overutilization of chemical fertilizers and seeds, and under utilization of plant chemical protection, machine labour and human labour in valley region whereas all the critical inputs taken into consideration are underutilised by the farmers of hill region excepting seeds which is to be reduced to optimise production of rice.*

***Keywords*:** Cobb-Douglas production function, elasticities, MVP, MFC, return to scale

Rice, the dominant cereal crop, constitutes about 86 per cent of the total food grains production of the Manipur. The state has produced 5.01 million tons of rice from an area of 2.24 million ha with an average productivity of 2237 kgha^{-1} in 2013-14which is marginallylower than all-India average (2424 kgha^{-1}), but higher than most of the neighbouring states. Though rice is extensively grown across the districts, there exists wide variation in yield between the two broad regions-hill region comprising five districts,namely, Senapati, Tamenglong, Churachandpur, Chandel and Ukhrul; and four districts namely, Imphal East, Imphal West, Thoubal and Bishnupur belong to the valley region.The average productivity of rice in valley region is recorded to be 2530 kg ha^{-1}whereas it is only 1586 kg ha^{-1}in hill region, *i.e.*, the yield of rice in hill region is 944 kg ha^{-1}lower compared to that of valley region. Even among the districts of the same region, wide gap in yield is very prominent. The difference between two districts of valley region with the highest (Thoubal) and lowest (Imphal East) level of yield is accounted to be 354 kg ha^{-1} whereas, in hill region, the same gap is found to be only 104 kg ha^{-1} (Ukhrul and Tamenglong respectively), *i.e.* the variation in productivity across the districts of valley region is greater than its counter parts in hill region. Apart from the differences in agro-climatic conditions and production techniques followed by the farmers impacting in productivity level of rice, there may have some variation in the efficiency of resource use which has resulted in differential yield of rice in two regions. As agricultural productivity depends on how factors are efficiently used in the production process which is indirectly determined by the technical knowledge of the farmers, there is enough scope of variation in productivity of crops due to variation in efficient management of critical inputs. Again, the ability to adopt new technology is affected by some characteristics of farmers such as age of the farmer, farm size, farming experience, managerial ability *etc.* along with some price and non-price factors which are external to farmers(Scandizzo and Savastano, 2010).The concept of efficiency has been widely applied in the field of agriculture by researchers and policy makers to analyse the farm business efficiency in the developing country. Farrel (1957) has identified three types of efficiency – technical, allocative and economic efficiency. Technical efficiency is the ability and willingness of an economic unit to produce the maximum possible output from a given combination of inputs and technologies regardless of demand and market price of inputs and outputs (Kahrajan and Vargunasingh, 1992). Allocative efficiency denotes the optimum allocation of scare resources between end users in order to produce that combination of goods and services that best accords with the pattern of consumers demand. A more precise definition of allocation efficiency is at an output level where the price of the goods produced equals to the marginal cost of production i.e. the optimum distribution is achieved when the marginal utility of the goods equals the marginal cost. A firm is said to be allocative efficient when production occurs at a point where the marginal value product equal to marginal factor cost. Economic efficiency is the capacity of a farm to produce a predetermined quantity of output at minimum cost for a

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given level of technology (Kopp and Diewort, 1982). The simultaneous achievement of both the technical and allocative efficiencies will lead the attainment of economic efficiency. So, the present study has been undertaken with the specific objective ofassessing the differences in efficient utilisation resources between two groups of rice farmers belonging to two different regions which may have some bearing on the differential growth in productivity of rice applying the concept of allocative efficiency.

MATERIALS AND METHODS

Source of data

The primary data related to the costs and returns structure of rice cultivation along with socio-economic information is collected on pre-tested schedule by adopting personal interview method from the selected respondents of the study area for the agricultural year 2014-15.

Sampling design

To study the difference in resource use efficiencies in the two broad region of the state, Imphal West and Churachandpur district from valley and hill region respectively are selected purposively.Thus, by adopting Simple Random Sampling Without Replacement Technique (SRSWOR),a total of 60 rice farmers, 30 each from purposively selected MayangLangjing and Phayeng villages of Lamsang sub division of Imphal West, and Matijang and Gangpichai villages of Churachandpur sub division of Churachandpur district respectively,are selected in order to gather information regarding the rice production

Analytical tools

Production function

Cobb-Douglas type of production function approach is used for studying the relationship between output and input variables because of its wide acceptability and theoretical fitness to agricultural data. The model specified for the present study is furnished below : $y = b_o x_i^{bi} e^u$

By taking logarithm on both sides, the power function is transformed into linear function as follows-

$$Iny = lnb_0 + b_1 lnx + b_2 lnx_2 + \dots\dots\dots\dots + b_n lnx_n + e^u$$

where; y = yield (Rs/ha), x_i = variable inputs expressed in Rs/ha (i = 1, 2, 3, ……, n), b_o = constant term, b_i = elasticity coefficients (i = 1, 2, 3, ……, n), and e^u = error term.

Resource-use efficiency

The estimated coefficients of the relevant independent variables are used to compute the marginal value products (MVP) and their corresponding marginal factor costs (MFC). The resources efficiency is examined by comparing the marginal value product of a given resource with the marginal factor cost(Rahman and Lawal 2003) as shown in the following equation:

r = MVP/MFC, here, r = Efficiency ratio, MVP denotesmarginal value product of a variable input and MFC indicates marginal factor cost (price per unit input).

The marginal value product of a particular resource represents the expected addition to the gross returns caused by an addition of one unit of that resource, while other inputs are held constant. The marginal value productivities (MVPs) of different resources are calculated by multiplying the marginal physical product of the i^{th} input by the unit price of the output. The most reliable and most useful estimate of MVP is obtained by taking resources (Xi) as well as gross return (Y) at their geometric means (Dhawan and Bansal 1977).

Since, all the variables of the regression model are measured in monetary value, the slope coefficient of those explanatory variables in the function represented the MVPs, is calculated by multiplying the production coefficient of given resources with the ratio of geometric mean (GM) of gross return to the GM of the given resources, that is,ln Y = ln a + bi ln Xi,

Therefore, $dY/dX_i = bi\,[Y/X_i]$ or, $MVP\,(X_i) = bi\,[Y(GM)/X_i\,(GM)]$ here, Y(GM) presents geometric mean value of gross return in rupees and Xi (GM) denotesgeometric mean value of the i^{th} variable input in rupees.

The MFCs of all the inputs will vary while calculating the ratio of MVP to MFC since MFC is the per unit price of input. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder *et al.*, 2009).

If the ratio of the MVP to MFC of input factor is unity, then the production input is said to be used efficiently according to the conventional neo-classical test of economic efficiency

Thus, a) if r <1, the resource is over utilized, b) if r > 1, the resource is underutilized, c) If r = 1,the resource is efficiently utilized.

The relative percentage change in MVP of each resource required so as to obtain optimal resource allocation that is, r = 1 or MVP = MFC, is estimated using the following equation:

$$D = (1 - MFC/MVP) \times 100 = (1 - 1/r) \times 100,$$

here, D indicates absolute value of percentage change in MVP of each resource (Mijindadi, 1980).

RESULTS AND DISCUSSION

The result of the Cobb-Douglas type of production function (Table 1) reveals that the values of co-efficients of plant protection chemicals, machine labour and human labour are positive and significant at 5 per cent, 10 per cent and 1per cent level respectively. It implies that one percent increase in the application of the factors will bring about 0.13, 0.43 and 0.62 per cent increase in production of rice in Imphal West district of valley region. Significant but negative value of co-efficient of seed indicates overutilization of the input. In case of Churachandpur district of hill region, the co-efficients of machine labour and human labour are positive and significant at 5 and 10 per cent level implying the opportunity of enhancing production though increased useof these factors. Co-efficients of plant protectionchemicalsand chemical fertilizers are positive but insignificant. The summation of elasticities measuring return to scale implies that value in close to unity (0.91) in case of valley region indicating nearly constant return to scale whereas in case of hill region, the elasticities value is 0.65 implying decreasing return to scale. Although, it is expected that an optimising farmer would operate within the range of diminishing returns to scale, but it occurs in agriculture due to managerial limitations. The limitations fall is the realm of proportionality when a single stock of management is limited in the sense that pure supervision becomes less exacting and co-ordination (true management or choice making) becomes less perfect when the knowledge of change and the future is uncertain, management must function continuously, therefore it does become a limiting factor in the production for a single firm (Heady, 1946). The estimated production function for rice cultivation in Imphal West districts of valley region and Churachandpur districts of hill region are represented as follows:

$\ln Y = 2.351^{**} - 0.075^{**} \ln X_1 - 0.193 \ln X_2 + 0.133^{**} \ln X_3 + 0.428^{***} \ln X_4 + 0.615^{*} \ln X_5$

and $\ln Y = 3.644 - 0.681 \ln X_1 + 0.05 \ln X_2 + 0.025 \ln X_3 + 0.869^{**} \ln X_4 + 0.385^{***} \ln X_5$

Table 1: Results of Cobb-Douglas production function of rice cultivation in Imphal West and Churachandpur district

Dependent variable: Rice production

Variables	District							
	Impahl West				Churachandpur			
	Coefficient	Std. Error	t-statistics	p-value	Coefficient	Std. Error	t-statistics	p-value
Intercept	2.351**	0.756	3.109	0.005	3.644 NS	2.049	1.779	0.119
Seed (X_1)	-0.075**	0.028	-2.637	0.014	-0.681 NS	0.365	-1.866	0.104
Chemical fertilizers (X_2)	-0.193 NS	0.254	-0.761	0.454	0.05 NS	0.036	1.381	0.21
Plant protection chemicals (X_3)	0.133**	0.06	2.204	0.037	0.025 NS	0.035	0.720	0.495
Machine labour (X_4)	0.428***	0.209	2.047	0.052	0.869**	0.351	2.474	0.043
Human labour (X_5)	0.615*	0.096	6.441	0.000	0.385***	0.189	2.036	0.081
R^2	**0.93**				**0.867**			
F	**64.139***				**9.141 ****			
Return to Scale (Σbi)	**0.908**				**0.648**			

*Note: *, **, *** and NS denote significant at 1, 5, 10 per cent probability level and non significant respectively*

In order to measure the economic efficiency of farmers belonging to each districts of the respective regions under study in utilising critical inputs in rice cultivation, the ratios of marginal value products (MVP) to their respective marginal factor cost (MFC) are estimated and presented in table 2. The ratios of seeds and chemical fertilizers are calculated to be -4.03 and -3.72 in case of farmers belonging to valley region implying overutilization of these inputs *i.e.* application of these factors may be reduced without disturbing output level or package of practices need to be modified to increase crop response. For plant protection chemicals, machine labour and human labour, the ratios are more than unity indicating under utilisation of these resources. The current level of application of these factors may be enhanced to increase production of rice in this region. The ratios of all these factors are more than unity except seeds in case of farmers belonging to Churachandpur districts of hill region implying under utilisation of inputs. The ratio of MVP to MFC for seed is worked out to be -25.20 indicating over utilisation of this critical input. So, the farmers have the opportunity of augmenting production of rice by increasing the application of chemical fertilizers, plant protection chemicals, machine labour and human labour, and decreasing the use of seed to optimise total revenue from rice cultivation. Summarily, in both region, farmers are over utilising seeds of rice but the extent of over utilization is greater in hill region compared to its counterpart in valley region which may be attributed to the system of farming adopted by the farmers of hill region i.e. *Jhumming*. To maintain optimum plant population, farmers apply higher seed rate to cover the risk of poor germination. Utilisation of chemical fertilizers is absolutely reverse from efficiency point of view. For other remaining factors of production, there is enough scope for increasing production of rice by raising application with varying magnitude in both regions.

Table 2: Estimates of measures of resource use efficiency of inputs used in rice cultivation in Imphal West and Churachandpur district

Variables	District									
	Impahl West					Churachandpur				
	MVP	MFC	MVP/MFC	Efficiency	% adjustment required	MVP	MFC	MVP/MFC	Efficiency	% adjustment required
Seed	-4.03	1	-4.03	Over Utilized	124.81	-25.20	1	-25.20	Over Utilized	103.97
Chemical fertilizers	-3.72	1	-3.72	Over Utilized	126.86	87.24	1	87.24	Under Utilized	98.85
Plant chemical protection	7.61	1	7.61	Under Utilized	86.85	1.19	1	1.19	Under Utilized	16.01
Machine labour	4.40	1	4.40	Under Utilized	77.29	4.25	1	4.25	Under Utilized	76.48
Human labour	1.74	1	1.74	Under Utilized	42.56	1.14	1	1.14	Under Utilized	12.38

All the critical inputs taken into consideration are underutilised by the farmers of hill region excepting seeds which is to be reduced to optimise production of rice in contrast to overutilization of chemical fertilizers and seeds and under utilization of plant chemical protection, machine labour and human labour in valley region. So, an increase in the application of critical inputs is urgently needed to uplift the yield of rice and thereby narrowing the difference in yield between two regions. It is crucial and critical to make an alternative arrangement for shifting cultivation by supporting and providing a sufficient working capital to ensure cultivators to adopt and use inputs effectively and efficiently. So, research for modification of prevailing rice cultivation system through incorporation of yield enhancing modern inputs along with identification of suitable rice varieties responsive to the techniques and extensive training programmes for dissemination of newly developed technology will be of great help in improving rice yield in hill regions of the state.

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