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Resource use and Technical Efficiency of Rice Production in Manipur

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Abstract

Rice is regarded as the first cultivated crop in Asia as well as important food crop of India. The cost and return structure and technical efficiency in rice production has been reported in different regions as well as in the state of Manipur to show different regions have adopted the latest technology. Primary data have been collected from the sample rice farms with the help of pre-tested scheduled through personal interview with respondent farmers. Technical efficiency of individual farms has been estimated through stochastic production function analysis. The total cost of cultivation on small farms was much higher than the large farms. Imputed rental value for owned land was the major cost items for all the farms. On an average majority (40%) of the rice growing farmers were operating at the technical efficiency level of (99-100)% in relation to frontier output level. Gross return as well as net return per hectare have been observed to be highest for category I followed by category II. Most of the farms have been observed to be potential to expand production and productivity, increasing technical efficiency as majority has been performing with increasing returns to scale.

Keywords: Cost and return, resource use efficiency, technical efficiency

Rice is the most important cereal food crop of India, and is cultivated in 43.81 million hectares (Singh and Singh, 2000). It plays a vital role in the national food grain supply and is the main driver of India's food security. Rice occupies about 23% of the gross cropped area in the country. It occupies 35% of the total area under food grains and contributes around 43% to the total food grain production in the country (Umashankara, 1998). The effect of technological breakthrough has been significant in almost all the states. However many agricultural scientists and farm experts have endorsed the view that the performance of agriculture is yet to reach its potential level. Rice is the only important food crop in respect of area, production and consumption in the state Manipur.

The paper has been drawn from M.Sc. thesis entitled "Resource use and Technical Efficiency of rice production in Manipur".

Table 1. Socio-economic indicators of sample rice growing farmers

Sl. No.	Particular	Farm category		
		Category I (≤ 0.25 ha.)	Category II (> 0.25 ha.)	Overall
1.	No. of farms	60	40	100
2.	Operational holdings (ha)	15	26	41
3.	Farm workers			
	a. Male	1.33 (57.14)	2.15 (54.37)	3.48 (50.38)
	b. Female (man equivalent)	1.00 (42.86)	1.81(45.63)	2.81 (49.62)
4.	Total worker	2.33(100)	3.90 (100)	6.29 (100)

Note: Figure in parentheses denotes the percentage to the total worker

In 2006-07, total area under rice crop is 165.37 thousand hectares and production 389.17 thousand tones, with the average productivity of 2353.33 kg/ha in the state (GoMa, 2007). Although, rice is cultivated both in hills and valley district of the state, its area and production is largely concentrated in the valley districts which is commonly known as "Rice bowl of Manipur". The hills and valley districts occupies about 52 and 60% of states' acreage and production respectively. Among the four valley districts in the state, Thoubal district has the highest rice acreage of about (32%) followed by Imphal East (28%), Imphal West (22%) and Bishnupur (18%) respectively (GoMb, 2007). Agriculture policy of the Government primarily aims to encourage sustainable increased in production of food-grains to attain self-sufficiency and food security in general and to improve socio-economic conditions of the farmers / rural people in particular. Increased in rice production can be achieved by expanding the acreage under rice and / or by increasing the productivity of the resources. It is observed that agricultural land in the state is found sinking during the last few years due to various factors viz. industrialization, expansion of roads, airfield, and construction of social institutions etc. Thus, acreage expansion in the state is constrained by the increasing population pressure. Hence, increasing productivity through either technological innovation or efficient use of resources remains as the only option for increasing rice production in the state. Yield of rice can be increased with the introduction and adoption of new technology. New technologies are designed to enhance farm output and income hence, use as a means of accelerating economic development. For a wide adoption by the farmers', the technology should be in consistent with topography, agro-climate conditions, irrigation facilities, agricultural infrastructures, credit facilities, availability of inputs, agricultural extension services etc. of the state, besides socio-economic conditions and educational levels of the farmers. The results of the technology should also be observable in the short run. Introduction of a new rice technology in a developing economy has found only partially successful in improving production efficiency because of lack of ability due to institutional and socio-economic constraints and / or willingness

to adjust input level due to familiarity with the existing technology. However, output growth may be achieved not only through technological innovation but also through the efficiency in which such technologies are used (Kibaara, 2005). Efficiency is the relative performance of the processes used in transferring the given inputs into outputs. Improvement in rice production efficiency by

Table 2. Cost of cultivation of rice for different categories of farms (Rs./ha)

Particulars		Farm Category					
		Category I		Category II		Overall	
A. Variable cost							
1.	Hired Human labor	18488	(25.34)	17488	(27.51)	18180	(26.37)
2.	Machine labor	8361	(11.46)	7229	(11.37)	7908	(11.47)
3.	Seed	2567	(3.51)	2514	(3.95)	2546	(3.69)
4.	Fertilizer	4741	(6.49)	3951	(6.21)	4425	(6.42)
5.	Plant protection chemical	1387	(1.90)	853	(1.34)	1174	(1.70)
6.	Interest on working capital	888.6	(1.21)	850.87	(1.33)	873.51	(1.26)
7.	Rental value for lease in land	0		0		0	
B. Fixed cost							
1.	Family labour	3725.6	(5.10)	2204.57	(3.46)	3117.66	(4.52)
2.	Depreciation	4584	(6.28)	2956	(4.65)	3533	(5.12)
3.	Land revenue	140	(0.19)	139.3	(0.21)	140	(0.20)
4.	Interest on fixed capital	337.98	(0.46)	172.03	(0.27)	271.62	(0.39)
5.	Imputed rental value of owned land	19500	(26.73)	18000	(28.32)	19000	(27.56)
6.	Managerial cost	4115.66	(5.64)	3598.21	(5.66)	3877.95	(5.62)
7.	Risk margins	4115.66		3598.21		3877.95	
	Cost A_1	41156.6		35982.17		38779.51	
	Cost A_2	41156.6		35982.17		38779.51	
	Cost B	60994.58		54154.20		58051.13	
	Cost C	64720.18		56358.77		61168.79	
	Cost D	72951.50		63555.21		68924.64	

Note: Figures in parentheses denote the percentage to the cost D.

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proper resource management within the existing technological framework to increase production hence, becomes an alternative viable solution to achieve self-sufficiency, food security and socio-economic development for the agrarian economy of the state. The resource use efficiency differs from region to region due to the variations in land, fertilizers, availability of resources, irrigation facilities, financial condition and extent of adopting agricultural practices. The inadequacy of capital and other resource inputs combined with their in-efficient use is being commonly reported to be the prime causes of low crop productivity under the given set of ecological, management and

Table 3: Cost of cultivation of rice for different categories of farms. (Rs./farm)

Particulars		Farm Category					
		Category I (= 0.25 ha)		Category II (> 0.25 ha)		Overall	
A. Variable cost							
1.	Hired Human labour	4622	(25.34)	4372	(27.51)	4545	(26.56)
2.	Machine labour	2090.19	(11.46)	1807.25	(11.37)	1977	(11.55)
3.	Seed	642	(3.52)	628.5	(3.95)	636.5	(3.72)
4.	Fertilizer	1185.25	(6.49)	987.75	(6.21)	1106.25	(6.46)
5.	Plant protection chemical	347	(1.90)	213.25	(1.34)	293.50	(1.71)
6.	Interest on working capital	222.15	(1.21)	212.72	(1.33)	218.37	(1.27)
7.	Rental value for lease in land	0		0		0	
B. Fixed cost							
1.	Family labour	931.40	(5.10)	551.14	(3.47)	779.42	(4.55)
2.	Depreciation	1146	(6.28)	739	(4.65)	883.25	(5.16)
3.	Land revenue	35	(0.19)	34.82	(0.21)	35	(0.20)
4.	Interest on fixed capital	84.49	(0.46)	43	(0.27)	67.9	(0.39)
5.	Imputed rental value of owned Land	4875	(26.73)	4500	(28.32)	4750	(27.76)
6.	Managerial cost	1028.91	(5.64)	899.55	(5.66)	969.48	(5.66)
7.	Risk margins	1028.91	(5.64)	899.55	(5.66)	969.48	(5.66)
	Cost A_1	10289.15		8995.54		9694.87	
	Cost A_2	10289.15		8995.54		9694.87	
	Cost B	15248.64		13538.55		14512.78	
	Cost C	16180.04		14089.69		15292.19	
	Cost D	18237.87		15888.80		17106.16	

Note: Figures in parentheses denote the per cent to the Cost D

technological conditions at a particular point of time. The consumption of rice is increasing at a rapid rate due to its high income elasticity of demand. So, an increase in production has to come from a breakthrough in productivity and increased efficiency. Efficiency is concerned with a relative performance of the processes used in transferring given inputs into outputs. The Governments goal of achieving self-sufficiency in rice production to a large extent will depend on the level of farmers' productivity which can be determined by their rates of adoption of improved technologies and efficiency of resource use.

Analysis and examination of resource use and production efficiency (technical efficiency) of rice using stochastic frontier production function model in the existing technological environment is of paramount importance to achieve the goals of sustainable production, self sufficiency, food security and overall development of rural economy (Sikander and Sandeep, 2004). Hence, research project entitled "Resource use and technical efficiency of rice production in Manipur" is proposed to be undertaken with the following objectives: (1) To examine cost and returns of rice production. (2) To analyze the resource use efficiency in rice production. (3) To determine technical efficiency in rice production. (4) To determine the production problems and solution in rice production.

Methodology

Rice is grown in all the 9 districts of the state, Manipur, however due to topographical nature of land; its cultivation is more concentrated in the valley region of the state. Perusal of district-wise distribution of rice acreage and production during 2007-08, observed that among the valley districts Imphal East district has highest production *i.e.,* 74.17 thousand tonnes followed by Imphal West district *i.e*., 67.99 thousand tonnes and Thoubal district *i.e.,*61.95 thousand tonnes (GoM, 2008). On the basis of higher yield and production of rice, Bishnupur and Imphal East districts were selected randomly for the study. With the help of officials of respective districts, blocks having highest acreage under rice has been identified for selection of blocks. Matai village of Imphal East district and Leimaram village of Bishnupur district are selected proportionately. From the prepared list by adopting proportionate allocation and simple random sampling technique the respondent farmers will be drawn using pre-tested schedule. A total of 100 farmers will be selected and categorized as category I (=0.25 hac) and category II (< 0.25 hac). Both the primary and secondary data were collected to meet the objectives of the study. The various cost concepts were used in working out cost of cultivation and returns of rice production. Cobb-Douglas type of production function is use for studying the relationship between output and input variables to estimate production elasticities in the study, because of its wide acceptability, theoretical fitness to agricultural data and simple in calculation. The model specified for the present study is furnished below:

$$y = b_0 x_i^{b_i} e^{u}$$

Where;

y = yield (kg / ha)

x_1 = seed (kg.)

x_2 = expenses on chemical fertilizer (Rs.)

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x_3 = expenses on plant protection chemicals (Rs.)

x_4 = human labour (Rs.)

x_5 = machine / bullock labour charges (Rs.)

b_0 = constant term

b_i = elasticity coefficients (i = 1, 2, 3, ……, 6)

e^u = error term

Table 4. Variable and fixed cost for different category of sampled farm. (Rs./ha.)

Particulars		Farm Category					
		Category I		Category II		Overall	
A. Variable cost							
1.	Hired Human labour	18488	(50.74)	17488	(53.17)	18180	(51.78)
2.	Machine labour	8361	(22.94)	7229	(21.98)	7908	(22.52)
3.	Seed	2567	(7.05)	2514	(7.64)	2546	(7.25)
4.	Fertilizer	4741	(13.01)	3951	(12.01)	4425	(12.60)
5.	Plant protection chemical	1387	(3.80)	853	(2.59)	1174	(3.34)
6.	Interest on working capital	888.6	(2.43)	850.87	(2.58)	873.51	(2.48)
7.	Rental value for lease in land	0		0		0	
Total variable cost		36432.6		32885.87		35106.51	
B. Fixed cost							
1.	Family labour	3725.6	(10.24)	2204.57	(7.18)	3117.66	(9.21)
2.	Depreciation	4584	(12.60)	2956	(9.63)	3533	(10.44)
3.	Land revenue	140	(0.38)	139.3	(0.45)	140	(0.41)
4.	Interest on fixed capital	337.98	(0.92)	172.03	(0.56)	271.62	(0.80)
5.	Imputed rental value of owned Land	19500	(53.60)	18000	(58.69)	19000	(56.18)
6.	Managerial cost	4115.66	(11.31)	3598.21	(11.73)	3877.95	(11.46)
7.	Risk margins	4115.66	(11.31)	3598.21	(11.73)	3877.95	(11.46)
Total fixed cost		36378.9		30668.32		33818.18	

Note: Figure in parentheses denotes the per cent to Cost D.

The estimated regression coefficients (b_i) was tested for their significance at the chosen level of probability using student t-test. And overall significance by using F test. Economic rationale of resource use on different categories of farms was examined by comparing marginal value product of a given resource with the marginal factor cost (allocative efficiency). For optimal use of an i^{th} resource the marginal value product of the ith factor/resource should equal to marginal factor cost of the i^{th} factor/ resource. The technical efficiency is defined as the ratio of the actual output produced to the potential

output produced from a given bundle of inputs when the farm operates on its production frontier. The maximum technical efficiency is achieved when the ratio equals to one (Neelappa, 2002).

Steps for measuring technical efficiency of output:

1. Setting of the production function say Cobb-Douglas production function

   $Y = b_0 \sum x_i^{bi}$

2. Transform the function, into linear function by taking natural logarithm

   $\ln y = \ln b_0 + \sum b_i \ln x_i$

3. Estimate the parameters using Ordinary Least Squares

   $\ln \hat{y} = \ln b_0 + \sum_{i=1}^{n} \widehat{b_i} \ln x_i$

4. Calculate specific individual error term ($\widehat{e_i}$) by subtracting estimated output ($\ln \widehat{y_i}$) from actual output ($\ln y_i$)

   $\widehat{e_i} = \ln y_i - \ln y_i$

5. Among the error terms, choose the largest positive error residual term (e_G) and added to the estimated intercept ($\ln b_0$) to make no residual is positive and one is zero. This correction of OLS estimates yields Frontier Production Function ($\ln \widehat{y_F}$).

   $\ln \widehat{y_F} = (\ln b_0 + \widehat{e_G}) + \sum_{i=1}^{n} \widehat{b_i} \ln x_i$

6. Technical Efficiency (TE) is calculated by subtracting frontier output from estimated output

   $TE_i = \ln \widehat{y_i} - \ln \widehat{y_i}$

   Where, $(\ln \widehat{y_i} - \ln \widehat{y_F}) < 1$ Or, $= TE_i \frac{\ln \hat{y_i}}{\ln \hat{y_F}}$ Where, $(\frac{\ln \hat{y_i}}{\ln \hat{y_F}}) < 1$

Steps for measuring technical efficiency of input:

1. The function $y = a_0 x_i^{b_i}$ after taking logarithm, it is transform to log linear production function.

   $$\ln y = \ln a_0 + b_1 \ln x_1 + b_2 \ln x_2 + \ldots\ldots\ldots\ldots\ldots + b_0 \ln x_0 + e$$

2. By using OLS (Ordinary Least Square) method, the parameters will be estimated and the estimated function

   $$\ln \hat{y} = \ln a_0 + \hat{b}_1 \ln x_1 + \hat{b}_2 \ln x_2 + \ldots\ldots\ldots\ldots + \hat{b}_n \ln x_2$$

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3. The errors will be calculated by subtracting the estimated function from the actual function as, ln y – ln

$$\ln \hat{y}_F = (\ln a_0 + E) + \hat{b}_1 \ln x_1 + \hat{b}_2 \ln x_2 + \ldots\ldots\ldots + \hat{b}_n \ln x_n$$

4. Addition of the largest positive error term (E) was done to yield frontier production function

$$\ln x_{i_F} = \left[\ln \hat{y}_F - (\ln \hat{a}_0 + E) - \hat{b}_i \left(\ln \frac{X_i}{X_1} + \ln \frac{X_i}{X_2} + \ldots\ldots + \ln \frac{X_i}{X_n} \right) \right] / \sum_{i=1}^{n} b_i$$

5. The frontier value of inputs is

6. Taking antilog of X_{i_F} will get frontier i^{th} value of input

Where, i = 1, 2, 3, 4, ..., n.

Technical efficiency (TE) $\frac{X_{iF}}{X_i}$ = Where, = Frontier value of the i^{th} input

X_i= Actual value of the i^{th} input

Table 5. Variable and fixed cost of rice cultivation for different category of sample farm

(₹/farm)

Particulars		Farm Category					
		Category I		Category II		Overall	
A. Variable cost							
1.	Hired Human labour	4622	(50.74)	4871.58	(55.33)	4721.54	(52.21)
2.	Machine labour	2090.19	(22.94)	1889.53	(21.46)	2066.95	(22.85)
3.	Seed	642	(7.04)	628.71	(7.14)	636.69	(7.04)
4.	Fertilizer	1185	(13.01)	987.58	(11.21)	1105.98	(12.22)
5.	Plant protection chemical	347	(3.80)	213.37	(2.42)	293.66	(3.24)
6.	Interest on working capital	222.15	(2.43)	212.71	(2.41)	218.36	(2.41)
7.	Rental value for lease in land	0		0		0	
Total variable cost		9108.34		8803.48		9043.18	
B. Fixed cost							
1.	Family labour	931.40	(10.20)	551.14	(7.83)	779.42	(9.66)
2.	Depreciation	1146	(12.55)	739	(10.50)	883.25	(10.95)
3.	Land revenue	35	(0.38)	34.82	(0.49)	35	(0.43)

4.	Interest on fixed capital	84.49	(0.92)	43.00	(0.61)	67.90	(0.84)
5.	Imputed rental value of owned Land	4875	(53.39)	4500	(63.99)	4750	(58.89)
6.	Managerial cost	1028.91	(11.26)	899.55	(12.79)	969.48	(12.02)
7.	Risk margins	1028.91	(11.26)	899.55	(12.79)	969.48	(12.02)
Total fixed cost		9129.71		7032.06		8064.53	

Note: Figure in parentheses denotes the per cent to Cost D.

Results and Discussions

From the above finding concluded that the total cost of cultivation (₹ 72951.50) on category I farms was higher than (₹ 63555.21) on category II farm in per hectare and in per farm basis it is higher (₹ 18237.87) on category I farm than (₹ 15888.80) on category II farms and the study also concluded that the gross income was higher in category I farms (₹ 89644.32) than the category II farms (₹ 74247.66) and the net income for the category I farm (₹ 12692.82) was higher than the category II farms (₹ 10692.45) in per hectare basis. Increasing use of inputs viz. fertilizer will bring more output to the sample farms. Therefore, the input fertilizers are the more efficient to the rice growing farmers of Manipur. The study also concluded that the regression coefficients for fertilizer was found to be 0.82 in category I farms, 0.79 in category II and 0.84 in overall farms. Chemical fertilizers were found to be positively significant on rice yield in category I, II and overall farms as (0.164), (0.321)and (0.199). Allocative efficient for the rice production reveals that fertilizer was under-utilized in the entire three categories. On an average majority (40%) of the rice growing farmers were operating at the technical efficiency level of 99-100% in relation to the frontier output level. Mean efficiency level for category II farmers was found to be 98.25% as compared to 98.62% of category I farmers.

Farm efficiency measures

Table 6. Return from rice farming for different category of sample farm

Measures Efficiency	Farm Category		
	Category I	Category II	Overall
1. Gross farm income	89644.32	74247.66	81342.96
2. Net farm income	12692.82	10692.45	12418.32
3. Farm business income	44487.72	33091.06	42563.45
4. Owned farm business income	44487.72	33091.06	42563.45
5. Family labour income	24649.74	20093.46	23291.83
6. Farm investment income	32530.80	28864.48	31689.94
7. Output/Input ratio over;			
(i) Total cost	1.22	1.16	1.18
(ii) Paid out cost	2.18	2.06	2.09

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Table 7. Return from rice farming for different category of sample farms (₹ / farm)

Efficiency measures	Farm category		
	Category I	Category II	Overall
1. Gross farm income	20410.08	17561.91	19035.74
2. Net farm income	2172.21	1673.11	1929.58
3. Farm business income	10120.93	8566.37	9340.86
4. Owned farm business income	10120.93	8566.37	9340.86
5. Family labour income	5161.44	4023.36	4522.96
6. Farm investment income	7131.70	6216.11	6747.48
7. Output/Input ratio			
(i) Total cost	1.12	1.10	1.11
(ii) Paid out cost	1.98	1.94	1.96

Table 8. Production function coefficients

Variables	Category I n = 60	Category II n = 40	Overall n = 100
Intercept	4.689*	7.710	3.930*
Seed (X_1)	0.167	-0.366	0.015
Chemical fertilizers (X_2)	0.164*	0.321*	0.199*
Plant protection chemicals (X_3)	0.394	0.020	0.017
Human labour (X_4)	0.173*	-0.328	-0.008
Machine labour (X_5)	-0.333	0.379*	0.307*
Σb_i	0.565	0.41	0.53
F	55.974	31.213	104.956
$\bar{R}^2$	0.823	0.795	0.840

Note: * significant at 1% probability level ** significant at 5% probability level

*** significant at 10% probability level

Resource use efficiency

Table 9. Marginal value productivity to factor cost ratio of rice of different categories of sample farms

Sl. No.	Particulars	Seed	Fertilizer	Plant protection chemicals	Human labour	Machine labour
1.	Category I	1.940**	2.060***	16.883*	0.556	2.366
2.	Category II	3.626	4.409*	1.302	0.913	2.848**
3.	Overall	-	2.591**	0.861	-	2.231

Note: * significant at 1% probability level ** significant at 5% probability level
*** significant at 10% probability level

Technical Efficiency

Table 10. Technical efficiency rating for different categories of rice sample farms

Technical Efficiency Rating (%)	Farm Category					
	Category I		Category II		Overall	
	No. of farms	%	No. of farms	%	No. of farms	%
91-92						
92-93					4	4
93-94					8	8
94-95					18	18
95-96					12	12
96-97	12	20	8	20	20	20
97-98			4	10	14	14
98-99	24	40	16	40	18	18
99-100	24	40	12	30	6	6
Total	**60**	**100**	**40**	**100**	**100**	**(100)**
Mean		98.62		98.25		**96.30**
Standard Deviation	**1.06**		1.18		1.91	

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Table 11. Production problems face by the rice growing farmer

Sl.No.	Problems	Percentage	Rank
1.	Poor quality of seed and cost of seeds are very high	90	I
2.	Poor credit facilities	82	II
3.	Attack of pest and disease	72	III
4.	Lack of technical guidance	68	IV
5.	Scarcity and untimely availability of seed	62	V
6.	Shortage and high price of fertilizer	58	VI
7.	Not available of desired brand of fertilizers	52	VII
8.	Skilled labour are not available in time and its increasing cost	40	VIII

Policy implication

Based on the findings of the constraints the following policy measures are suggested as means to increase the income from rice production in the study area:

- Increase availabilities will help in enhancing the cauliflower production. Effort should be made to strengthen the linkage between the financial institutions and the farmers to provide the strategy so that the farmer can come forward easily for financial assistant. Measures should be adopted to flow the credit (1) at minimum interest rate with greater incentive (2) minimizing the formalities in advancing the credit (3) adequate and reasonable terms. The existing cooperative bank should revive and encourage advancing short term loans for purchasing seed, fertilizer, plant protection chemical and other variable inputs. On the other hand, Agriculture Department in the respective district should link with the financial institutes for easy accessibility of credit to the farmers.
- High quality disease free seed could made the rice farming profitable. Availability of seed at reasonable price to the farmers should be ensure. Government need to take up certain measure to make timely availability of seed at subsidized rate. Plan should be taken up to establishment of large number of nursery farms within the district.
- Under – utilization of fertilizers in the entire three categories of farm were reported from the study. The constant used of these inputs will be beneficial in the rice farming. Government should take certain training programmes for the farmers to develop proper knowlege of farming and use of fertilizers, plant protection chemicals, machine labour etc.
- Inter farm category differences in farrm incomes of the selected rice grower pointed out the differences in the quantity and the use pattern of various resources by the rice growers. As a result, these farms differ in their resource use efficiency. It is thus become imperative to

strengthen the network for dissemination of technical know-how to the farmers, so that the optimum use of resources can be made. In this regard the study brought out the difference between the farm categories growing a particular crop and also between the farmers growing different crops. These are farmers who are operating at lower level of efficiency as against the realised production potential as depicted by the frontier outputs. Since a group of rice growers could achieved a higher level of technical efficiency, it needs to be analysed in detail as to what measures would push the output levels of the rest of farmers, even under the existing levels of resources and production technology.

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